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TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A SUBMISSION UNDER 35 U.S.C. 371

Attorney Docket No. ORCKIT-001-US		U.S. Application No. (if known, see 37 CFR 1.5)
International Application No. PCT/US2015/026869	International Filing Date 21 April 2015	Priority Date Claimed 22 April 2014

Title of Invention
A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS

First Named Inventor
BARSHESHET, Yossi

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information.

1. ☑ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). NOTE: The express request under 35 U.S.C. 371(f) will not be effective unless the requirements under 35 U.S.C. 371(c)(1), (2), and (4) for payment of the basic national fee, copy of the International Application and English translation thereof (if required), and the oath or declaration of the inventor(s) have been received.
2. ☐ A copy of the International Application (35 U.S.C. 371(c)(2)) is attached hereto (not required if the International Application was previously communicated by the International Bureau or was filed in the United States Receiving Office (RO/US)).
3. An English language translation of the International Application (35 U.S.C. 371(c)(2))
   a. ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
4. An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4))
   a. ☑ is attached.
   b. ☐ was previously filed in the international phase under PCT Rule 4.17(iv).

Items 5 to 8 below concern amendments made in the international phase.

PCT Article 19 and 34 amendments

5. ☐ Amendments to the claims under PCT Article 19 are attached (not required if communicated by the International Bureau) (35 U.S.C. 371(c)(3)).
6. ☐ English translation of the PCT Article 19 amendment is attached (35 U.S.C. 371(c)(3)).
7. ☐ English translation of annexes (Article 19 and/or 34 amendments only) of the International Preliminary Examination Report is attached (35 U.S.C. 371(c)(5)).

Cancellation of amendments made in the international phase

8a. ☐ Do not enter the amendment made in the international phase under PCT Article 19.

8b. ☐ Do not enter the amendment made in the international phase under PCT Article 34.

NOTE: A proper amendment made in English under Article 19 or 34 will be entered in the U.S. national phase application absent a clear instruction from applicant not to enter the amendment(s).

The following items 9 to 17 concern a document(s) or information included.

9. ☑ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
10. ☑ A preliminary amendment.
11. ☑ An Application Data Sheet under 37 CFR 1.76.
12. ☐ A substitute specification. NOTE: A substitute specification cannot include claims. See 37 CFR 1.125(b).
13. ☑ A power of attorney and/or change of address letter.
14. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13*ter*.3 and 37 CFR 1.821-1.825.
15. ☑ Assignment papers *(cover sheet and document(s))*. Name of Assignee: ORCKIT IP, LLC
16. ☐ 37 CFR 3.73(c) Statement *(when there is an Assignee)*.

U.S. APPLN. No. (if known – see 37 CFR 1.5)	INTERNATIONAL APPLICATION No.	ATTORNEY DOCKET No.
	PCT/US2015/026869	ORCKIT-001-US

17. ☑ Other items or information:

Declaration, PCT-Request, Four (4) PCT/IB/306 forms

The following fees have been submitted.	CALCULATIONS	PTO USE ONLY
18. ☑ Basic national fee (37 CFR 1.492(a)) ………… **$280**	$ 280	
19. ☑ Examination fee (37 CFR 1.492(c)) If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4) ………… **$0** All other situations ………… **$720**	$ 720	
20. ☑ Search fee (37 CFR 1.492(b)) If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4) ………… **$0** Search fee (37 CFR 1.445(a)(2)) has been paid on the international application to the USPTO as an International Searching Authority ………… **$120** International Search Report prepared by an ISA other than the US and provided to the Office or previously communicated to the US by the IB ………… **$480** All other situations ………… **$600**	$ 600	
TOTAL OF 18, 19, and 20 =	$ 1600	
☐ Additional fee for specification and drawings filed in paper over 100 sheets (excluding sequence listing in compliance with 37 CFR 1.821(c) or (e) in an electronic medium or computer program listing in an electronic medium) (37 CFR 1.492(j)). Fee for each additional 50 sheets of paper or fraction thereof ………… **$400**		

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26 - 100 =	/ 50 =		x **$400**	$	

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CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	54 - 20 =	34	x **$80**	$ 2720	
Independent claims	2 - 3 =		x **$420**	$	
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TOTAL OF ABOVE CALCULATIONS =	$ 4320	
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Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property. **+**	$ 40	
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Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File)Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013, and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.

NOTE 1: By providing this statement under 37 CFR 1.55 or 1.78, **this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA**.

NOTE 2: A U.S. national stage application may not claim priority to the international application of which it is the national phase. The filing date of a U.S. national stage application is the international filing date. See 35 U.S.C. 363.

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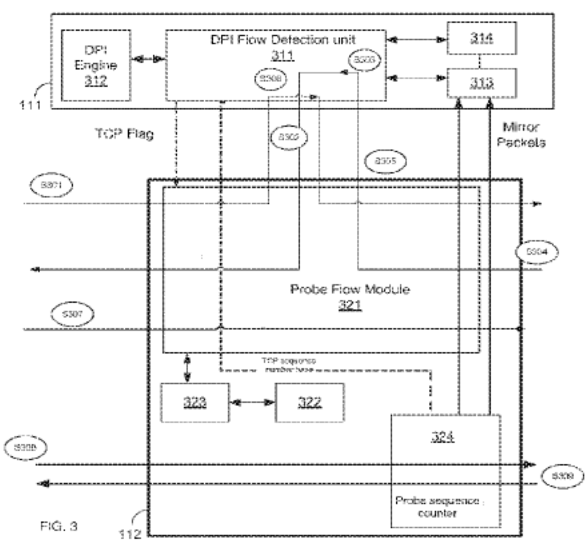

FIG. 3

(57) **Abstract**: A method for deep packet inspection (DPI) in a software defined network (SDN). The method includes configuring a plurality of network nodes operable in the SDN with at least one probe instruction; receiving from a network node a first packet of a flow, the first packet matches the at least one probe instruction and includes a first sequence number; receiving from a network node a second packet of the flow, the second packet matches the at least one probe instruction and includes a second sequence number, the second packet is a response of the first packet; computing a mask value respective of at least the first and second sequence numbers indicating which bytes to be mirrored from subsequent packets belonging to the same flow; generating at least one mirror instruction based on at least the mask value; and configuring the plurality of network nodes with at least one mirror instruction.

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A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS

CROSS REFERENCE TO RELATED APPLICATIONS

[001] This application claims the benefit of US provisional application No. 61/982,358 filed on April 22, 2014, the contents of which are herein incorporated by reference.

TECHNICAL FIELD

[002] This disclosure generally relates to techniques for deep packet inspection (DPI), and particularly for DPI of traffic in cloud-based networks utilizing software defined networks.

BACKGROUND

[003] Deep packet inspection (DPI) technology is a form of network packet scanning technique that allows specific data patterns to be extracted from a data communication channel. Extracted data patterns can then be used by various applications, such as security and data analytics applications. DPI currently performs across various networks, such as internal networks, Internet service providers (ISPs), and public networks provided to customers. Typically, the DPI is performed by dedicated engines installed in such networks.

[004] A software defined networking is a relatively new type of networking architecture that provides centralized management of network nodes rather than a distributed architecture utilized by conventional networks. The SDN is prompted by an ONF (open network foundation). The leading communication standard that currently defines communication between the central controller (e.g., a SDN controller) and the network nodes (e.g., vSwitches) is the OpenFlow™ standard.

[005] Specifically, in SDN-based architectures the data forwarding (e.g. data plane) is typically decoupled from control decisions (e.g. control plane), such as routing, resources, and other management functionalities. The decoupling may also allow the data plane and the control plane to operate on different hardware, in different runtime environments, and/or operate using different models. As such, in an SDN network, the

network intelligence is logically centralized in the central controller which configures, using OpenFlow protocol, network nodes and to control application data traffic flows.

[006] Although, the OpenFlow protocol allows addition of programmability to network nodes for the purpose of packets-processing operations under the control of the central controller, the OpenFlow does not support any mechanism to allow DPI of packets through the various networking layers as defined by the OSI model. Specifically, the current OpenFlow specification defines a mechanism to parse and extract only packet headers, in layer-2 through layer-4, from packets flowing via the network nodes. The OpenFlow specification does not define or suggest any mechanism to extract non-generic, uncommon, and/or arbitrary data patterns contained in layer-4 to layer 7 fields. In addition, the OpenFlow specification does not define or suggest any mechanism to inspect or to extract content from packets belonging to a specific flow or session. This is a major limitation as it would not require inspection of the packet for the purpose of identification of, for example, security threats detection.

[007] The straightforward approach of routing all traffic from network nodes to the central controller introduces some significant drawbacks, such as increased end-to-end traffic delays between the client and the server; overflowing the controller capability to perform other networking functions; and a single point of failure for the re-routed traffic.

[008] Therefore, it would be advantageous to provide a solution that overcomes the deficiencies noted above and allow efficient DPI in SDNs.

SUMMARY

[009] A summary of several example embodiments of the disclosure follows. This summary is provided for the convenience of the reader to provide a basic understanding of such embodiments and does not wholly define the breadth of the disclosure. This summary is not an extensive overview of all contemplated embodiments, and is intended to neither identify key or critical nodes of all aspects nor delineate the scope of any or all embodiments. Its sole purpose is to present some concepts of one or more embodiments in a simplified form as a prelude to the more detailed description that is presented later. For convenience, the term some embodiments may be used herein to refer to a single embodiment or multiple embodiments of the disclosure.

[0010] Certain embodiments disclosed herein include a method for deep packet inspection (DPI) in a software defined network (SDN), wherein the method is performed by a central controller of the SDN. The method comprises: configuring a plurality of network nodes operable in the SDN with at least one probe instruction; receiving from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first sequence number; receiving from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second sequence number, wherein the second packet is a response of the first packet; computing a mask value respective of at least the first and second sequence numbers, wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected; generating at least one mirror instruction based on at least the mask value; and configuring the plurality of network nodes with at least one mirror instruction.

[0011] Certain embodiments disclosed herein include a system for deep packet inspection (DPI) in a software defined network (SDN), wherein the method is performed by a central controller of the SDN. The system comprises: a processor; a memory connected to the processor and configured to contain a plurality of instructions that when executed by the processor configure the system to: set a plurality of network nodes operable in the SDN with at least one probe instruction; receive from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first sequence number; receive from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second sequence number, wherein the second packet is a response of the first packet; compute a mask value respective of at least the first and second sequence numbers, wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected; generate at least one mirror instruction based on at least the mask value; and configure the plurality of network nodes with at least one mirror instruction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The subject matter disclosed herein is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other objects, features, and advantages of the invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings.

[0013] Figure 1 is a schematic diagram of a network system utilized to describe the various disclosed embodiments.

[0014] Figure 2 illustrates is a schematic diagram of a flow table stored in a central controller.

[0015] Figure 3 is a schematic diagram of a system utilized for describing the process of flow detection as performed by a central controller and a network node according to one embodiment.

[0016] Figure 4 is a schematic diagram of a system utilized for describing the process of flow termination as performed by a central controller and a network node according to one embodiment.

[0017] Figure 5 is a data structure depicting the organization of flows according to one embodiment.

[0018] Figure 6 is flowchart illustrating the operation of the central controller according to one embodiment.

DETAILED DESCRIPTION

[0019] It is important to note that the embodiments disclosed herein are only examples of the many advantageous uses of the innovative teachings herein. In general, statements made in the specification of the present application do not necessarily limit any of the various claimed embodiments. Moreover, some statements may apply to some inventive features but not to others. In general, unless otherwise indicated, singular nodes may be in plural and vice versa with no loss of generality. In the drawings, like numerals refer to like parts through several views.

[0020] Fig. 1 is an exemplary and non-limiting diagram of a network system 100 utilized to describe the various disclosed embodiments. The network system 100 includes a software defined network (SDN) 110 (not shown) containing a central controller 111 and a plurality of network nodes 112. The network nodes 112 communicate with the central

controller 111 using, for example, an OpenFlow protocol. The central controller 111 can configure the network nodes 112 to perform certain data path operations. The SDN 110 can be implemented in wide area networks (WANs), local area networks (LANs), the Internet, metropolitan area networks (MANs), ISP backbones, datacenters, inter-datacenter networks, and the like. Each network node 112 in the SDN may be a router, a switch, a bridge, and so on.

[0021] The central controller 111 provides inspected data (such as application metadata) to a plurality of application servers (collectively referred to as application servers 120, merely for simplicity purposes). An application server 120 executes, for example, security applications (e.g., Firewall, intrusion detection, etc.), data analytic applications, and so on.

[0022] In the exemplary network system 100, a plurality of client devices (collectively referred to as client devices 130, merely for simplicity purposes) communicate with a plurality of destination servers (collectively referred to as destination servers 140, merely for simplicity purposes) connected over the network 110. A client device 130 may be, for example, a smart phone, a tablet computer, a personal computer, a laptop computer, a wearable computing device, and the like. The destination servers 140 are accessed by the devices 130 and may be, for example, web servers.

[0023] According to some embodiments, the central controller 111 is configured to perform deep packet inspection on designated packets from designated flows or TCP sessions. To this end, the central controller 111 is further configured to instruct each of the network nodes 112 which of the packets and/or sessions should be directed to the controller 111 for packet inspections.

[0024] According to some embodiments, each network node 112 is configured to determine if an incoming packet requires inspection or not. The determination is performed based on a set of instructions provided by the controller 111. A packet that requires inspection is either redirected to the controller 111 or mirrored and a copy thereof is sent to the controller 111. It should be noted that traffic flows that are inspected are not affected by the operation of the network node 112. In an embodiment, each network node 112 is configured to extract and send only a portion of a packet data that contains meaningful information.

[0025] The set of instructions that the controller 111 configures each of the network nodes 112 with include “probe instructions”, “mirroring instructions”, and “termination instructions.” According to some exemplary and non-limiting embodiments, the probe instructions include:

If (TCP FLAG SYN=1) then (re-direct packet to central controller);
If (TCP FLAG SYN=1 and ACK=1) then (re-direct packet to central controller); and
If (TCP FLAG ACK=1) then (forward packet directly to a destination server).

The termination instructions include:

If (TCP FLAG FIN=1) then (re-direct packet to controller);
If (TCP FLAG FIN=1 and ACK=1) then (re-direct packet to controller); and
If (TCP FLAG RST=1) then (re-direct packet to controller).

[0026] The TCP FLAG SYN, TCP FLAG ACK, TCP FLAG FIN, TCP FLAG RST are fields in a TCP packet’s header that can be analyzed by the network nodes 112. That is, each node 112 is configured to receive an incoming packet (either a request from a client device 130 or response for a server 140), analyze the packet’s header, and perform the action (redirect the packet to controller 111 or send to destination server 140) respective of the value of the TCP flag.

[0027] The controller 111 also configures each of the network nodes 112 with mirroring instructions with a mirror action of X number of bytes within a packet. The mirrored bytes are sent to the controller 111 to perform the DPI analysis. According to some exemplary embodiments, the set of mirroring instructions have the following format:

If (source IP Address = V1 and destination IP Address = V2 and source TCP port = V3 and destination IP address = V4 and TCP sequence = V5 and TCP sequence mask = V6) then (mirror V7 bytes)

[0028] The values V1 through V7 are determined by the controller 111 per network node or for all nodes 112. The values of the TCP sequence, and TCP sequence mask are computed, by the controller 111, as discussed in detail below.

[0029] In another embodiment, in order to allow analysis of TCP packets' headers by a network node 112 and tracks flows, new type-length-value (TLV) structures are provided. The TLV structures may be applied to be utilized by an OpenFlow protocol standard as defined, for example, in the OpenFlow 1.3.3 specification published by the Open Flow Foundation on September 27, 2013 or OpenFlow 1.4.0 specification published on October 14, 2013, for parsing and identifying any arbitrary fields within a packet. According to non-limiting and exemplary embodiments, the TLV structures disclosed herein include:

1. TCP_FLG_OXM_HEADER (0x80FE, 2, 1). This TVL structure allows identification of the TCP header flags. The '0x80FE' value represents a unique vendor identification (ID), the value '2' represents a unique Type=2 value for the TLV, and the '1' value is 1-byte total length that stores the TCP flags header.
2. TCP_SEQ_OXM_HEADER (0x80FE, 1, 4) - This TLV structure allows identification of the TCP sequence number field. The '0x80FE' value represents a unique vendor ID, the value '1' represents a unique Type=1 value for this TLV, and the value '4' is a 4-byte total length that stores the TCP sequence number.

[0030] In order to track the flows, the central controller 111 also maintains a flow table having a structure 200 as illustrated in the exemplary and non-limiting Fig. 2. The flow table 200 contains two main fields KEY 210 and DATA 220. The KEY field 210 holds information with respect to the addresses/port numbers of a client device 130 and a destination server 140. The DATA field 220 contains information with respect to a TCP flow, such as a flow ID, a request (client to server) sequence number M, a response (server to client) sequence number N, a flow state (e.g., ACK, FIN), a creation timestamp, a client to server hit counter, server to client hit counter Y [bytes], client to server data buffer, server to client buffer, and an aging bit.

[0031] Fig. 3 shows an exemplary and non-limiting schematic diagram of a system 300 for describing the process of flow detection as performed by the central controller 111 and a network node 112 according to one embodiment. In an exemplary implementation, the central controller 111 includes a DPI flow detection module 311, a DPI engine 312, and a memory 313, and a processing unit 314. The DPI engine 312 in configured to inspect a packet or a number of bytes to provide application metadata as required by an application executed by an application server 120.

[0032] According to various embodiments discussed in detail above, the DPI flow detection module 311 is configured to detect all TCP flows and maintain them in the flow table (e.g., table 200). The module 311 is also configured to generate and provide the network logs with the required instructions to monitor, redirect, and mirror packets. The DPI flow detection module 311 executes certain functions including, but not limited to, flow management, computing sequence masks, and TCP flow analysis. These functions are discussed in detail below.

[0033] In exemplary implementation, the network node 112 includes a probe flow module 321, a memory 322, and a processing unit 323. The probe flow module 321 is configured to redirect any new TCP connection state initiation packets to the DPI flow detection module 311, as well as to extract several packets from each detected TCP flow and mirror them to the flow detection module 311. In an embodiment, probe flow module 321 executes functions and/or implements logic to intercept TCP flags, redirect packets, and count sequence numbers.

[0034] Both processing units 314 and 323 uses instructions stored in the memories 313 and 322 respectively to execute tasks generally performed by the central controllers of SDN as well as to control and enable the operation of behavioral network intelligence processes disclosed herewith. In an embodiment, the processing unit (314, 323) may include one or more processors. The one or more processors may be implemented with any combination of general-purpose microprocessors, multi-core processors, microcontrollers, digital signal processors (DSPs), field programmable gate array (FPGAs), programmable logic devices (PLDs), controllers, state machines, gated logic, discrete hardware components, dedicated hardware finite state machines, or any other suitable entities that can perform calculations or other manipulations of information. The

memories 313 and 322 may be implemented using any form of a non-transitory computer readable medium.

[0035] Prior to performing the flow detection process the network node 112 is set with the probe instructions, such as those discussed above. Referring to Fig. 3, at S301, a packet arrives from a client (e.g., client 130, Fig. 1) at a port (not shown) at the network node 112. The packet is a TCP packet with a header including the following value [TCP FLAG SYN=1, SEQUENCE = M].

[0036] As the header' value matches a redirect action, at S302, the probe flow module 321 redirects the packet to the controller 111, and in particular to the module 311.

[0037] In response, at S303, the module 311 traps the packet and creates a new flow-id in the flow table (e.g., table 200) and marks the flow-id's state as 'SYN'. The flow table is saved in the memory 313. The initial sequence from the client to a destination server number equals M and saved in the flow table as well. Then, the packet is sent to the node 112 for further processing.

[0038] At S304, a response packet arrives from a destination server (e.g., server 140, Fig. 1) with header value [TCP FLAG SYN=1, TCP FLAG ACK=1, SEQUENCE = N]. The response is received at the node's 112 port. At S305, as the header's value matches a probe instruction, the response packet is sent to the module 311 in the controller 111.

[0039] In response, the module 311 traps the packet and searches for a pre-allocated corresponding flow-id in the flow table and updates the respective state as 'SYN/ACK'. The module 311 also stores the initial sequence number of a packet from the server to client as equals to N. This will create a new bi-directional flow-id with M and N sequence numbers identified and the sequence mask logic can be calculated respective thereof.

[0040] According to various embodiments, the DPI flow detection module 311 implements or executes a sequence mask logic that computes a mask for the initial trapped sequence numbers (M and N) to be used for a new flow to be configured into the node 112. Specifically, the computed mask is used to define new mirroring instructions to allow mirroring of a number of bytes from the TCP session in both directions. The computed mask value specifies which bytes respective of the correct sequence number would be required to mirror from the TCP session. In an embodiment, the computed value is placed in a mask filed defined by the OpenFlow protocol.

[0041] The following steps are taken to extract the computed mask value: Compute a temporary mask value (temp_mask_val) as follows:

temp_mask_val = M XOR (M+ TCP_DATA_SIZE_DPI);

The value TCP_DATA_SIZE_DPI specifies the number of bytes the node 112 would be required to mirror from the TCP session. In an embodiment, a different value of the TCP_DATA_SIZE_DPI may be set for the upstream and downstream traffic. For example, for an upstream traffic fewer bytes may be mirrored than the downstream traffic, thus the TCP_DATA_SIZE_DPI value for upstream traffic would be smaller than a downstream traffic. The temp_mask_val returns a number where the most significant bit (MSB) set to one indicates the first bit of the mask. Then a sequence MSB is computed as follows:

seq_msb = (int32_t)msb32(temp_Mask_val);

The 'msb32' function returns the MSB place of temp_mask_val. Finally, the mask value is computed as follows:

mask = (int32_t)(0 - ((0x1 << seq_msb))).

[0042] As an example, if the sequence number M is M=0xf46d5c34, and TCP_DATA_SIZE_DPI = 16384, then:

temp_mask_val = 0xf46d5c34 XOR (0xf46d5c34 + 16384) = 0xc000
seq_msb = (int32_t)msb32(0xf46d9c34) = 16
mask = (int32_t)(0 - (0x1 << 16)) = 0xFFFF8000

[0043] The mask is defined such that a '0' in a given bit position indicates a "don't care" match for the same bit in the corresponding field, whereas a '1' means match the bit exactly. In above example, all data packets containing sequence number in the range of {0xf46d5c34 to 0xf46d9c34} be mirrored to the controller 111.

[0044] Using the computed mask value, the module 311 using a TCP flow analysis logic (not shown) creates the mirroring instructions related to the client and server traffic. One instruction identifies the client to server flow traffic, including the OXM_OF__TCP_SEQ to identify the initial sequence number of the flow with the mask_M computed. The action of the flow is to mirror all packets that the instruction applies, which will result in the TCP_DATA_SIZE_DPI number of bytes from the client to server direction to be mirrored to the controller 111. The second instruction identifies the server-to-client flow traffic, including the OXM_OF_TCP_SEQ to identify the initial sequence number of the flow with the mask_N. The action is to mirror all packets that the instruction applies to, which will result in the TCP_DATA_SIZE_DPI number of byte from the server to client direction to be mirrored to the controller 111 for further analysis. The mask_N and mask_M are computed using the sequence numbers N and M< respectively using the process discussed above. As a non-limiting example, the mirroring instructions includes:

Match							result	
Source IP address	destination IP address	source TCP port	destination TCP port	IP protocol number	TCP sequence	TCP sequence mask	action	Count byte
192.1.1.1	209.1.4.4	15431	21	6	0xf46d5c34	0xFFFF8000	Mirror	X
209.1.4.4	192.1.1.1	21	15431	6	0x3c98b9ab	0xFFFF8000	Mirror	Y

[0045] Referring back to Fig. 3, at S306, in the module 311 the processed packet is sent back to the node 112 for further processing. In an embodiment, a set of mirroring instructions generated respective of the computed mask value are sent to the node 112. At S307, a response TCP ACK packet with [TCP FLAG ACK=1] is received at a port of the node 112 and, based on the respective probe instruction, the packet is switched directly to the destination server 140.

[0046] In an embodiment, an audit mechanism scans the flow table every predefined time interval from the last timestamp and deletes all flows from the state is not SYN/ACK. Furthermore, an aging mechanism deletes all entries wherein their aging bit equal = 1. The aging bit is initialized to 0 upon flow creation of a flow-id entry and is set to 1 in the first audit pass if buffer length is 0. When a flow-id is deleted from the flow table, the flow-id also removed from the tables maintained by the probe sequence counter 324.

[0047] At S308 and S309, packets arrive from either the client device or a destination server with their sequence number that matches the mirroring instructions and are mirrored to the central controller 111 for buffering and for analysis by the DPI engine 312. It should be noted that each instruction hit increments a counter Client-to-Server hit counter X [bytes] and Server-to-Client hit counter Y [bytes]. The flow table audit mechanism scans the flow table, every predefined time interval, and updates the mask to 0x00000000 and the ACTION to "no Action" of all entries that their Client-to-Server buffer length = TCP_DATA_SIZE_DPI or Server-to-Client buffer length = TCP_DATA_SIZE_DPI. The various fields of the flow table are shown in Fig. 2.

[0048] Fig. 4 show an exemplary and non-limiting diagram of a system 400 for describing the process of flow termination as performed by the central controller 111 and a network node 112 according to one embodiment. The various module of the controller 111 and node 112 are discussed with reference to Fig. 3.

[0049] In the flow termination process, the module 311 follows a termination of a TCP flow and is responsible to remove the exiting flow from the flow table. In addition, the module 311 disables or removes the mirroring instructions from the node 112. According to one embodiment, the module 311 configures the node 112 with a set of termination instructions. Examples for such instructions are provided above.

[0050] At S401, a packet arrives, at the node 112, from a client 130 with a header including the value of [TCP FLAG FIN=1]. The value matches one of the termination instructions, thus, at S402, to the packet is sent to the center controller 111.

[0051] In response, at S403, the module 311 traps the packet and marks the corresponding flow-id in the flow table to update the state to FIN. Then, the packet is sent back it to the network log.

[0052] At S404, a response packet from the destination server (e.g., server 140) with a header's value containing [TCP FLAG FIN=1, ACK=1] is received at the node 112. As the value matches one of the termination instructions, at S405, to the packet is sent to the center controller 111.

[0053] At S406, the module 311 traps the received packet and marks the corresponding FLOW-ID in its flow table DB as state=FIN/FIN/ACK. Then, the packet is sent back to the network node 112. At S407, a response TCP ACK packet arrives from a

client 130 with a header's value containing [TCP FLAG ACK=1] and is switched directly to the server 140. If the response packet includes the header's value of [TCP FLAG RST=1], the module 311 marks the state of respective flow id in the flow table.

[0054] In an embodiment, the audit mechanism implemented by the module 311 scans the flow table every predefined time interval to all flows that their respective state is any one of FIN, FIN/ACK, FIN/FIN/ACK, or RST. The flows are removed from the probe flow module 321 and the flow table.

[0055] According to one embodiment, each network node 112 is populated with one or more probe tables generated by the central controller 111. Fig. 5 shows a non-limiting and exemplary data structure 500 depicting the organization of the flows to allow functionality of both the probe flow detection module 321 and probe sequence counter 324.

[0056] The data structure 500 which may be in a form of a table is updated with a general instruction to match all traffic type with instruction 501 to go to a probe table 510. The instruction 501 is set to the highest priority, unless the controller 111 requires pre-processing of other instructions. All packets matching the instruction 500 are processed in the probe table 510.

[0057] In an embodiment, the probe table 510 is populated with a medium priority probe and termination instructions 511 to detect all SYN, SYN/ACK, FIN, FIN/ACK that are the TCP connection initiation packets. The instructions 511 allows the module 311 to update the flow table and as a consequence create new instructions for mirroring N bytes from each TCP connection setup.

[0058] The probe table 510 table is also populated with highest priority instructions 512, these are two bi-direction instructions per flow-id that match a number 'r' tupple flow headers including the TCP sequence number as calculated by the sequence mask logic. The instructions 512 are to send the packet to the central controller 111 and also to perform go to table ID <next table ID>. The instructions 512 will cause sending the packet to continue switching processing. Each of these bi-directional instructions 512 will cause the node to copy several bytes from the TCP stream to the TCP flow analysis logic to be stored for further DPI engine metadata analysis.

[0059] The final instruction 513 placed in the probe table 510 is in the lowest priority to catch all and proceed with the switch functionality. All traffic which does not correspond to the TCP initiation packets, nor a specific detected flow and the corresponding TCP sequence number shall continue regular processing.

[0060] Fig. 6 shows an exemplary and non-limiting flowchart 600 illustrating the operation of the central controller 111 according to one embodiment. At S610, all network nodes 112 are configured with a set of probe instructions utilized to instruct each node 112 to redirect a TCP packet having at least a flag value as designated in each probe instruction. Examples for probe instructions are provided above.

[0061] At S620, a first TCP packet with at least one TCP FLAG SYN value equal to 1 is received. This packet may have a sequence number M and may be sent from a client device 130. At S630, a second TCP packet with at least one TCP FLAG ACK value equal to 1 is received. This packet may have a sequence number N and may be sent from a destination server 140 in response to the first TCP packet. In an embodiment, the flow table is updated with the respective flow ID and the state of the first and second packets.

[0062] At S640, using at least the sequence numbers of the first and second packets a mask value is computed. The mask value is utilized to determine which bytes from the flow respective of the sequence numbers N and M should be mirrored by the nodes. An embodiment for computing the mask value is provided above.

[0063] At S650, a set of mirroring instructions are generated using the mirror value and sent to the network nodes. Each such instruction defines the packets (designed at least by a specific source/destination IP addresses, and TCP sequences), the number of bytes, and the bytes that should be mirrored. At S660, the received mirror bytes are inspected using a DPI engine in the controller 111. In addition, the flow table is updated with the number of the received mirror bytes.

[0064] In S670, it is checked if the inspection session should be terminated. The decision is based on the FIN and/or RST values of the TCP FLAG. As noted above, packets with TCP FLAG FIN=1 or TCP FLAG RST=1 are directed to the controller respective of the set of termination instructions. Some examples for the termination instructions are provided above. If S670, results with No answer execution returns to S660; otherwise, execution continues with S680. At S680, related exiting flows from the

flow table are removed. In addition, the nodes 112 are instructed not to perform the mirroring instructions provided at S650.

[0065] The various embodiments disclosed herein can be implemented as hardware, firmware, software, or any combination thereof. Moreover, the software is preferably implemented as an application program tangibly embodied on a program storage unit or computer readable medium consisting of parts, or of certain devices and/or a combination of devices. The application program may be uploaded to, and executed by, a machine comprising any suitable architecture. Preferably, the machine is implemented on a computer platform having hardware such as one or more central processing units ("CPUs"), a memory, and input/output interfaces. The computer platform may also include an operating system and microinstruction code. The various processes and functions described herein may be either part of the microinstruction code or part of the application program, or any combination thereof, which may be executed by a CPU, whether or not such a computer or processor is explicitly shown. In addition, various other peripheral units may be connected to the computer platform such as an additional data storage unit and a printing unit. Furthermore, a non-transitory computer readable medium is any computer readable medium except for a transitory propagating signal.

[0066] All examples and conditional language recited herein are intended for pedagogical purposes to aid the reader in understanding the principles of the disclosed embodiments and the concepts contributed by the inventor to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions. Moreover, all statements herein reciting principles, aspects, and embodiments of the invention, as well as specific examples thereof, are intended to encompass both structural and functional equivalents thereof. Additionally, it is intended that such equivalents include both currently known equivalents as well as equivalents developed in the future, i.e., any nodes developed that perform the same function, regardless of structure.

CLAIMS

What is claimed is:

1. A method for deep packet inspection (DPI) in a software defined network (SDN), wherein the method is performed by a central controller of the SDN, comprising:

configuring a plurality of network nodes operable in the SDN with at least one probe instruction;

receiving from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first sequence number;

receiving from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second sequence number, wherein the second packet is a response of the first packet;

computing a mask value respective of at least the first and second sequence numbers, wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected;

generating at least one mirror instruction based on at least the mask value; and

configuring the plurality of network nodes with at least one mirror instruction.

2. The method of claim 1, further comprising:

receiving mirrored bytes from a network node respective of the at least one mirror instruction; and

inspecting the mirrored bytes using a DPI engine.

3. The method of claim 1, further comprising:

maintaining a flow table listing each flow inspected by the central controller; and

updating a status field in the flow table upon reception of any one of: the first packet, the second packet, and the mirrored bytes.

4. The method of claim 3, further comprising:

configuring the plurality of network nodes with at least one termination instruction;

removing all entries from the flow table for each flow matching the at least one termination instruction; and

disabling the at least one mirror instruction for each flow matching the at least one termination instruction.

5. The method of claim 1, wherein the at least one probe instruction is any one of:

if (TCP FLAG SYN=1) then (re-direct packet to the central controller) and if (TCP FLAG SYN=1 and ACK=1) then (re-direct packet to central controller).

6. The method of claim 1, wherein the least one mirror action is at least: if (source IP Address = V1 and destination IP Address = V2 and source TCP port = V3 and destination IP address = V4 and TCP sequence = V5 and TCP sequence mask = V6) then (mirror V7 bytes).

7. The method of claim 4, wherein the at least one termination instruction is any one of: if (TCP FLAG FIN=1) then (re-direct packet to controller); if (TCP FLAG FIN=1 and ACK=1) then (re-direct packet to controller); and if (TCP FLAG RST=1) then (re-direct packet to controller).

8. The method of claim 1, wherein a number of bytes mirrored from each packet is a portion of the packet, wherein the bytes are mirrored from packets in sequence.

9. The method of claim 1, wherein the communication between central controller and the plurality of network nodes is performed using the OpenFlow standard.

10. A non-transitory computer readable medium having stored thereon instructions for causing one or more processing units to execute the computerized method according to claim 1.

11. A system for deep packet inspection (DPI) in a software defined network (SDN), wherein the method is performed by a central controller of the SDN, comprising:

a processor;

a memory connected to the processor and configured to contain a plurality of instructions that when executed by the processor configure the system to:

set a plurality of network nodes operable in the SDN with at least one probe instruction;

receive from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first sequence number;

receive from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second sequence number, wherein the second packet is a response of the first packet;

compute a mask value respective of at least the first and second sequence numbers, wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected;

generate at least one mirror instruction based on at least the mask value; and

configure the plurality of network nodes with at least one mirror instruction.

12. The system of claim 11, wherein the system is further configured to:

receive mirrored bytes from a network node respective of the at least one mirror instruction; and

inspect the mirrored bytes using a DPI engine.

13. The system of claim 11, wherein the system is further configured to:

maintain a flow table listing each flow inspected by the central controller; and

update a status field in the flow table upon reception of any one of: the first packet, the second packet, and the mirrored bytes.

14. The system of claim 13, wherein the system is further configured to:

configure the plurality of network nodes with at least one termination instruction;

remove all entries from the flow table for each flow matching the at least one termination instruction; and

disable the at least one mirror instruction for each flow matching the at least one termination instruction.

15. The system of claim 11, wherein the at least one probe instruction is any one of:

if (TCP FLAG SYN=1) then (re-direct packet to the central controller) and if (TCP FLAG SYN=1 and ACK=1) then (re-direct packet to central controller).

16. The system of claim 11, wherein the least one mirror action is at least: if (source IP Address = V1 and destination IP Address = V2 and source TCP port = V3 and destination IP address = V4 and TCP sequence = V5 and TCP sequence mask = V6) then (mirror V7 bytes).

17. The system of claim 14, wherein the at least one termination instruction is any one of: if (TCP FLAG FIN=1) then (re-direct packet to controller); if (TCP FLAG FIN=1 and ACK=1) then (re-direct packet to controller); and if (TCP FLAG RST=1) then (re-direct packet to controller).

18. The system of claim 11, wherein a number of bytes mirrored from each packet is a portion of the packet, wherein the bytes are mirrored from packets in sequence.

19. The system of claim 11, wherein the communication between central controller and the plurality of network node is performed using the OpenFlow standard

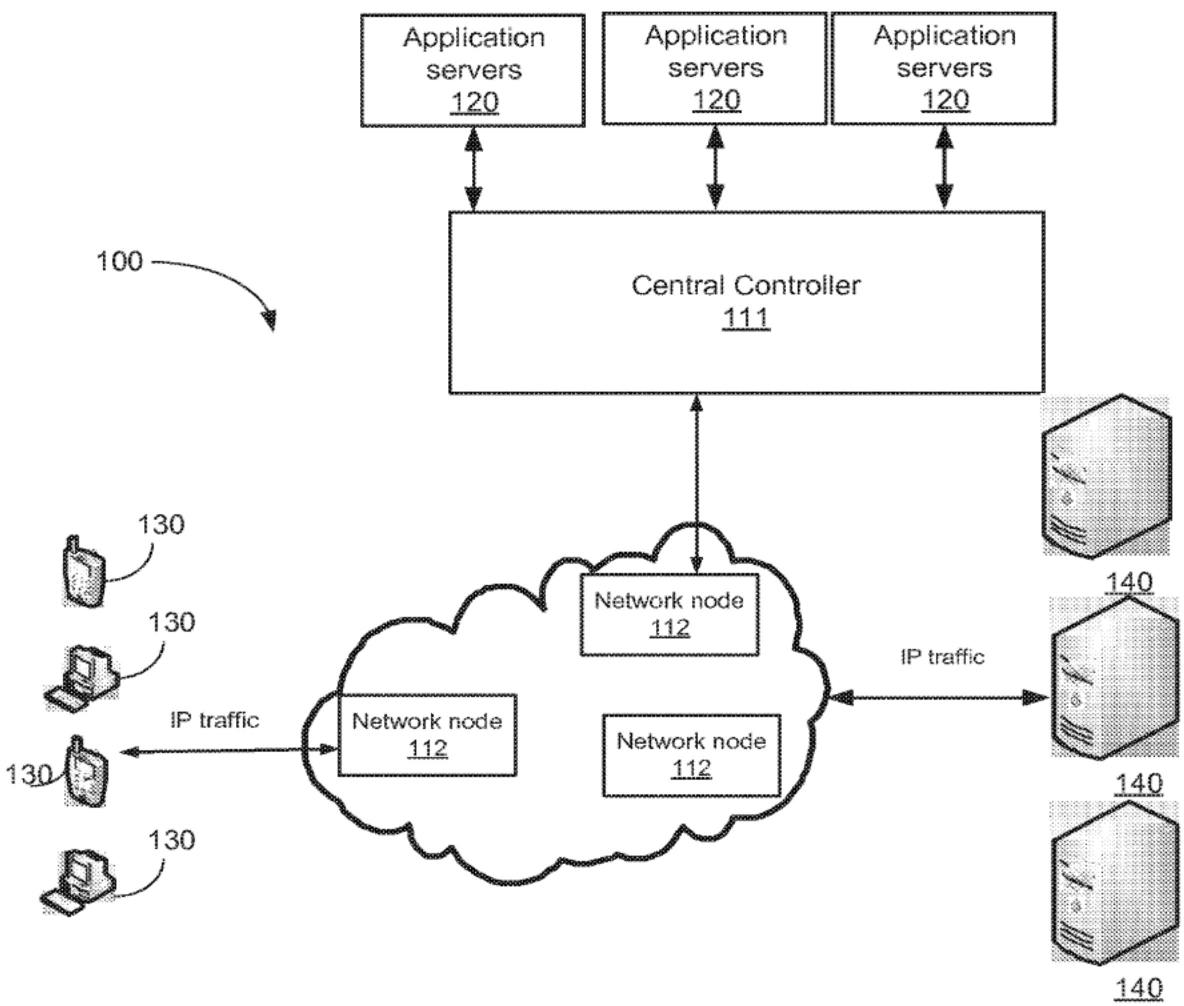

Application servers 120
Application servers 120
Application servers 120
100
Central Controller 111
130
130
130
130
Network node 112
Network node 112
Network node 112
IP traffic
IP traffic
140
140
140

FIG. 1

200

KEY **210**					DATA **220**										
Client IP address	Server IP address	Client source TCP port	Server destination TCP port	IP protocol number	Flow ID	Client→ Server sequence number M	Server→ Client sequence number N	state	Creation timestamp	Client→ Server Hit counter X [bytes]	Server → Client Hit counter Y [bytes]	Client→ Server data buffer	Server→ Client buffer	Age bit
192.1.1.1	209.1.4.4	15431	21	6	1	0xf46d5c34	0x3c98b9ab	ACK	15:32:13					

FIG. 2

3/6

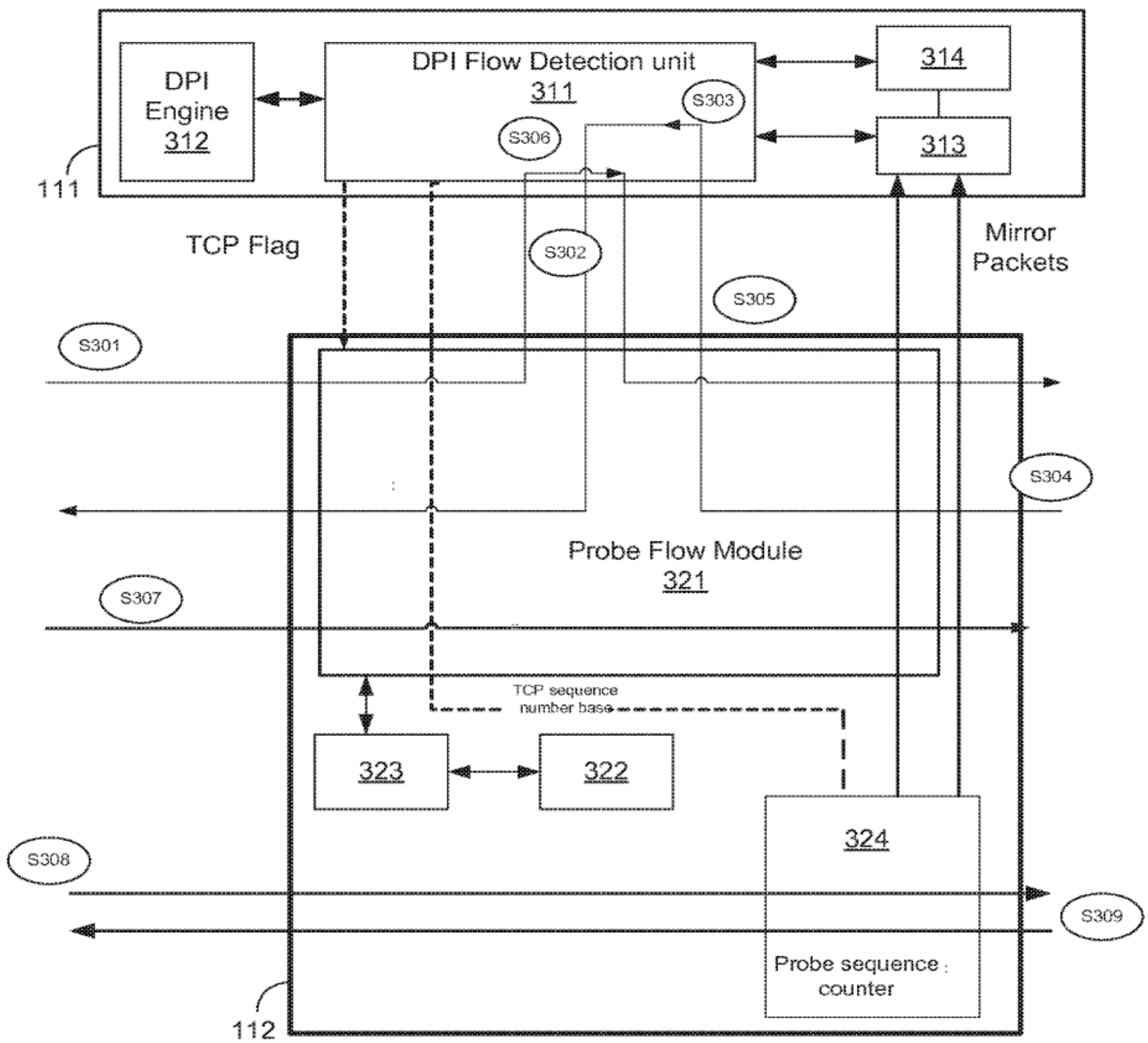
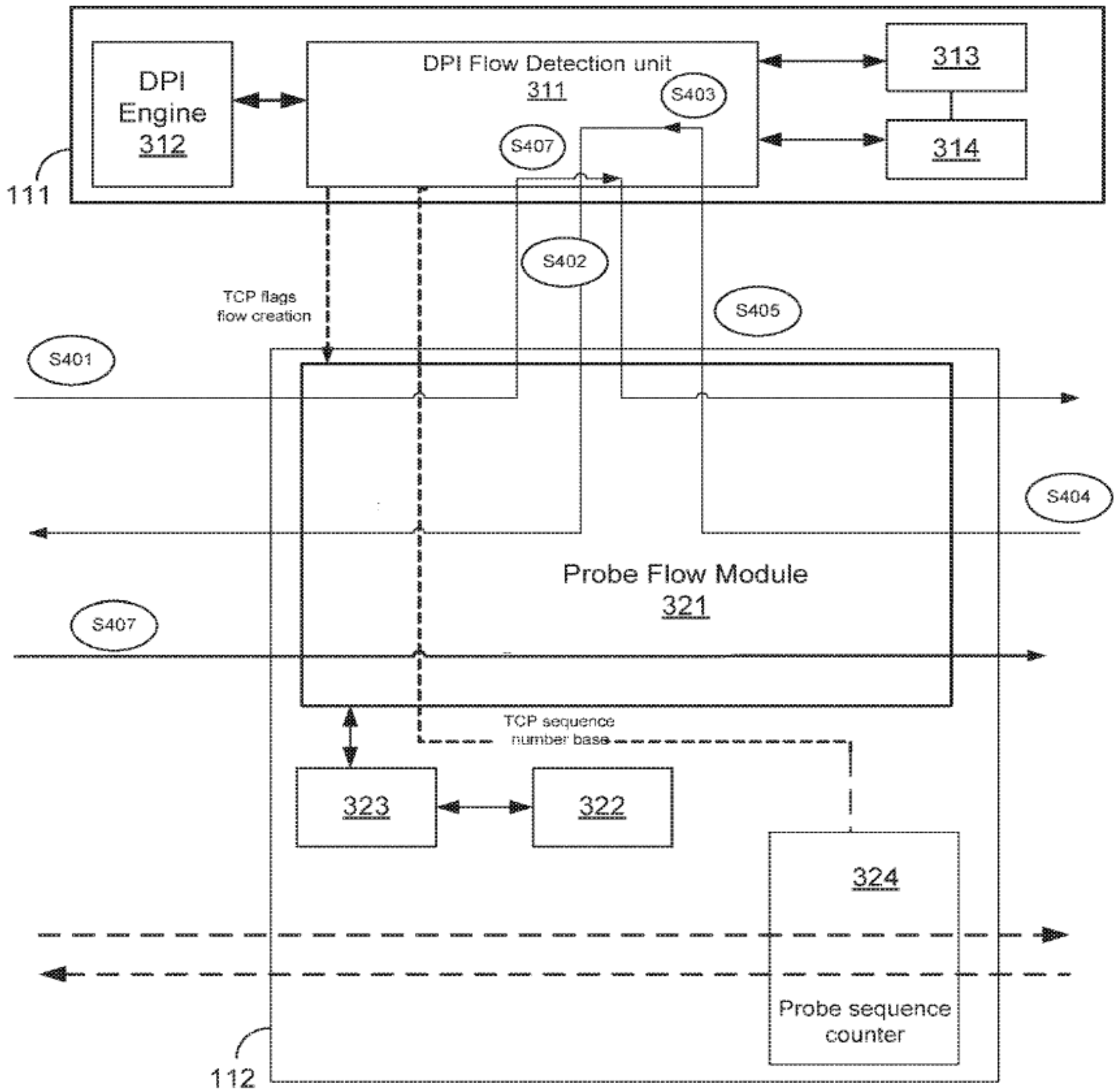

DPI Engine 312
DPI Flow Detection unit 311
314
313
S303
S306
111
TCP Flag
S302
Mirror Packets
S305
S301
S304
Probe Flow Module 321
S307
TCP sequence number base
323
322
324
S308
S309
Probe sequence counter
112

FIG. 3



DPI Engine 312
DPI Flow Detection unit 311
313
314
S403
S407
111
S402
S405
TCP flags flow creation
S401
S404
Probe Flow Module 321
S407
TCP sequence number base
323
322
324
Probe sequence counter
112

FIG. 4

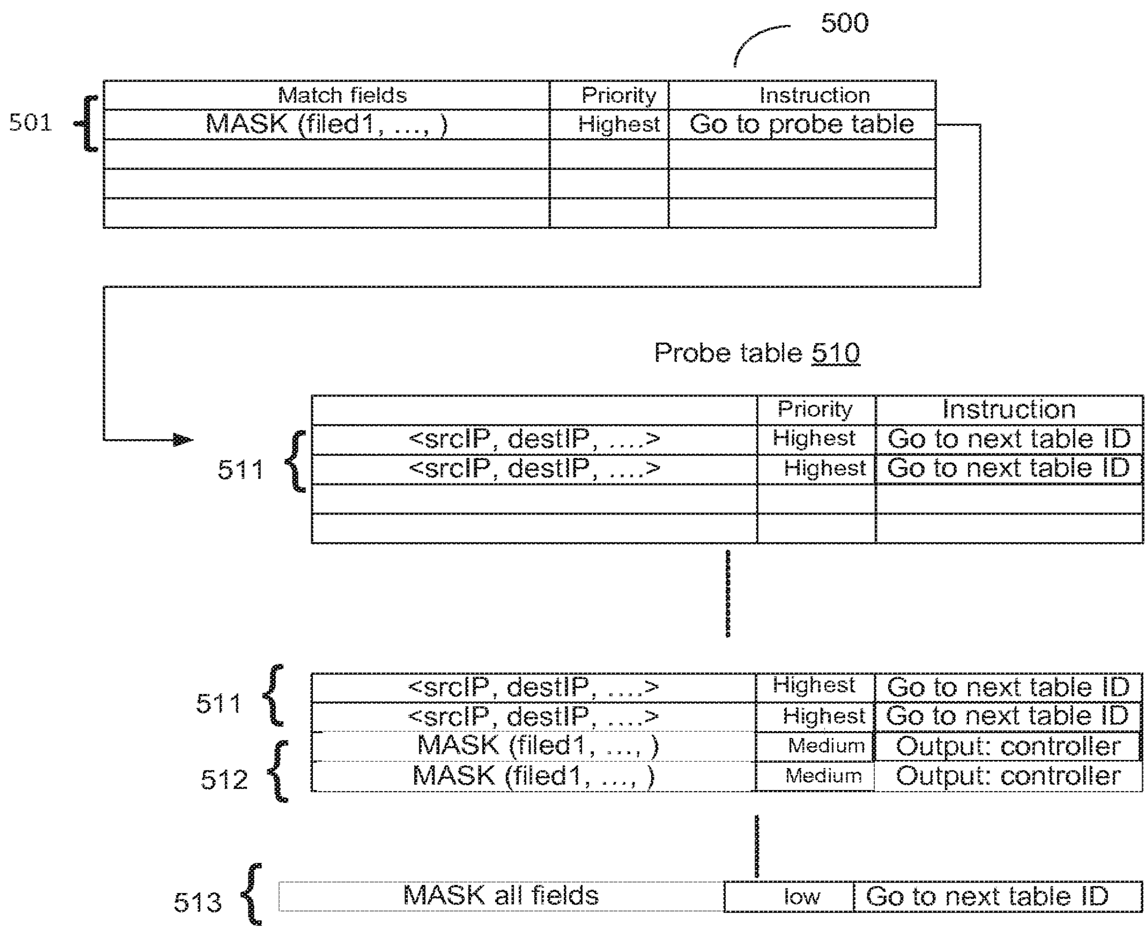

500
501
Match fields
Priority
Instruction
MASK (filed1, …,)
Highest
Go to probe table
Probe table 510
511
Priority
Instruction
<srcIP, destIP, ….>
Highest
Go to next table ID
<srcIP, destIP, ….>
Highest
Go to next table ID
511
<srcIP, destIP, ….>
Highest
Go to next table ID
<srcIP, destIP, ….>
Highest
Go to next table ID
512
MASK (filed1, …,)
Medium
Output: controller
MASK (filed1, …,)
Medium
Output: controller
513
MASK all fields
low
Go to next table ID

FIG. 5

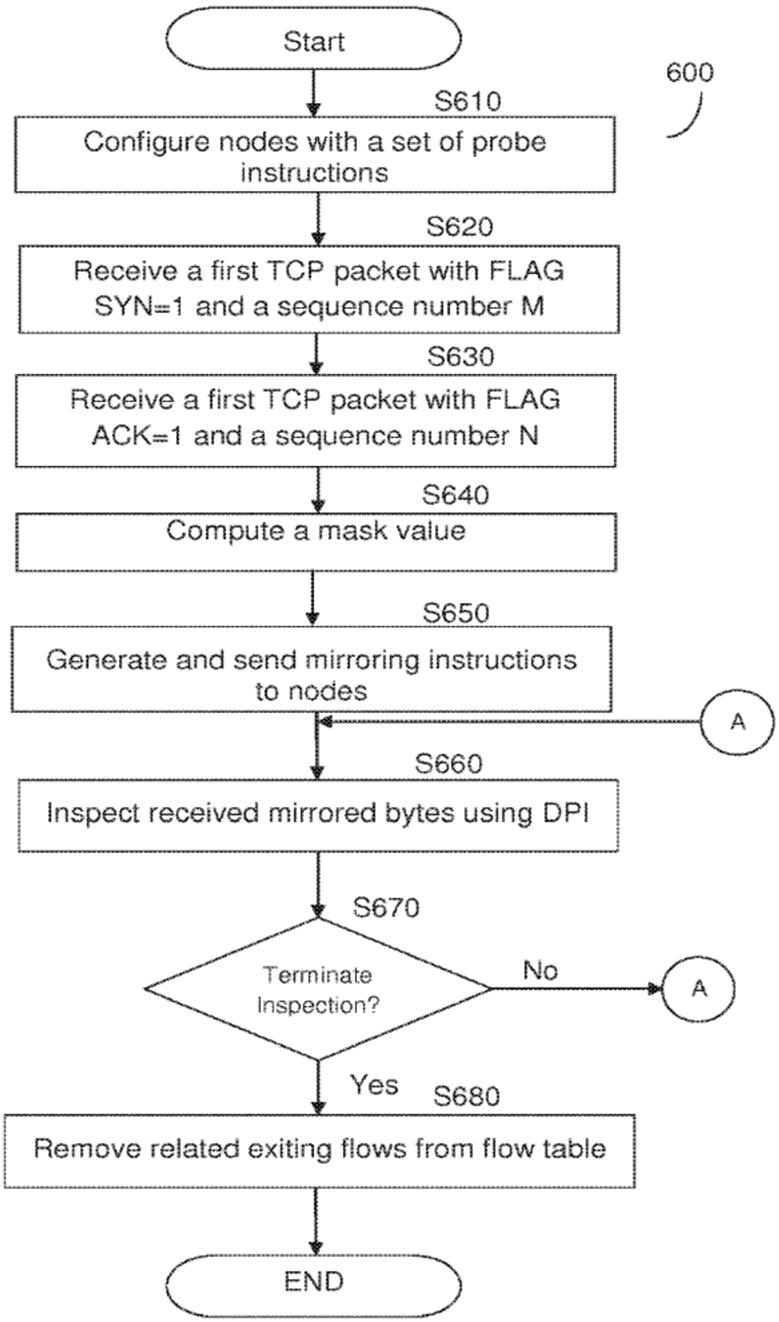

Start
600
S610
Configure nodes with a set of probe instructions
S620
Receive a first TCP packet with FLAG SYN=1 and a sequence number M
S630
Receive a first TCP packet with FLAG ACK=1 and a sequence number N
S640
Compute a mask value
S650
Generate and send mirroring instructions to nodes
A
S660
Inspect received mirrored bytes using DPI
S670
Terminate Inspection?
No
A
Yes
S680
Remove related exiting flows from flow table
END

FIG. 6

INTERNATIONAL SEARCH REPORT	International application No. PCT/US 2015/026869

A. CLASSIFICATION OF SUBJECT MATTER

H04L 12/26 *(2006.01)*
H04L 12/741 *(2013.01)*

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04L 12/00-12/733, G06F 15/00-15/173, 21/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatSearch (RUPTO internal), USPTO, PAJ, K-PION, Esp@cenet, Information Retrieval System of FIPS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2010/0208590 A1 (ALCATEL LUCENT) 19.08.2010, abstract, paragraphs [0012]-[0014], [0030], [0034], [0044]-[0046], [0048], [0051]-[0057], [0070], [0075]	1-19
Y	EP 2672668 A1 (JUNIPER NETWORKS INC) 11.12.2013, paragraphs [0006], [0186], [0222]	1-19
Y	US 2011/0264802 A1 (ALCATEL LUCENT) 27.10.2011, abstract, paragraphs [0043]-[0048]	1-19
A	US 2010/0212006 A1 (ALCATEL LUCENT) 19.08.2010	1-19

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 July 2015 (27.07.2015)	06 August 2015 (06.08.2015)

Name and mailing address of the ISA/RU:	Authorized officer
Federal Institute of Industrial Property, Berezhkovskaya nab., 30-1, Moscow, G-59, GSP-3, Russia, 125993 Facsimile No: (8-495) 531-63-18, (8-499) 243-33-37	A. Tokarev Telephone No. (499) 240-25-91

Form PCT/ISA/210 (second sheet) (January 2015)

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS
First Named Inventor/Applicant Name:	Yossi BARSHESHET
Filer:	Yehuda Binder
Attorney Docket Number:	ORCKIT-001-US

Filed as Small Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Basic National Stage Fee	2631	1	140	140
Natl Stage Search Fee - all other cases	2632	1	300	300
Natl Stage Exam Fee - all other cases	2633	1	360	360
Pages:				
Claims:				
Claims in excess of 20	2615	34	40	1360
Miscellaneous-Filing:				
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**2160**

Electronic Acknowledgement Receipt

EFS ID:	26930733
Application Number:	15126288
International Application Number:	PCT/US2015/026869
Confirmation Number:	9263
Title of Invention:	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS
First Named Inventor/Applicant Name:	Yossi BARSHESHET
Customer Number:	131926
Filer:	Yehuda Binder
Filer Authorized By:	
Attorney Docket Number:	ORCKIT-001-US
Receipt Date:	15-SEP-2016
Filing Date:	
Time Stamp:	04:36:06
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$2160
RAM confirmation Number	7114
Deposit Account	600117
Authorized User	Binder, Yehuda

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 CFR 1.492 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 CFR 1.492(a) (basic national fee only)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Oath or Declaration filed	Signed-Oath-Yossi.pdf	79370 24f526b46f5d7da42a39df0a4dc7d2c4d614 75f7	no	1
Warnings:					
Information:					
2	Oath or Declaration filed	Signed-Oath-Simhon.pdf	77322 3268dcb0e3c22613a9829b658a21d14835c 3042a	no	1
Warnings:					
Information:					
3	Oath or Declaration filed	Signed-Oath-Ronen.pdf	651854 41b762b95645bd89c940e4d4d5cc48f7ac4 d9c88	no	2
Warnings:					
Information:					
4	Power of Attorney	Signed-POA-082.pdf	268617 5c9012e893e3cbc09842db9c16b8313a0ea 6a92d	no	3
Warnings:					
Information:					
5	Application Data Sheet	aiaADS.pdf	1819185 8e376334688c233231ddb1ffa8cf4f864189 5d22	no	7
Warnings:					
Information:					
6	Preliminary Amendment	Preliminary-amendment.pdf	264949 45c3e477bf7430b62bfd09302ed8f7d919a 9dc21	no	12
Warnings:					
Information:					

7	Documents submitted with 371 Applications	WO2015164370-IB306-Applicant.pdf	42064 856c79f4b715c305dc296491323561b057d31478	no	1
Warnings:					
Information:					
8	Documents submitted with 371 Applications	WO2015164370-IB306-Inventor-address-1.pdf	40958 ed66a1f505879e928935355141c37401383f0d16	no	1
Warnings:					
Information:					
9	Documents submitted with 371 Applications	WO2015164370-IB306-Inventor-address-2.pdf	40827 de566885cef184dbd82b2e4aae31a84b8db846ee	no	1
Warnings:					
Information:					
10	Documents submitted with 371 Applications	WO2015164370-IB306-Inventor-address-3.pdf	40885 cf3ea8e39cfd4cee41cbe0979be622fdd90f4e78	no	1
Warnings:					
Information:					
11	Documents submitted with 371 Applications	WO2015164370-RO101.pdf	315208 c30ab06fff7d844eecf7279d7394fd5460ae1d06	no	5
Warnings:					
Information:					
12	Information Disclosure Statement (IDS) Form (SB08)	IDS.pdf	1035047 dfb1b047bf632aa9a5819cbebdfb6500db8046e8	no	4
Warnings:					
Information:					
13	Other Reference-Patent/App/Search documents	WO2015164370-ISR.pdf	101913 cfa5939035f995ab2946e068cfd6e3296a7b6635	no	2
Warnings:					
Information:					

14	Foreign Reference	EP2672668A1.pdf	3539151 9950adda27ce59e1cc3b94761370c8594b4d5581	no	49
Warnings:					
Information:					
15	Transmittal of New Application	pto-1390-Transmittal-Form.pdf	220335 16c66794504e09e2b94fe7f92c2c2d6623046346	no	4
Warnings:					
Information:					
16		Specification.pdf	2892475 df22e4b98da651b263b4a5ee643e464d093382a7	yes	27

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Abstract	1	1
	Specification	2	16
	Claims	17	20
	Drawings-only black and white line drawings	21	26
	Other Reference-Patent/App/Search documents	27	27

Warnings:					
Information:					
17	Fee Worksheet (SB06)	fee-info.pdf	36743 eb0c52b311abb3fcbad4f2bdc024c8d0ac4c18ca	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	11466903	

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/AIA/01 (06-12)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number ____________________

filed on ____________________.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: BARSHESHET, Yossi   Date (Optional): 23rd Aug 2016

Signature: ____________________

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

PTO/AIA/01 (06-12)
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Title of Invention	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS

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- [x] The attached application, or
- [ ] United States application or PCT international application number ____________________

filed on ____________________.

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Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: DOCTORI, Simhon Date (Optional) : ____________________

Signature: ____________________

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number ____________
  filed on ____________.

The above-identified application was made or authorized to be made by me.

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LEGAL NAME OF INVENTOR

Inventor: SOLOMON, Ronen   Date (Optional): 28 August 2016

Signature: ____________

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

convey the entire interest herein assigned, and that he has (they have) not executed and will not execute, any agreement in conflict herewith.

6) The undersigned hereby grant(s) the firm of **May Patents Ltd.** the power to insert on this assignment any further identification which may be necessary or desirable in order to comply with the rules of the United States Patent Office for recordation of this document.

7) All existing rights and future rights relating to the invention are hereby assigned.

8) This Assignment shall be binding upon my (our) heirs, executors, administrators, and/or assigns, and shall inure to the benefit of the heirs, executors, administrators, successors and/or assigns of the Assignee.

In witness whereof, executed by the undersigned on the date(s) opposite the undersigned name(s).

Full Name of Inventor: **BARSHESHET, Yossi**

Inventor's Signature: ______________________ Date: ____________

Witness ______________________

Full Name of Inventor: **DOCTORI, Simhon**

Inventor's Signature: ______________________ Date: ____________

Witness ______________________

Full Name of Inventor: **SOLOMON, Ronen**

Inventor's Signature: ______________________ Date: 28 August 2016

Witness ______________________

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
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TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	
Filing Date	
First Named Inventor	BARSHESHET, Yossi
Title	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS
Art Unit	
Examiner Name	
Attorney Docket Number	ORCKIT-001-US

SIGNATURE of Applicant or Patent Practitioner

Signature	/Yehuda Binder/	Date (Optional)	
Name	Yehuda Binder	Registration Number	73,612
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ *Total of __________ forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82B (07-13)
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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 131926

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☑ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

ORCKIT IP, LLC

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	ORCKIT IP, LLC DE LLC # 5886551 831 Beacon St. # 307 Newton, MA 02459-1840	Date (Optional) AUGUST 28, 2016
Name	Yehuda Binder	
Title	CEO and Owner of ORCKIT IP, LLC	

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ Total of forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	ORCKIT-001-US
	Application Number	

Title of Invention	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove
Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Yossi		BARSHESHET	

Residence Information (Select One) ○ US Residency ● Non US Residency ○ Active US Military Service

City	Ashdod	Country of Residence i	IL

Mailing Address of Inventor:

Address 1	19 Shevet Levi St.		
Address 2			
City	Ashdod	**State/Province**	
Postal Code	7767618	**Country i**	IL

Inventor 2 Remove
Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Simhon		DOCTORI	

Residence Information (Select One) ○ US Residency ● Non US Residency ○ Active US Military Service

City	Gan-Yavne	Country of Residence i	IL

Mailing Address of Inventor:

Address 1	15 Revivim St.		
Address 2			
City	Gan-Yavne	**State/Province**	
Postal Code	7080000	**Country i**	IL

Inventor 3 Remove
Legal Name

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	ORCKIT-001-US
	Application Number	
Title of Invention	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS	

Prefix	Given Name	Middle Name	Family Name	Suffix
	Ronen		SOLOMON	

Residence Information (Select One) US Residency ◉ Non US Residency Active US Military Service

City	Ranat-Gan	Country of Residence i	IL

Mailing Address of Inventor:

Address 1	23 Rozen St.		
Address 2			
City	Ranat-Gan	**State/Province**	
Postal Code	5222469	**Country** i	IL

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	131926
Email Address	Add Email Remove Email

Application Information:

Title of the Invention	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS		
Attorney Docket Number	ORCKIT-001-US	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	6	**Suggested Figure for Publication (if any)**	3

Filing By Reference :

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country i

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	ORCKIT-001-US
	Application Number	
Title of Invention	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS	

Publication Information:

☐	Request Early Publication (Fee required at time of Request 37 CFR 1.219)
☐	**Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	● Customer Number	US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	131926		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the application number blank.

Prior Application Status	Pending		Remove
Application Number	**Continuity Type**	**Prior Application Number**	**Filing Date (YYYY-MM-DD)**
	a 371 of international	PCT/US2015/026869	2015-04-21
Prior Application Status	Expired		Remove
Application Number	**Continuity Type**	**Prior Application Number**	**Filing Date (YYYY-MM-DD)**
PCT/US2015/026869	Claims benefit of provisional	61982358	2014-04-22

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	ORCKIT-001-US
	Application Number	
Title of Invention	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS	

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Remove Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices

If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date o f filing this Authorization.

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	ORCKIT-001-US
	Application Number	

Title of Invention	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS

Applicant 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

● Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :	
If the Applicant is an Organization check here.	☒
Organization Name	ORCKIT IP, LLC.

Mailing Address Information For Applicant:

Address 1	331 Beacon St. #307		
Address 2			
City	Newton	**State/Province**	MA
Country	US	Postal Code	02459
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not subsitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication . An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

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If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	ORCKIT-001-US
	Application Number	
Title of Invention	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS	

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Signature	/Yehuda Binder/			Date (YYYY-MM-DD)	2016-09-15
First Name	Yehuda	Last Name	Binder	Registration Number	73612

Additional Signature may be generated within this form by selecting the Add button. Add

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent C o o p eration Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

ATTY.'S DOCKET: ORCKIT-001-US

In re Application of:	)	Confirmation No.
Yossi BARSHESHET et al.	)	Art Unit:
Appln. No.:	)	Examiner:
Filed:	)	Washington, D.C.
For: A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS	)	September 15, 2016

PRELIMINARY AMENDMENT:

Honorable Commissioner for Patents
U.S. Patent and Trademark Office
Randolph Building, Mail Stop Amendments
401 Dulany Street
Alexandria, VA 22314

Sir:

Amendments to the Claims begin on page 2 of this paper,

Remarks/Arguments begin on page 12 of this paper.

Amendments to the Claims.

This listing of claims replaces all prior versions and listings of claims in the application.

Listing of Claims:

1-19 (Canceled).

20. (New) A method for use with a packet network including a network node for transporting packets between first and second entities under control of a controller, the method comprising:

sending, by the controller to the network node over the packet network, an instruction and a packet-applicable criterion;

receiving, by the network node from the controller, the instruction and the criterion;

receiving, by the network node from the first entity over the packet network, a packet addressed to the second entity;

checking, by the network node, if the packet satisfies the criterion;

responsive to the packet not satisfying the criterion, sending, by the network node over the packet network, the packet to the second entity; and

responsive to the packet satisfying the criterion, sending the packet, by the network node over the packet network, in response to the instruction.

21. (New) The method according to claim 20, wherein the instruction is ‘probe’, ‘mirror’, or ‘terminate’ instruction, and upon receiving by the network node the ‘terminate’ instruction, the method further comprising blocking, by the

network node, the packet from being sent to the second entity and to the controller.

22. (New) The method according to claim 20, wherein the instruction is a ‘probe’, a ‘mirror’, or a ‘terminate’ instruction, and upon receiving by the network node the ‘mirror’ instruction and responsive to the packet satisfying the criterion, the method further comprising sending the packet, by the network node, to the second entity and to the controller.

23. (New) The method according to claim 20, wherein the instruction is ‘probe’, ‘mirror’, or ‘terminate’ instruction, and upon receiving by the network node the ‘probe’ instruction and responsive to the packet satisfying the criterion, the method further comprising:

sending the packet, by the network node, to the controller;

responsive to receiving the packet, analyzing the packet, by the controller;

sending the packet, by the controller, to the network node; and

responsive to receiving the packet, sending the packet, by the network node, to the second entity.

24. (New) The method according to claim 20, further comprising responsive to the packet satisfying the criterion and to the instruction, sending the packet or a portion thereof, by the network node, to the controller.

25. (New) The method according to claim 24, further comprising storing the received packet or a portion thereof, by the controller, in a memory.

26. (New) The method according to claim 24, further comprising responsive to the packet satisfying the criterion and to the

instruction, sending a portion of the packet, by the network node, to the controller.

27. (New) The method according to claim 26, wherein the portion of the packet consists of multiple consecutive bytes, and wherein the instruction comprises identification of the consecutive bytes in the packet.

28. (New) The method according to claim 24, further comprising responsive to receiving the packet, analyzing the packet, by the controller.

29. (New) The method according to claim 28, further for use with an application server that communicates with the controller, wherein the analyzing comprising sending the packet, by the controller, to the application server, and analyzing the packet by the application server.

30. (New) The method according to claim 29, wherein the analyzing further comprising sending the packet after analyzing by the application server to the controller, and sending the packet, after receiving from the controller by the network node, to the second entity.

31. (New) The method according to claim 28, wherein the analyzing comprises applying security or data analytic application.

32. (New) The method according to claim 28, wherein the analyzing comprises applying security application that comprises firewall or intrusion detection functionality.

33. (New) The method according to claim 28, wherein the analyzing comprises performing Deep Packet Inspection (DPI) or using a DPI engine on the packet.

34. (New) The method according to claim 28, wherein the packet comprises distinct header and payload fields, and wherein the

analyzing comprises checking part of, or whole of, the payload field.

35. (New) The method according to claim 20, wherein the packet comprises distinct header and payload fields, the header comprises one or more flag bits, and wherein the packet-applicable criterion is that one or more of the flag bits is set.

36. (New) The method according to claim 35, wherein the packet is an Transmission Control Protocol (TCP) packet, and wherein the one or more flag bits comprises comprise a SYN flag bit, an ACK flag bit, a FIN flag bit, a RST flag bit, or any combination thereof.

37. (New) The method according to claim 20, wherein the packet comprises distinct header and payload fields, the header comprises at least the first and second entities addresses in the packet network, and wherein the packet-applicable criterion is that the first entity address, the second entity address, or both match a predetermined address or addresses.

38. (New) The method according to claim 37, wherein the addresses are Internet Protocol (IP) addresses.

39. (New) The method according to claim 20, wherein the packet is an Transmission Control Protocol (TCP) packet that comprises source and destination TCP ports, a TCP sequence number, and a TCP sequence mask fields, and wherein the packet-applicable criterion is that the source TCP port, the destination TCP port, the TCP sequence number, the TCP sequence mask, or any combination thereof, matches a predetermined value or values.

40. (New) The method according to claim 20, wherein the packet network comprises a Wide Area Network (WAN), Local Area Network (LAN), the Internet, Metropolitan Area Network (MAN), Internet

Service Provider (ISP) backbone, datacenter network, or inter-datacenter network.

41. (New) The method according to claim 20, wherein the first entity is a server device and the second entity is a client device, or wherein the first entity is a client device and the second entity is a server device.

42. (New) The method according to claim 41, wherein the server device comprises a web server, and wherein the client device comprises a smartphone, a tablet computer, a personal computer, a laptop computer, or a wearable computing device.

43. (New) The method according to claim 41, wherein the communication between the network node and the controller is based on, or uses, a standard protocol.

44. (New) The method according to claim 43, wherein the standard protocol is according to, based on, or compatible with, an OpenFlow protocol version 1.3.3 or 1.4.0.

45. (New) The method according to claim 44, wherein the instruction comprises a Type-Length-Value (TLV) structure.

46. (New) The method according to claim 20, wherein the network node comprises a router, a switch, or a bridge.

47. (New) The method according to claim 20, wherein the packet network is an Internet Protocol (IP) network, and the packet is an IP packet.

48. (New) The method according to claim 47, wherein the packet network is an Transmission Control Protocol (TCP) network, and the packet is an TCP packet.

49. (New) The method according to claim 20, further comprising:

receiving, by the network node from the first entity over the packet network, one or more additional packets;

checking, by the network node, if any one of the one or more additional packets satisfies the criterion;

responsive to an additional packet not satisfying the criterion, sending, by the network node over the packet network, the additional packet to the second entity; and

responsive to the additional packet satisfying the criterion, sending the additional packet, by the network node over the packet network, in response to the instruction.

50. (New) The method according to claim 20, wherein the packet network is a Software Defined Network (SDN), the packet is routed as part of a data plane and the network node communication with the controller serves as a control plane.

51. (New) A method for use with a packet network including a network node for transporting packets between first and second entities under control of a controller, the method by the network node comprising:

receiving, from the controller, the instruction and the criterion;

receiving, from the first entity over the packet network, a packet addressed to the second entity;

checking if the packet satisfies the criterion;

responsive to the packet not satisfying the criterion, sending over the packet network, the packet to the second entity; and

responsive to the packet satisfying the criterion, sending the packet over the packet network, in response to the instruction.

52. (New) The method according to claim 51, wherein the instruction is 'probe', 'mirror', or 'terminate' instruction, and upon receiving the 'terminate' instruction, the method further comprising blocking, the packet from being sent to the second entity and to the controller.

53. (New) The method according to claim 51, wherein the instruction is a 'probe', a 'mirror', or a 'terminate' instruction, and upon receiving the 'mirror' instruction and responsive to the packet satisfying the criterion, the method further comprising sending the packet to the second entity and to the controller.

54. (New) The method according to claim 51, wherein the instruction is 'probe', 'mirror', or 'terminate' instruction, and upon receiving the 'probe' instruction and responsive to the packet satisfying the criterion, the method further comprising:

sending the packet to the controller;

receiving the packet, from the controller; and

responsive to receiving the packet, sending the packet, to the second entity.

55. (New) The method according to claim 51, further comprising responsive to the packet satisfying the criterion and to the instruction, sending the packet or a portion thereof to the controller.

56. (New) The method according to claim 55, further comprising responsive to the packet satisfying the criterion and to the instruction, sending a portion of the packet to the controller.

57. (New) The method according to claim 56, wherein the portion of the packet consists of multiple consecutive bytes, and wherein the instruction comprises identification of the consecutive bytes in the packet.

58. (New) The method according to claim 51, wherein the packet comprises distinct header and payload fields, the header comprises one or more flag bits, and wherein the packet-applicable criterion is that one or more of the flag bits is set.

59. (New) The method according to claim 58, wherein the packet is an Transmission Control Protocol (TCP) packet, and wherein the one or more flag bits comprises comprise a SYN flag bit, an ACK flag bit, a FIN flag bit, a RST flag bit, or any combination thereof.

60. (New) The method according to claim 51, wherein the packet comprises distinct header and payload fields, the header comprises at least the first and second entities addresses in the packet network, and wherein the packet-applicable criterion

is that the first entity address, the second entity address, or both match a predetermined address or addresses.

61. (New) The method according to claim 60, wherein the addresses are Internet Protocol (IP) addresses.

62. (New) The method according to claim 51, wherein the packet is an Transmission Control Protocol (TCP) packet that comprises source and destination TCP ports, a TCP sequence number, and a TCP sequence mask fields, and wherein the packet-applicable criterion is that the source TCP port, the destination TCP port, the TCP sequence number, the TCP sequence mask, or any combination thereof, matches a predetermined value or values.

63. (New) The method according to claim 51, wherein the packet network comprises a Wide Area Network (WAN), Local Area Network (LAN), the Internet, Metropolitan Area Network (MAN), Internet Service Provider (ISP) backbone, datacenter network, or inter-datacenter network.

64. (New) The method according to claim 51, wherein the first entity is a server device and the second entity is a client device, or wherein the first entity is a client device and the second entity is a server device.

65. (New) The method according to claim 64, wherein the server device comprises a web server, and wherein the client device comprises a smartphone, a tablet computer, a personal computer, a laptop computer, or a wearable computing device.

66. (New) The method according to claim 64, wherein the communication with the controller is based on, or uses, a standard protocol.

67. (New) The method according to claim 66, wherein the standard protocol is according to, based on, or compatible with, an OpenFlow protocol version 1.3.3 or 1.4.0.

68. (New) The method according to claim 67, wherein the instruction comprises a Type-Length-Value (TLV) structure.

69. (New) The method according to claim 51, wherein the network node comprises a router, a switch, or a bridge.

70. (New) The method according to claim 51, wherein the packet network is an Internet Protocol (IP) network, and the packet is an IP packet.

71. (New) The method according to claim 70, wherein the packet network is a Transmission Control Protocol (TCP) network, and the packet is an TCP packet.

72. (New) The method according to claim 51, further comprising:

receiving, from the first entity over the packet network, one or more additional packets;

checking, if any one of the one or more additional packets satisfies the criterion;

responsive to an additional packet not satisfying the criterion, sending over the packet network, the additional packet to the second entity; and

responsive to the additional packet satisfying the criterion, sending the additional packet over the packet network, in response to the instruction.

73. (New) The method according to claim 51, wherein the packet network is a Software Defined Network (SDN), the packet is routed as part of a data plane and the communication with the controller serves as a control plane.

REMARKS

Via the present Preliminary Amendment, applicant amends the claims as shown above.

Respectfully submitted,

By /Yehuda Binder/
Yehuda Binder
Registration No. 73,612

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92*bis*.1 and Administrative Instructions, Section 422)

To:

BEN-SHIMON, Michael
M&B IP Analysts, LLC
45 S. Park Place #262
Morristown, NJ 07960
ÉTATS-UNIS D'AMÉRIQUE

Date of mailing *(day/month/year)* 31 May 2016 (31.05.2016)	
Applicant's or agent's file reference ORCK P0406PCT	**IMPORTANT NOTIFICATION**
International application No. PCT/US2015/026869	International filing date *(day/month/year)* 21 April 2015 (21.04.2015)

1. The following indications appeared on record concerning:

☒ the applicant ☐ the inventor ☐ the agent ☐ the common representative

Name and Address	State of Nationality	State of Residence
ORCKIT IP, LLC 831 Beacon St. #307 Newton, MA 02459 United States of America	IL	IL
	Telephone No.	
	Facsimile No.	
	E-mail address pair@mb-ip.com	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☐ the name ☐ the address ☒ the nationality ☒ the residence

Name and Address	State of Nationality	State of Residence
ORCKIT IP, LLC 831 Beacon St. #307 Newton, MA 02459 United States of America	US	US
	Telephone No.	
	Facsimile No.	
	E-mail address pair@mb-ip.com ☐ Notifications by e-mail authorized	

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office
☐ the International Searching Authority
☐ the Authority(ies) specified for supplementary search
☐ the International Preliminary Examining Authority
☒ the designated Offices concerned
☐ the elected Offices concerned
☐ other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 71 30	Authorized officer Ben-Mansour Naceur e-mail pt09.pct@wipo.int Telephone No. +41 22 338 74 09

PATENT COOPERATION TREATY

ADVANCE E-MAIL

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92*bis*.1 and Administrative Instructions, Section 422)

To:

BINDER (SHEM-TOV), Dorit
11 Shu'alei Shimshon St.
P.O.Box 7230
Ramat-Gan 5217102
ISRAËL

Date of mailing *(day/month/year)* 08 June 2016 (08.06.2016)	
Applicant's or agent's file reference ORCKIT-001-PCT	**IMPORTANT NOTIFICATION**
International application No. PCT/US2015/026869	International filing date *(day/month/year)* 21 April 2015 (21.04.2015)

1. The following indications appeared on record concerning:

☐ the applicant ☒ the inventor ☐ the agent ☐ the common representative

Name and Address	State of Nationality	State of Residence
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	Telephone No.	
	Facsimile No.	
	E-mail address	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☐ the name ☒ the address ☐ the nationality ☐ the residence

Name and Address	State of Nationality	State of Residence
BARSHESHET, Yossi 19 Shevet Levi St., Ashdod (IL); Israel		
	Telephone No.	
	Facsimile No.	
	E-mail address ☐ Notifications by e-mail authorized	

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office
☐ the International Searching Authority
☐ the Authority(ies) specified for supplementary search
☐ the International Preliminary Examining Authority
☒ the designated Offices concerned
☐ the elected Offices concerned
☐ other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 71 30	Authorized officer Ben-Mansour Naceur e-mail pt09.pct@wipo.int Telephone No. +41 22 338 74 09

ADVANCE E-MAIL

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92*bis*.1 and Administrative Instructions, Section 422)

To:

BINDER (SHEM-TOV), Dorit
11 Shu'alei Shimshon St.
P.O.Box 7230
Ramat-Gan 5217102
ISRAËL

Date of mailing *(day/month/year)* 08 June 2016 (08.06.2016)	
Applicant's or agent's file reference ORCKIT-001-PCT	**IMPORTANT NOTIFICATION**
International application No. PCT/US2015/026869	International filing date *(day/month/year)* 21 April 2015 (21.04.2015)

1. The following indications appeared on record concerning:

☐ the applicant ☒ the inventor ☐ the agent ☐ the common representative

Name and Address	State of Nationality	State of Residence
DOCTORI, Simhon Orckit-corrigent Ltd. 126 Yigal Allon Street 67443 Tel Alviv Israel		
	Telephone No.	
	Facsimile No.	
	E-mail address	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☐ the name ☒ the address ☐ the nationality ☐ the residence

Name and Address	State of Nationality	State of Residence
DOCTORI, Simhon 15 Revivim St., Gan-Yavne (IL); Israel		
	Telephone No.	
	Facsimile No.	
	E-mail address ☐ Notifications by e-mail authorized	

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office
☐ the International Searching Authority
☐ the Authority(ies) specified for supplementary search
☐ the International Preliminary Examining Authority
☒ the designated Offices concerned
☐ the elected Offices concerned
☐ other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 71 30	Authorized officer Ben-Mansour Naceur e-mail pt09.pct@wipo.int Telephone No. +41 22 338 74 09

PATENT COOPERATION TREATY PCT/US2015/026869

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NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92*bis*.1 and Administrative Instructions, Section 422)

To:

BINDER (SHEM-TOV), Dorit
11 Shu'alei Shimshon St.
P.O.Box 7230
Ramat-Gan 5217102
ISRAËL

Date of mailing *(day/month/year)* 08 June 2016 (08.06.2016)	
Applicant's or agent's file reference ORCKIT-001-PCT	**IMPORTANT NOTIFICATION**
International application No. PCT/US2015/026869	International filing date *(day/month/year)* 21 April 2015 (21.04.2015)

1. The following indications appeared on record concerning:

☐ the applicant ☒ the inventor ☐ the agent ☐ the common representative

Name and Address	State of Nationality	State of Residence
SOLOMON, Ronen Orckit-corrigent Ltd. 126 Yigai Allon Street 67443 Tel-aviv Israel		
	Telephone No.	
	Facsimile No.	
	E-mail address	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☐ the name ☒ the address ☐ the nationality ☐ the residence

Name and Address	State of Nationality	State of Residence
SOLOMON, Ronen 23 Rozen St. Ranat-Gan (IL). Israel		
	Telephone No.	
	Facsimile No.	
	E-mail address ☐ Notifications by e-mail authorized	

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office
☐ the International Searching Authority
☐ the Authority(ies) specified for supplementary search
☐ the International Preliminary Examining Authority
☒ the designated Offices concerned
☐ the elected Offices concerned
☐ other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 71 30	Authorized officer Ben-Mansour Naceur e-mail pt09.pct@wipo.int Telephone No. +41 22 338 74 09

Form PCT/IB/306 (January 2009) 1/ELUMPUUA7WN560

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

PCT/US15/26869

International Application No.

21 APRIL 2015 (21.04.15)

International Filing Date

PCT INTERNATIONAL APPLICATION RO/US

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* ORCK P0406PCT

Box No. I TITLE OF INVENTION

A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS

Box No. II APPLICANT ☐ This person is also inventor

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

Orckit-Corrigent Ltd.
126 Yigal Allon Street
Tel-Aviv 67443
ISRAEL

Telephone No.

Facsimile No.

Applicant's registration No. with the Office

E-mail authorization: Marking one of the check-boxes below authorizes the receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority to use the e-mail address indicated in this Box to send, notifications issued in respect of this international application to that e-mail address if those offices are willing to do so.

☐ as advance copies followed by paper notifications; or ☒ exclusively in electronic form (no paper notifications will be sent).

E-mail address: pair@mb-ip.com

State *(that is, country)* of nationality: IL

State *(that is, country)* of residence: IL

This person is applicant for the purposes of: ☒ all designated States ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

BEN-SHIMON, Michael
MYERS, Brian S.
M&B IP Analysts, LLC
45 S. Park Place #262
Morristown NJ 07960
UNITED STATES

Telephone No. 1-908-655-6864

Facsimile No. 1-908-325-0276

Agent's registration No. with the Office 69610

E-mail authorization: Marking one of the check-boxes below authorizes the receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority to use the e-mail address indicated in this Box to send, notifications issued in respect of this international application to that e-mail address if those offices are willing to do so.

☐ as advance copies followed by paper notifications; or ☒ exclusively in electronic form (no paper notifications will be sent).

E-mail address: pair@mb-ip.com

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Sheet No. . . .2 . . .

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

M&B IP Analysts, LLC
45 S. Park Place #262
Morristown NJ 07960
UNITED STATES

This person is:
- [x] applicant only
- [ ] applicant and inventor
- [ ] inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality: US

State *(that is, country)* of residence: US

This person is applicant for the purposes of: [ ] all designated States [x] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

BARSHESHET, Yossi
ORCKIT-CORRIGENT LTD.
126 Yigal Allon Street
Tel-Aviv 67443
ISRAEL

This person is:
- [ ] applicant only
- [ ] applicant and inventor
- [x] inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: [ ] all designated States [ ] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

DOCTORI, Simhon
ORCKIT-CORRIGENT LTD.
126 Yigal Allon Street
Tel-Aviv 67443
ISRAEL

This person is:
- [ ] applicant only
- [ ] applicant and inventor
- [x] inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: [ ] all designated States [ ] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

SOLOMON, Ronen
ORCKIT-CORRIGENT LTD.
126 Yigal Allon Street
Tel-Aviv 67443
ISRAEL

This person is:
- [ ] applicant only
- [ ] applicant and inventor
- [x] inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: [ ] all designated States [ ] the States indicated in the Supplemental Box

[ ] Further applicants and/or (further) inventors are indicated on another continuation sheet.

Supplemental Box *If the Supplemental Box is not used, this sheet should not be included in the request.*

1. *If, in any of the Boxes, except Boxes Nos. VIII(i) to (v) for which a special continuation box is provided,* ***the space is insufficient*** *to furnish all the information: in such case, write "Continuation of Box No...." (indicate the number of the Box) and furnish the information in the same manner as required according to the captions of the Box in which the space was insufficient, in particular:*

(i) ***if more than one person is to be indicated as applicant and/or inventor*** *and no "continuation sheet" is available: in such case, write "Continuation of Box No. III" and indicate for each additional person the same type of information as required in Box No. III. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below;*

(ii) *if, in Box No. II or in any of the sub-boxes of Box No. III, the indication* ***"the States indicated in the Supplemental Box"*** *is checked: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the applicant(s) involved and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is applicant;*

(iii) *if, in Box No. II or in any of the sub-boxes of Box No. III,* ***the inventor or the inventor/applicant is not inventor for the purposes of all designated States****: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the inventor(s) and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is inventor;*

(iv) *if, in addition to the agent(s) indicated in Box No. IV, there are* ***further agents****: in such case, write "Continuation of Box No. IV" and indicate for each further agent the same type of information as required in Box No. IV;*

(v) *if, in Box No. VI, there are* ***more than three earlier applications whose priority is claimed****: in such case, write "Continuation of Box No. VI" and indicate for each additional earlier application the same type of information as required in Box No. VI.*

2. *If the applicant intends to make an indication of the wish that the international application be treated, in certain designated States, as an application for a patent of addition, certificate of addition, inventor's certificate of addition or utility certificate of addition: in such case, write the name or two-letter code of each designated State concerned and the indication "****patent of addition,****" "****certificate of addition,****" "****inventor's certificate of addition****" or "****utility certificate of addition,****" the number of the parent application or parent patent or other parent grant and the date of grant of the parent patent or other parent grant or the date of filing of the parent application (Rules 4.11(a)(i) and 49bis.1(a) or (b)).*

3. *If the applicant intends to make an indication of the wish that the international application be treated, in the United States of America, as a continuation or continuation-in-part of an earlier application: in such case, write "United States of America" or "US" and the indication "****continuation****" or "****continuation-in-part****" and the number and the filing date of the parent application (Rules 4.11(a)(ii) and 49bis.1(d)).*

M&B IP Analysts, LLC is Applicant for the State of Belize ONLY

Box No. V DESIGNATIONS

The filing of this request **constitutes under Rule 4.9(a) the designation** of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.

However,

☐ DE Germany **is not designated** for any kind of national protection

☐ JP Japan **is not designated** for any kind of national protection

☐ KR Republic of Korea **is not designated** for any kind of national protection

(The check-boxes above may only be used to exclude (irrevocably) the designations concerned if, at the time of filing or subsequently under Rule 26bis.1, the international application contains in Box No. VI a priority claim to an earlier national application filed in the particular State concerned, in order to avoid the ceasing of the effect, under the national law, of this earlier national application.)

Box No. VI PRIORITY CLAIM AND DOCUMENT

The priority of the following earlier application(s) is hereby claimed:

Filing date of earlier application *(day/month/year)*	Number of earlier application	Where earlier application is: national application: country or Member of WTO	regional application: regional Office	international application: receiving Office
item (1) 22/04/2014 22 APRIL 2014	61/982,358	US		
item (2)				
item (3)				

☐ Further priority claims are indicated in the Supplemental Box.

Furnishing the priority document(s):

☒ The **receiving Office** is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application(s) was filed with the receiving Office which, for the purposes of this international application, is the receiving Office)* identified above as:

☒ all items ☐ item (1) ☐ item (2) ☐ item (3) ☐ other, see Supplemental Box

☐ The **International Bureau** is requested to obtain from a digital library a certified copy of the earlier application(s) identified above, using, where applicable, the access code(s) indicated below *(if the earlier application(s) is available to it from a digital library)*:

☐ item (1) access code ______ ☐ item (2) access code ______ ☐ item (3) access code ______ ☐ other, see Supplemental Box

Restore the right of priority: the receiving Office is requested to restore the right of priority for the earlier application(s) identified above or in the Supplemental Box as item(s) (______). *(See also the Notes to Box No. VI; further information **must** be provided to support a request to restore the right of priority.)*

Incorporation by reference: where an element of the international application referred to in Article 11(1)(iii)(d) or (e) or a part of the description, claims or drawings referred to in Rule 20.5(a) is not otherwise contained in this international application but is completely contained in an earlier application whose priority is claimed on the date on which one or more elements referred to in Article 11(1)(iii) were first received by the receiving Office, that element or part is, subject to confirmation under Rule 20.6, incorporated by reference in this international application for the purposes of Rule 20.6.

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if more than one International Searching Authority is competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used)*:

ISA/ RU

Box No. IX CHECK LIST for EFS-Web filings - this sheet is only to be used when filing an international application with RO/US via **EFS-Web**

This international application **contains** the following:	Number of sheets
(a) request form PCT/RO/101 (including any declarations and supplemental sheets) .... :	5
(b) description (excluding any sequence listing part of the description, see (f), below) ..... :	15
(c) claims .... :	4
(d) abstract .... :	1
(e) drawings (if any) .... :	6
(f) sequence listing part of the description in the form of an **image file** (e.g. PDF).......... :	
Total number of sheets (including the sequence listing part of the description if **filed as an image file**) .... :	31

(g) sequence listing part of the description

☐ filed in the form of an **Annex C/ST.25 text file**

☐ WILL BE filed separately on physical data carrier(s), on the same day and in the form of an **Annex C/ST.25 text file**

Indicate type and number of physical data carrier(s) ....

This international application is **accompanied by** the following item(s) *(mark the applicable check-boxes below and indicate in right column the number of each item):*	Number of items
1. ☒ fee calculation sheet .... :	1
2. ☐ original separate power of attorney .... :	
3. ☒ original general power of attorney .... :	5
4. ☐ copy of general power of attorney; reference number: .... :	
5. ☐ priority document(s) identified in Box No. VI as item(s) .... :	
6. ☐ Translation of international application into *(language)*: .... :	
7. ☐ separate indications concerning deposited microorganism or other biological material .... :	
8. ☐ *(only where item (f) is marked in the left column)* copy of the sequence listing in electronic form (Annex C/ST.25 text file) not forming part of the international application but **furnished only for the purposes of international search** under Rule 13*ter*.............. :	
9. ☐ *(only where item (f) is marked in the left column)* a statement confirming that "the information recorded in electronic form submitted under Rule 13*ter* is identical to the sequence listing as contained in the international application" as filed via EFS-Web: .... :	
10. ☐ copy of results of earlier search(es) (Rule 12*bis*.1(a)) .. :	
11. ☒ other *(specify)*: Transmittal Letter .... :	2

Figure of the drawings which should accompany the abstract: FIG. 3

Language of filing of the international application: English

Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

/Michael Ben-Shimon/

Michael Ben-Shimon
USPTO Reg. No. 69610

For receiving Office use only

1. Date of actual receipt of the purported international application: 21 APRIL 2015 (21.04.15)	2. Drawings:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:	☐ received:
4. Date of timely receipt of the required corrections under PCT Article 11(2):	☐ not received:
5. International Searching Authority (if two or more are competent): ISA / RU — 6. ☐ Transmittal of search copy delayed until search fee is paid	

For International Bureau use only

Date of receipt of the record copy by the International Bureau:

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	
	Filing Date	
	First Named Inventor	BARSHESHET, Yossi
	Art Unit	
	Examiner Name	
	Attorney Docket Number	ORCKIT-001-US

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20100208590	A1	2010-08-19	ALCATEL LUCENT	
	2	20110264802	A1	2011-10-27	ALCATEL LUCENT	
	3	20100212006	A1	2010-08-19	ALCATEL LUCENT	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2672668	EP	A1	2013-12-11	JUNIPER NETWORKS INC		

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	
	Filing Date	
	First Named Inventor	BARSHESHET, Yossi
	Art Unit	
	Examiner Name	
	Attorney Docket Number	ORCKIT-001-US

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5
	1	International Search Report of PCT/US2015/026869 dated 06 August 2015	

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	
	Filing Date	
	First Named Inventor	BARSHESHET, Yossi
	Art Unit	
	Examiner Name	
	Attorney Docket Number	ORCKIT-001-US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Yehuda Binder/	Date (YYYY-MM-DD)	2016-09-15
Name/Print	Yehuda Binder	Registration Number	73612

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference ORCKP0406PCT	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US 2015/026869	International filing date *(day/month/year)* 21 April 2015 (21.04.2015)	(Earliest) Priority Date *(day/month/year)* 22 April 2014 (22.04.2014)
Applicant ORCKIT-CORRIGENT LTD. et al.		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      ☒ the international application in the language in which it was filed.
      ☐ a translation of the international application into ______________ , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).
   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.
2. ☐ **Certain claims were found unsearchable** (see Box No. II).
3. ☐ **Unity of invention is lacking** (see Box No. III).
4. With regard to the **title,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:
5. With regard to the **abstract,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. With regard to the **drawings,**
   a. the figure of the drawings to be published with the abstract is Figure No. 3
      ☒ as suggested by the applicant.
      ☐ as selected by this Authority, because the applicant failed to suggest a figure.
      ☐ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT	International application No. PCT/US 2015/026869

A. CLASSIFICATION OF SUBJECT MATTER

H04L 12/26 *(2006.01)*
H04L 12/741 *(2013.01)*

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04L 12/00-12/733, G06F 15/00-15/173, 21/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatSearch (RUPTO internal), USPTO, PAJ, K-PION, Esp@cenet, Information Retrieval System of FIPS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2010/0208590 A1 (ALCATEL LUCENT) 19.08.2010, abstract, paragraphs [0012]-[0014], [0030], [0034], [0044]-[0046], [0048], [0051]-[0057], [0070], [0075]	1-19
Y	EP 2672668 A1 (JUNIPER NETWORKS INC) 11.12.2013, paragraphs [0006], [0186], [0222]	1-19
Y	US 2011/0264802 A1 (ALCATEL LUCENT) 27.10.2011, abstract, paragraphs [0043]-[0048]	1-19
A	US 2010/0212006 A1 (ALCATEL LUCENT) 19.08.2010	1-19

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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(54) **Creating searchable and global database of user visible process traces**

(57) In one example, a controller device includes one or more network interfaces communicatively coupled to one or more devices of a virtual network, and a processor configured to determine, for the virtual network, a set of two or more related processes executed by respective devices in the virtual network, receive via the network interfaces data for the set of two or more related processes, and aggregate the data for the set of two or more related processes to form aggregated data for the set of two or more related processes.

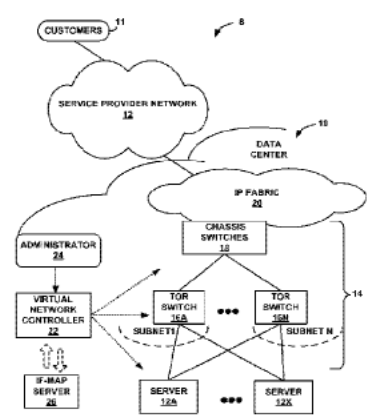

FIG. 1

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Description

PRIORITY CLAIM

[0001] This application claims the benefit of U.S. Application No. 13/835,483, filed March 15, 2013 and of U.S. Application No. 13/842,909, filed March 15, 2013, which claim the benefit of U.S. Provisional Application No. 61/729,474, filed November 23, 2012, U.S. Provisional Application No. 61/723,684, filed November 7, 2012; U.S. Provisional Application No. 61/723,685, filed November 7, 2012; U.S. Provisional Application No. 61/722,696, filed November 5, 2012; U.S. Provisional Application No. 61/721,979, filed November 2, 2012; U.S. Provisional Application No. 61/721,994, filed November 2, 2012; U.S. Provisional Application No. 61/718,633, filed October 25, 2012; U.S. Provisional Application No. 61/656,468, filed June 6, 2012; U.S. Provisional Application No. 61/656,469, filed June 6, 2012; and U.S. Provisional Application No. 61/656,471, filed June 6, 2012, the entire content of each of which being incorporated herein by reference.

FIELD AND BACKGROUND

[0002] This disclosure generally relates to computer networks, and more particularly to fault detection in computer networks.

[0003] In a typical cloud data center environment, there is a large collection of interconnected servers that provide computing and/or storage capacity to run various applications. For example, a data center may comprise a facility that hosts applications and services for subscribers, i.e., customers of data center. The data center may, for example, host all of the infrastructure equipment, such as networking and storage systems, redundant power supplies, and environmental controls. In a typical data center, clusters of storage systems and application servers are interconnected via high-speed switch fabric provided by one or more tiers of physical network switches and routers. More sophisticated data centers provide infrastructure spread throughout the world with subscriber support equipment located in various physical hosting facilities.

[0004] Within a data center or other massively distributed complex system, faults and failures are not equivalent. Faults may allow for the continued operation of components of the system that rely on the faulted component. However, faults may develop into and tend to indicate pending failure of one or more components of the system, which deleteriously affects the operation of the system.

SUMMARY

[0005] Particular aspects are set out in the claims

[0006] In general, this disclosure describes techniques for automatically tracing back from a central location (e.g., by using a structurally-queryable (SQL-able) central database), where the trace-back occurs long after a failure occurred, for thereby identifying likely faulty processes in massively distributed complex systems, such as software defined network (SDN) systems.

[0007] This disclosure additionally describes techniques for automatically identifying likely faulty components in massively distributed complex systems. In some examples, snapshots of component parameters are automatically repeatedly fed to a pre-trained classifier and the classifier indicates whether each received snapshot is likely to belong to a fault and failure class or to a non-fault/failure class. Components whose snapshots indicate a high likelihood of fault or failure are investigated, restarted or taken off line as a pre-emptive measure. The techniques may be applied in a massively distributed complex system such as a data center.

[0008] In one example, a method includes determining, by a controller device for a virtual network, a set of two or more related processes executed by respective devices in the virtual network, receiving, by the controller device, data for the set of two or more related processes, and aggregating, by the controller device, the data for the set of two or more related processes to form aggregated data for the set of two or more related processes.

[0009] In another example, a controller device includes one or more network interfaces communicatively coupled to one or more devices of a virtual network, and a processor configured to determine, for the virtual network, a set of two or more related processes executed by respective devices in the virtual network, receive via the network interfaces data for the set of two or more related processes, and aggregate the data for the set of two or more related processes to form aggregated data for the set of two or more related processes.

[0010] In another example, a computer-readable storage medium having stored thereon instructions that, when executed, cause a processor to determine, by a controller device for a virtual network, a set of two or more related processes executed by respective devices in the virtual network, receive, by the controller device, data for the set of two or more related processes, and aggregate, by the controller device, the data for the set of two or more related processes to form aggregated data for the set of two or more related processes.

[0011] The details of one or more examples are set forth in the accompanying drawings and the description below. Other features, objects, and advantages will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF DRAWINGS

[0012] FIG. 1 is a block diagram illustrating an example data center in which examples of the techniques described herein may be implemented.

[0013] FIG. 2 is a block diagram illustrating in further detail an example system in which the techniques described herein may be implemented.

[0014] FIG. 3 is another block diagram illustrating an example system 50 illustrating example configuration of chassis switch and TOR switches as described herein.

[0015] FIG. 4 is a block diagram illustrating an example implementation of a virtual network controller for facilitating operation of one or more virtual networks in accordance with one or more examples of this disclosure.

[0016] FIG. 5 is a block diagram illustrating an example implementation of a virtual network controller for facilitating operation of one or more virtual networks in accordance with one or more examples of this disclosure

[0017] FIG. 6 is a block diagram of a massively distributed complex system, and more specifically, of an SDN system in which a method of tagging traces for later identifying likely faulty processes may be carried out.

[0018] FIG. 7 is a block diagram showing further details (e.g., tiers) of a telecom virtualizing subsystem in which the method of identifying likely faulty components may be carried out.

[0019] FIG. 8 is a schematic and signal flow diagram illustrating how reports are tagged and aggregated.

[0020] FIG. 9 is a flowchart illustrating a process usable in the system of FIG. 8.

[0021] FIG. 10 is a block diagram illustrating an example computing device for aggregating data of various processes, in accordance with one or more techniques of this disclosure.

[0022] FIG. 11A is a block diagram of a massively distributed complex system in which identifying likely faulty components may be carried out according to techniques described in this disclosure.

[0023] FIG. 11B is a block diagram showing further details of a virtualizing subsystem in which identifying likely faulty components may be carried out according to techniques described in this disclosure.

[0024] FIG. 12 is a schematic and signal flow diagram illustrating how a trainable classifier is used to heuristically develop a classification algorithm for predicting the likelihood of component fault and/or failure according to techniques described herein.

[0025] FIGS. 13A-13B depict a flow chart for an example mode of operation of a system according to techniques described herein.

[0026] FIG. 14 is a block diagram illustrating an example computing device for performing operations in accordance with one or more aspects of the present disclosure.

DETAILED DESCRIPTION

[0027] Faults and failures, in the context of software systems, are not one and the same thing. When a failure happens, it is not always easy to determine who or what was at fault (blameworthy), especially if the failure is discovered long after the fault occurred and especially if the point of fault can be anywhere in a massively distributed system such as in a software defined network (SDN) system.

[0028] A simple example of a "fault" might be an attempted division by zero in a math processing part of an executing software process. Ideally, the CPU or other data processing hardware component will issue an exception flag when such a violation of basic math rules is attempted and a corresponding error log will be generated locally for the hardware component and/or software component in which the violation was attempted. Later, when a problem debugging analyst reviews the local log, he/she will spot the exception flag(s) and recognize that a simple math rule violation such as division by zero was attempted.

[0029] A slightly more complex example of a "fault" might be a generation of an out-of-range result value in a math processing part of an executing software process. For example, the allowed range for an accounting procurement account might be: not less than $5.00 but not more than $1000.00; where, for some reason, an executed math operation produces a result value such as $4.99 or $1000.01 and the violation is not caught by hardware means. Ideally, the executing software will include a results validation thread, and the latter will issue one or more exception flags when such a violation of non-basic math and application-specific rules is attempted. Thereafter, a corresponding error log may be generated locally for the results validation thread of the local process in which the violation was attempted. Later, when a problem debugging analyst reviews the local log, he/she will spot the exception flag(s) and recognize that one or more application-specific rule violations were attempted. The problem debugging analyst may then formulate corrective code for avoiding recurrence of the violation(s).

[0030] These simple examples do not address the question of what happens when a rules violating (or other fault-causing) procedure takes place in a multi-encapsulated computing and/or telecommunications environment, such as that where many virtual machines are respectively executing many distributed processes across a massively distributed system such as a software defined network (SDN) system. In that case, even if an exception log exists, the problem debugging analyst often does not know where in the massively distributed system to look because there are too many possibilities and too many spaced apart locations (e.g., physical servers that are miles apart) in which the fault-indicating log or logs might reside. Moreover, because it may take a long time to realize that a problem occurred, by the time the problem debugging analyst retrospectively begins the query the local exception logs, some of them may have already been overwritten by more recent logs due to memory capacity constraints at given local facilities.

[0031] This problem may become particularly acute in systems that are very complex, massive in size (in terms of number of unique components and/or in terms of spatial/geographic extent), and where such systems are expected to be up and running at full capacity as much as possible. An example of such a highly complex, massively sized and full time running system is a software defined networking (SDN) system.

[0032] Examples of SDN systems include so-called data-centers (e.g., cloud computing centers) that are used to support operations of the Internet, including data storage, search, and retrieval. Additional details for one SDN example are given below. In brief, and sufficient for the present introduction; an SDN system may be comprised of many thousands of complex server computers (a.k.a. servers programmed to run plural virtual machines and encapsulated processes and sub-processes thereof), many thousands of network channels and routers/ switches distributed over many thousands of miles where the expectation of users is that both the complex software and hardware components of such a system will remain failure free and operational on a highly reliable and scalable basis.

[0033] It is to be understood that the term, "virtual" as used herein does not mean abstract. Instead it refers to physical means by way of which details of an underlying hardware and/or software system are hidden from a user (encapsulated) and/or by way of which details of an underlying other virtual system are hidden from a user. It is also to be understood that the term, "software" as used herein does not mean software in an abstract sense but rather means a physically real and not ephemerally transient thing which non-abstract, non-ephemerally-transient thing is usable for digitally controlling how a configurable digital data processing system and/or configurable analog signal processing system operates.

[0034] In view of the above introductory description as to the difference between simple fault/failures in simple systems, and in view of the above introductory description as to the difference between small simple systems and massively complex and distributed systems that execute hundreds of thousands if not more of processes and sub-processes encapsulated in respectively large numbers of virtual machines and cross-communicated over a vast telecommunications system, it would advantageous to have a method and system for automatically tracing back from a central location and long after a failure occurred, the exception logs that were generated for thereby identifying likely faulty processes in such massively distributed complex systems.

[0035] The techniques of this disclosure are generally directed to providing trace back from a central location in a massively distributed, complex system, such as a software defined network (SDN) system.

[0036] In one example, a method of identifying likely faulty processes in a massively distributed complex system includes subdividing the system into a plurality of tiers each having alike components and alike kinds of processes normally executing therein, subdividing system executions as belong to respective ones of a plurality of user-accessible entities such as user-viewable virtual networks (a.k.a. user-viewable VNets, or more generally User-Viewable Entities-UVE's) and assigning a unique identifying key (UVEKey) for each respective UVE of each respective system tier (TRx), of each respective virtual and/or physical execution machine (VOPEM) and of each respective process instance (PIN), tagging corresponding trace logs with two or more of such UVE, TRx and PIN identifying keys (e.g., UVEKey, TRxKey, PINKey, VMKey, PMKey) when the trace is locally generated, transmitting the tagged traces to, and storing them in a centralized database that can be structurally queried with use of one or more of these identifying keys (e.g., UVEKey, TRxKey, PINKey, VMKey, PMKey).

[0037] For each respective UVE and tier, the method may include identifying respective process reports that cross correlate with a corresponding UVE Key and a corresponding Tier key where the reports may include quantitative failure or fault parameters such as memory failures, telecommunications failures, processor failures, packet resends and/or drops, etc.) and relaying the UVE and Tier tagged reports to a centralized and query-able database. For each respective process report that is locally generated, automatically tagging the report with one or more linking keys including a UVEKey. For each respective tier, the method may include automatically determining what part of its resources are used by each of respective UVE's and automatically determining if the allocated resources of any UVE are insufficient due to repeated component failures (e.g., lost packets). For each respective UVE and its detected component failures, the method may include logically associating the detected component failures with one or more of the respective captured parameter snapshots that immediately preceded the respective component failures for that UVE.

[0038] The method may further include investigating those of the UVE associated reports that were correlated to failure as being likely to point to the at-fault components and/or tiers of that UVE. The method may also include taking preemptive corrective and/or work-around measures for those of the respective tier components and UVEs that were determined to be more highly likely to enter a failure mode based on the investigation.

[0039] FIG. 1 is a block diagram illustrating an example network 8 having a data center 10 in which examples of the techniques described herein may be implemented. In general, data center 10 provides an operating environment for applications and services for customers 11 coupled to the data center by service provider network 12. Data center 5 may, for example, host infrastructure equipment, such as networking and storage systems, redundant power supplies, and environmental controls. Service provider network 12 may be coupled to one or more networks administered by other providers, and may thus form part of a large-scale public network infrastructure, e.g., the Internet.

[0040] In some examples, data center 10 may represent one of many geographically distributed network data centers. As illustrated in the example of FIG. 1, data center 10 may be a facility that provides network services for customers 11. Customers 11 may be collective entities such as enterprises and governments or individuals. For example, a network data center may host web services for several enterprises and end users. Other example services may include data storage, virtual private networks, traffic engineering, file service, data mining, scientific- or super- computing, and so on. In some examples, data center 10 may be individual network servers, network peers, or otherwise.

[0041] In this example, data center 5 includes set of storage systems and application servers 12A-12X (herein, "servers 12") interconnected via high-speed switch fabric 14 provided by one or more tiers of physical network switches and routers. Switch fabric 14 is provided by a set of interconnected top-of-rack (TOR) switches 16A-16BN ("TOR switches" 16) coupled to a distribution layer of chassis switches 18. Although not shown, data center 10 may also include, for example, one or more non-edge switches, routers, hubs, gateways, security devices such as firewalls, intrusion detection, and/or intrusion prevention devices, servers, computer terminals, laptops, printers, databases, wireless mobile devices such as cellular phones or personal digital assistants, wireless access points, bridges, cable modems, application accelerators, or other network devices.

[0042] In this example, TOR switches 16 and chassis switches 18 provide servers 12 with redundant (multi-homed) connectivity to IP fabric 20 and service provider network 12. Chassis switches 18 aggregates traffic flows and provides high-speed connectivity between TOR switches 16. TOR switches 16A and 16B may be network devices that provide layer 2 (MAC address) and/or layer 3 (IP address) routing and/or switching functionality. TOR switches 16 and chassis switches 18 may each include one or more processors and a memory, and that are capable of executing one or more software processes. Chassis switches 18 are coupled to IP fabric 20, which performs layer 3 routing to route network traffic between data center 10 and customers 11 using service provider network 12.

[0043] Virtual network controller 22 ("VNC") provides a logically centralized controller for facilitating operation of one or more virtual networks within data center 10 in accordance with one or more examples of this disclosure. In some examples, virtual network controller 22 may operate in response to configuration input received from network administrator 24.

[0044] In accordance with the techniques of this disclosure, virtual network controller 22 may be configured to aggregate data for a set of two or more related processes, to form aggregated data for the set of two or more related processes. In particular, virtual network controller 22 may determine the set of two or more related processes executed by respective devices (e.g., servers 12) in a virtual network of data center 10, and receive data for the set of two or more related processes. In general, the set of processes may correspond to a common "tier," e.g., a common network plane, and each of the processes in a particular set may be substantially similar. By executing substantially similar processes on different devices, data center 10 may provide high availability and reduce risk of failure.

[0045] More particularly, in accordance with the techniques of this disclosure, computing devices of data center 10, and processes executed by the computing devices, may be divided into various tiers. Within each tier there may be a set of related (e.g., substantially similar) processes. Furthermore, virtual network controller 22 may define User-Visible Entities (UVEs) for the various tiers. The UVEs may define various data for monitoring processes of the various tiers. For example, the UVEs may define attributes of processes to retrieve. Virtual network controller 22 may receive data output during execution of the processes, and in accordance with the UVEs, extract values for the attributes defined by the UVEs. Virtual network controller 22 may further aggregate this data. For example, the UVE may define a manner in which to aggregate certain types of data, corresponding to the attributes, such as addition, union over sets, concatenation, list generation, or the like.

[0046] Virtual network controller 22 may then generate one or more reports that are indicative of a tier and aggregated values for one or more attributes corresponding to the tier, as defined by a corresponding UVE. This aggregation can be performed transparently to the devices executing the processes. That is, the devices executing the processes need not take any part in the aggregation. An administrator may use the generated report to diagnose various aspects of the virtual network of data center 10. For example, the report may include data indicative of one or more of a quantitative failure, a fault parameter, a memory failure, a telecommunications failure, a processor failure, a packet resend, and/or a dropped communication session. The administrator may determine, using the report, whether any or all of these conditions apply and act accordingly, e.g., by reprogramming a device of data center 10, replacing a device of data center 10, adding, replacing, or removing links between devices, adding or upgrading software for one or more devices of data center 10, or the like, based on the contents of the report.

[0047] In some examples, virtual network controller 22 includes an analytics layer, that is, an intermediate layer that acts on generic rules. The UVEs may define rules in accordance with the analytics layer. Thus, virtual network controller 22 may operate substantially automatically, that is, without user interference, to perform the techniques of this disclosure. The analytics tier may use definitions of the UVEs to extract information from communications output by the devices executing the corresponding processes and aggregate values for certain attributes, as defined by the UVEs, of the communications.

[0048] In this manner, virtual network controller 22 represents an example of a controller device configured to determine, for a virtual network, a set of two or more related processes executed by respective devices in the virtual network, receive data for the set of two or more related processes, and aggregate the data for the set of two or more related processes to form aggregated data for the set of two or more related processes.

[0049] FIG. 2 is a block diagram illustrating an example implementation of data center 10 of FIG. 1 in further detail. In the example of FIG. 2, data center 10 includes an overlay network that extends switch fabric 14 from physical switches 16, 18 to software switches 30A-30X (also referred to as a "virtual switches). Virtual switches 30 dynamically create and manage one or more virtual networks 34 to be used by applications communicating with application instances. In one example, virtual switches 30 execute the virtual network as an overlay network, which provides the capability to decouple an application's virtual address from a physical address (e.g., IP address) of the one of servers 12A-12X ("servers 12") on which the application is executing. Each virtual network 34 may use its own addressing and security scheme and may be viewed as orthogonal from the physical network and its addressing scheme. For example, virtual switch 30A may represent a virtual network switch implemented server 12A (which may be an edge device positioned at an edge of the one or more virtual networks) and may be configured to facilitate overlay of a plurality of networks in the one or more virtual networks using a layer 3 protocol, which is a network layer protocol. Facilitating the network overlay using the layer 3 protocol may be substantially easier than using a layer 2 protocol. This may reduce an implementation cost of the one or more virtual networks. Various techniques may be used to transport packets within and across virtual network(s) 34 over the physical network.

[0050] Each virtual switch 30 may execute within a hypervisor, a host operating system or other component of each of servers 12. In some instances, any of virtual switches 30 may be present in a campus access switch or Wi-Fi access point (WAP). In the example of FIG. 2, virtual switch 30 executes within hypervisor 31, also often referred to as a virtual machine manager (VMM), which provides a virtualization platform that allows multiple operating systems to concurrently run on one of host servers 12. In the example of FIG. 2, virtual switch 30A manages virtual networks 34, each of which provides a network environment for execution of one or more virtual machines (VMs) 36 on top of the virtualization platform provided by hypervisor 31. Each VM 36 is associated with one of the virtual subnets VNO-VN2 managed by the hypervisor 31.

[0051] In general, each VM 36 may be any type of software application and may be assigned a virtual address for use within a corresponding virtual network 34, where each of the virtual networks may be a different virtual subnet provided by virtual switch 30A. A VM 36 may be assigned its own virtual layer three (L3) IP address, for example, for sending and receiving communications but may be unaware of an IP address of the physical server 12A on which the virtual machine is executing. In this way, a "virtual address" is an address for an application that differs from the logical address for the underlying, physical computer system, i.e., server 12A in the example of FIG. 2.

[0052] In one implementation, each of servers 12 includes a virtual network agent ("VN agent") 35A-35X ("VN agents 35") that controls the overlay of virtual networks 34 and that coordinates the routing of data packets within server 12. In general, each VN agent 35 communicates with virtual network controller 22, which generates commands to control routing of packets through data center 10. VN agents 35 may operate as a proxy for control plane messages between virtual machines 36 and virtual network controller 22. For example, a VM 36 may request to send a message using its virtual address via the VN agent 35A, and VN agent 35A may in turn send the message and request that a response to the message be received for the virtual address of the VM 36 that originated the first message. In some cases, a VM 36 may invoke a procedure or function call presented by an application programming interface of VN agent 35A, and the VN agent 35A may handle encapsulation of the message as well, including addressing.

[0053] In one example, network packets, e.g., layer three (L3) IP packets or layer two (L2) Ethernet packets generated or consumed by the instances of applications executed by virtual machines 36 within the virtual network domain may be encapsulated in another packet (e.g., another IP or Ethernet packet) that is transported by the physical network. The packet transported in a virtual network may be referred to herein as an "inner packet" while the physical network packet may be referred to herein as an "outer packet." Encapsulation and/or de-capsulation of virtual network packets within physical network packets may be performed within virtual switches 30, e.g., within the hypervisor or the host operating system running on each of servers 12. As another example, encapsulation and de-capsulation functions may be performed at the edge of switch fabric 14 at a first-hop TOR switch 16 that is one hop removed from the application instance that originated the packet. This functionality is referred to herein as tunneling and may be used within data center to create one or more overlay networks. Other example tunneling protocols may be used, including IP over GRE, VxLAN, MPLS over GRE, etc.

[0054] As noted above, virtual network controller 22 provides a logically centralized controller for facilitating operation of one or more virtual networks within data center 10. Virtual network controller 22 may, for example, maintain a routing information base, e.g., on or more routing tables that store routing information for the physical network as well as the overlay network of data center 10. Similarly, switches 16, 18 and virtual switches 30 maintain routing information, such as one or more routing and/or forwarding tables. In one example implementation, virtual switch 30A of hypervisor 31 implements a network forwarding table (NFT) 32 for each virtual network 34. In general, each NFT 32 stores forwarding information for the corresponding virtual network 34 and identifies where data packets are to be forwarded and whether the packets are to be encapsulated in a tunneling protocol, such as with one or more outer IP addresses.

[0055] The routing information may, for example, map packet key information (e.g., destination IP information and other select information from packet headers) to one or more specific next hops within the networks provided by virtual switches 30 and switch fabric 14. In some case, the next hops may be chained next hop that specify a set of operations to be performed on each packet when forwarding the packet, such as may be used for flooding next hops and multicasting replication. In some cases, virtual network controller 22 maintains the routing information in the form of a radix tree having leaf nodes that represent destinations within the network. U.S. Patent 7,184,437 provides details of an example router that utilizes a radix tree for route resolution, the contents of U.S. Patent 7,184,437 being incorporated herein by reference in its entirety.

[0056] As shown in FIG. 2, each virtual network 34 provides a communication framework for encapsulated packet communications 37 for the overlay network established through switch fabric 14. In this way, network packets associated with any of virtual machines 36 may be transported as encapsulated packet communications 37 via the overlay network. In addition, in the example of FIG. 2, each virtual switch 30 includes a default network forwarding table NFT_0 and provides a default route that allows packet to be forwarded to virtual subnet VNO without encapsulation, i.e., non-encapsulated packet communications 39 per the routing rules of the physical network of data center 10. In this way, subnet VNO and virtual default network forwarding table NFT_0 provide a mechanism for bypassing the overlay network and sending non-encapsulated packet communications 39 to switch fabric 14.

[0057] Moreover, virtual network controller 22 and virtual switches 30 may communicate using virtual subnet VNO in accordance with default network forwarding table NFT_0 during discovery and initialization of the overlay network, and during conditions where a failed link has temporarily halted communication via the overlay network. Once connectivity with the virtual network controller 22 is established, the virtual network controller 22 updates its local routing table to take into account new information about any failed links and directs virtual switches 30 to update their local network forwarding tables 32. For example, virtual network controller 22 may output commands to virtual network agents 35 to update one or more NFTs 32 to direct virtual switches 30 to change the tunneling encapsulation so as to re-route communications within the overlay network, for example to avoid a failed link.

[0058] When link failure is detected, a virtual network agent 35 local to the failed link (e.g., VN Agent 35A) may immediately change the encapsulation of network packet to redirect traffic within the overlay network and notifies virtual network controller 22 of the routing change. In turn, virtual network controller 22 updates its routing information and may issue messages to other virtual network agents 35 to update local routing information stored by the virtual network agents within network forwarding tables 32.

[0059] FIG. 3 is another block diagram illustrating an example system 50 illustrating example configuration of routing information within chassis switch and TOR switches as described herein. System 50 of FIG. 3 may, for example, correspond to portions of data center 10 illustrated in FIGS 1 and 2.

[0060] In this example, chassis switch 52 ("CH 52"), which may be any of chassis switches 18 of FIG. 1, is coupled to Top of Rack (TOR) switches 58A-58B ("TORs 58") by chassis link 60A and chassis link 60B, respectively ("chassis links 60"). TORs 58 may, in some examples, be any of TORs 16 of FIG. 1. In the example of FIG. 3, TORs 58 are also coupled to servers 50A-50B ("servers 50") by TOR links 62A-62D ("TOR links 62"). Servers 50 may be any of servers 12 (FIG. 1). Here, servers 50 communicate with both TORs 58, and can physically reside in either associated rack. TORs 58 each communicate with a number of network switches, including chassis switch 18A.

[0061] Chassis switch 52 has a processor 54A in communication with an interface for communication with a network as shown, as well as a bus that connects a memory (not shown) to processor 54A. The memory may store a number of software modules. These modules include software that controls network routing, such as an Open Shortest Path First (OSPF) module (not shown) containing instructions for operating the chassis switch 18A in compliance with the OSPF protocol. Chassis switch 52 maintains routing table ("RT table") 56A containing routing information for packets, which describes a topology of a network. Routing table 56A may be, for example, a table of packet destination Internet protocol (IP) addresses and the corresponding next hop, e.g., expressed as a link to a network component.

[0062] TORs 58 each have a respective processor 54B, 54C, an interface in communication with chassis switch 18A, and a memory (not shown). Each memory contains software modules including an OSPF module and routing table 56B, 56C as described above.

[0063] TORs 58 and chassis switch 52 may exchange routing information specifying available routes, such as by using a link-state routing protocol such as OSPF or IS-IS. TORs 58 may be configured as owners of different routing subnets. For example, TOR 58A is configured as the owner of Subnet 1, which is the subnet 10.10.10.0/24 in the example of FIG. 2, and TOR 58B is configured as the owner of Subnet 2, which is the subnet 10.10.11.0/24 in the example of FIG. 2. As owners of their respective Subnets, TORs 58 locally store the individual routes for their subnets and need not broadcast all route advertisements up to chassis switch 18A. Instead, in general TORs 58 will only advertise their subnet addresses to chassis switch 18A.

[0064] Chassis switch 52 maintains a routing table

("RT table") 56A, which includes routes expressed as subnets reachable by TORs 58, based on route advertisements received from TORs 58. In the example of FIG. 2, RT table 56A stores routes indicating that traffic destined for addresses within the subnet 10.10.11.0/24 can be forwarded on link 60B to TOR 58B, and traffic destined for addresses within the subnet 10.10.10.0/24 can be forwarded on link 60A to TOR 58A.

[0065] In typical operation, chassis switch 18A receives Internet Protocol (IP) packets through its network interface, reads the packets' destination IP address, looks up these addresses on routing table 56A to determine the corresponding destination component, and forwards the packets accordingly. For example, if the destination IP address of a received packet is 10.10.10.0, i.e., the address of the subnet of TOR 58A, the routing table of chassis switch 52 indicates that the packet is to be sent to TOR 58A via link 60A, and chassis switch 52 transmits the packet accordingly, ultimately for forwarding to a specific one of the servers 50.

[0066] Similarly, each of TORs 58 receives Internet Protocol (IP) packets through its network interface, reads the packets' destination IP address, looks up these addresses on its routing table 56 to determine the corresponding destination component, and forwards the packets according to the result of the lookup.

[0067] FIG. 4 is a block diagram illustrating an example implementation of a virtual network controller 22 for facilitating operation of one or more virtual networks in accordance with one or more examples of this disclosure. Virtual network controller 22 may, for example, correspond to virtual network controller 22 of data center 10 of FIGS. 1 and 2.

[0068] Virtual network controller (VNC) 22 of FIG. 4 illustrates a distributed implementation of a VNC that includes multiple VNC nodes 80A-80N (collectively, "VNC nodes 80") to execute the functionality of a data center VNC, including managing the operation of virtual switches for one or more virtual networks implemented within the data center. Each of VNC nodes 80 may represent a different server of the data center, e.g., any of servers 12 of FIGS. 1-2, or alternatively, on a server or controller coupled to the IP fabric by, e.g., an edge router of a service provider network or a customer edge device of the data center network. In some instances, some of VNC nodes 80 may execute as separate virtual machines on the same server.

[0069] Each of VNC nodes 80 may control a different, non-overlapping set of data center elements, such as servers, individual virtual switches executing within servers, individual interfaces associated with virtual switches, chassis switches, TOR switches, and/or communication links. VNC nodes 80 peer with one another using peering links 86 to exchange information for distributed databases, including distributed databases 82A-82K (collectively, "distributed databases 82"), and routing information (e.g., routes) for routing information bases 84A-84N (collectively, "RIBs 84"). Peering links 86 may represent peering links for a routing protocol, such as a Border Gateway Protocol (BGP) implementation, or another peering protocol by which VNC nodes 80 may coordinate to share information according to a peering relationship.

[0070] VNC nodes 80 of VNC 22 include respective RIBs 84 each having, e.g., one or more routing tables that store routing information for the physical network and/or one or more overlay networks of the data center controlled by VNC 22. In some instances, one of RIBs 84, e.g., RIB 84A, may store the complete routing table for any of the virtual networks operating within the data center and controlled by the corresponding VNC node 80 (e.g., VNC node 80A).

[0071] In general, distributed databases 82 define the configuration or describe the operation of virtual networks by the data center controlled by distributed VNC 22. For instance, distributes databases 82 may include databases that describe a configuration of one or more virtual networks, the hardware/software configurations and capabilities of data center servers, performance or diagnostic information for one or more virtual networks and/or the underlying physical network, the topology of the underlying physical network including server/chassis switch/TOR switch interfaces and interconnecting links, and so on. Distributed databases 82 may each be implemented using, e.g., a distributed hash table (DHT) to provide a lookup service for key/value pairs of the distributed database stored by different VNC nodes 22. Distributed databases 82 may be implemented/stored using computer-readable media of or associated with VNC nodes 22.

[0072] FIG. 5 is a block diagram illustrating an example implementation of a virtual network controller 100 for facilitating operation of one or more virtual networks in accordance with one or more examples of this disclosure. Virtual network controller 100 may, for example, correspond to virtual network controller 22 of data center 10 of FIGS. 1 and 2 or virtual network controller 22 of FIG. 4.

[0073] As illustrated in the example of FIG. 5, distributed virtual network controller (VNC) 100 includes one or more virtual network controller ("VNC") nodes 102A-102N (collectively, "VNC nodes 102"). Each of VNC nodes 102 may represent any of VNC nodes 80 of virtual network controller 22 of FIG. 4. VNC nodes 102 that peer with one another according to a peering protocol operating over network 160. Network 160 may represent an example instance of switch fabric 14 and / or IP fabric 20 of FIG. 1. In the illustrated example, VNC nodes 102 peer with one another using a Border Gateway Protocol (BGP) implementation, an example of a peering protocol. In this sense, VNC nodes 102A and 102N may represent a first controller node device and a second controller node device peered using a peering protocol. VNC nodes 102 include respective network discovery modules 114A-114N to discover network elements of network 160.

[0074] VNC nodes 102 provide, to one another using the peering protocol, information related to respective elements of the virtual network managed, at least in part, by the VNC nodes 102. For example, VNC node 102A may manage a first set of one or more servers operating as virtual network switches for the virtual network. VNC node 102A may send information relating to the management or operation of the first set of servers to VNC node 102N by BGP 118A. Other elements managed by VNC nodes 102 may include network controllers and/or appliances, network infrastructure devices (e.g., L2 or L3 switches), communication links, firewalls, and VNC nodes 102, for example. Because VNC nodes 102 have a peer relationship, rather than a master-slave relationship, information may be sufficiently easily shared between the VNC nodes 102. In addition, hardware and/or software of VNC nodes 102 may be sufficiently easily replaced, providing satisfactory resource fungibility. Further, distributed VNC 100 may enable may enable horizontally scalable configuration and management, which may give a single system view of the one or more virtual networks.

[0075] Each of VNC nodes 102 may include substantially similar/analogous components for performing substantially similar/analogous functionality, said functionality being described hereinafter primarily with respect to VNC node 102A. VNC node 102A may include an analytics database 106A for storing diagnostic information related to a first set of elements managed by VNC node 102A. Analytics database 106A may include a horizontally scalable network analytics database, which may represent a fully integrated analytics collector configured to troubleshoot, visualize, and analyze distributed VNC 100 and the one or more virtual networks. VNC node 102A may share at least some diagnostic information related to VNC node 102A and/or one or more of the first set of elements managed by VNC node 102A and stored in analytics database 106, as well as to receive at least some diagnostic information related to any of the elements managed by others of VNC nodes 102. Analytics database 106A may represent a distributed hash table (DHT), for instance, or any suitable data structure for storing diagnostic information for network elements in a distributed manner in cooperation with others of VNC nodes 102. Analytics databases 106A-106N (collectively, "analytics databases 106") may represent, at least in part, one of distributed databases 82 of distributed virtual network controller 22 of FIG. 4.

[0076] VNC node 102A may include a configuration database 110A for storing configuration information related to a first set of elements managed by VNC node 102A. Control plane components of VNC node 102A may store configuration information to configuration database 110A using interface 144A, which may represent an Interface for Metadata Access Points (IF-MAP) protocol implementation. VNC node 102A may share at least some configuration information related to one or more of the first set of elements managed by VNC node 102A and stored in configuration database 110A, (including, e.g., VNC node 102A), as well as to receive at least some configuration information related to any of the elements managed by others of VNC nodes 102. Configuration database 110A may represent a distributed hash table (DHT), for instance, or any suitable data structure for storing configuration information for network elements in a distributed manner in cooperation with others of VNC nodes 102. Configuration databases 110A-110N (collectively, "configuration databases 110") may represent, at least in part, one of distributed databases 82 of distributed virtual network controller 22 of FIG. 4. Configuration databases 110 may store respective RIBs 84 of FIG. 4. Portions of RIBs 84 may be stored by control plane VMs 112 to facilitate operation of network discovery modules 114 and BGPs 118.

[0077] Virtual network controller 100 may perform any one or more of the illustrated virtual network controller operations represented by modules 130, which may include orchestration 132, user interface 134, VNC global load balancing 136, and one or more applications 138. VNC 100 executes orchestration module 132 to facilitate the operation of one or more virtual networks in response to a dynamic demand environment by, e.g., spawning/removing virtual machines in data center servers, adjusting computing capabilities, allocating network storage resources, and modifying a virtual topology connecting virtual switches of a virtual network. VNC global load balancing 136 executed by VNC 100 supports load balancing of analytics, configuration, communication tasks, e.g., among VNC nodes 102. Applications 138 may represent one or more network applications executed by VNC nodes 102 to, e.g., change topology of physical and/or virtual networks, add services, or affect packet forwarding. In some instances, a centralized network management system or other controller executes modules 130 and communicates using a northbound interface of VNC nodes 102 to perform orchestration, configure VNC nodes 102, perform VNC global load balancing, and execute VNC nodes 102 with virtual network applications 138.

[0078] User interface 134 includes an interface usable to an administrator (or software agent) to control the operation of VNC nodes 102. For instance, user interface 134 may include methods by which an administrator may modify, e.g. configuration database 110A of VNC node 102A. Administration of the one or more virtual networks operated by VNC 100 may proceed by uniform user interface 134 that provides a single point of administration, which may reduce an administration cost of the one or more virtual networks.

[0079] VNC node 102A may include a control plane virtual machine (VM) 112A that executes control plane protocols to facilitate the distributed VNC techniques described herein. Control plane VM 112A may in some instances represent a native process. In the illustrated example, control VM 112A executes BGP 118A to provide information related to the first set of elements managed by VNC node 102A to, e.g., control plane virtual machine 112N of VNC node 102N. Control plane VM 112A may use an open standards based protocol (e.g., BGP based L3VPN) to distribute information about its virtual network

(s) with other control plane instances and/or other third party networking equipment(s). Given the peering based model according to one or more aspects described herein, different control plane instances (e.g., different instances of control plane VMs 112A-112N) may execute different software versions. In one or more aspects, e.g., control plane VM 112A may include a type of software of a particular version, and the control plane VM 112N may include a different version of the same type of software. The peering configuration of the control node devices may enable use of different software versions for the control plane VMs 112A-112N. The execution of multiple control plane VMs by respective VNC nodes 102 may prevent the emergence of a single point of failure.

[0080] Control plane VM 112A communicates with virtual network switches, e.g., illustrated VM switch 174 executed by server 170, using a communication protocol operating over network 160. Virtual network switches facilitate overlay networks in the one or more virtual networks. In the illustrated example, control plane VM 112A uses Extensible Messaging and Presence Protocol (XMPP) 116A to communicate with at least virtual network switch 174 by XMPP interface 150A. Virtual network route data, statistics collection, logs, and configuration information may in accordance with XMPP 116A be sent as XML documents for communication between control plane VM 112A and the virtual network switches. Control plane VM 112A may in turn route data to other XMPP servers (such as an analytics collector, e.g., analytics VM 104A) or may retrieve configuration information on behalf of one or more virtual network switches. Control plane VM 112A may further execute a communication interface 144A for communicating with configuration virtual machine (VM) 108A associated with configuration database 110A. Communication interface 144A may represent an IF-MAP interface. Server 170 may represent an example instance of any of servers 12 of FIGS. 1-2 or servers 50 of FIG. 3, with virtual network switch 174 representing any of virtual switches 30 and virtual network switch agent 172 representing any of virtual network agents 35 of FIG. 2, for example.

[0081] VNC node 102A may further include configuration VM 108A to store configuration information for the first set of element to and manage configuration database 110A. Configuration VM 108A, although described as a virtual machine, may in some aspects represent a native process executing on an operating system of VNC node 102A. Configuration VM 108A and control plane VM 112A may communicate using IF-MAP by communication interface 144A and using XMPP by communication interface 146A. In some aspects, configuration VM 108A may include a horizontally scalable multi-tenant IF-MAP server and a distributed hash table (DHT)-based IF-MAP database represented by configuration database 110A. In some aspects, configuration VM 108A may include a configuration translator, which may translate a user friendly higher-level virtual network configuration to a standards based protocol configuration (e.g., a BGP L3VPN configuration), which may be stored using configuration database 110A. Communication interface 140 may include an IF-MAP interface for communicating with other network elements. The use of the IF-MAP may make the storage and management of virtual network configurations very flexible and extensible given that the IF-MAP schema can be dynamically updated. Advantageously, aspects of virtual network controller 100 may be flexible for new applications 138.

[0082] VNC node 102A may further include an analytics virtual machine (VM) 104A to store diagnostic information (and/or visibility information) related to at least the first set of elements managed by VNC node 102A. Control plane VM and analytics VM 104 may communicate using an XMPP implementation by communication interface 146A. Analytics VM 104A, although described as a virtual machine, may in some aspects represent a native process executing on an operating system of VNC node 102A.

[0083] Analytics VM 104A may include analytics database 106A, which may represent an instance of a distributed database that stores visibility data for virtual networks, such as one of distributed database 82 of distributed virtual network controller 22 of FIG. 4. Visibility information may describe visibility of both distributed VNC 100 and of customer networks. Analytics database 106A of analytics VM 104A may include an XMPP interface on a first (southbound) side and a REST/JASON/XMPP interface on a (northbound) second side by communication interface 142A.

[0084] Virtual network switch 174 may implement the layer 3 forwarding and policy enforcement point for one or more end points and/or one or more hosts. The one or more end points or one and/or one or more hosts may be classified into a virtual network due to configuration from control plane VM 112A. Control plane VM 112A may also distribute virtual-to-physical mapping for each end point to all other end points as routes. These routes may give the next hop mapping virtual IP to physical IP and encapsulation technique used (e.g., one of IPinIP, NVGRE, VXLAN, etc.). Virtual network switch 174 may be agnostic to actual tunneling encapsulation used. Virtual network switch 174 may also trap interesting layer 2 (L2) packets, broadcast packets, and/or implement proxy for the packets, e.g. using one of Address Resolution Protocol (ARP), Dynamic Host Configuration Protocol (DHCP), Domain Name Service (DNS), multicast DNS (mDNS), etc.

[0085] In some cases, different VNC nodes 102 may be provided by different suppliers. However, the peering configuration of VNC nodes 102 may enable use of different hardware and/or software provided by different suppliers for implementing the VNC nodes 102 of distributed VNC 100. A system operating according to the techniques described above may provide logical view of network topology to end-hosts irrespective of physical network topology, access type, and/or location. Distributed VNC 100 may provide programmatic ways for network operators and/or applications to change topology, to affect packet forwarding, and/or to add services, as well as horizontal scaling of network services, e.g. firewall, without changing the end-host view of the network.

[0086] In accordance with the techniques of this disclosure, virtual network controller 100 may be configured to aggregate data for a set of two or more related processes, to form aggregated data for the set of two or more related processes. In particular, virtual network controller 100 may determine the set of two or more related processes executed by respective devices in a virtual network of network 160, and receive data for the set of two or more related processes. In general, the set of processes may correspond to a common "tier," e.g., a common network plane, and each of the processes in a particular set may be substantially similar. By executing substantially similar processes on different devices, network 160 may provide high availability and reduce risk of failure.

[0087] More particularly, in accordance with the techniques of this disclosure, computing devices of network 160, and processes executed by the computing devices, may be divided into various tiers. Within each tier there may be a set of related (e.g., substantially similar) processes. Furthermore, virtual network controller 100 may define User-Visible Entities (UVEs) for the various tiers. The UVEs may define various data for monitoring processes of the various tiers. For example, the UVEs may define attributes of processes to retrieve. Virtual network controller 100 may receive data output during execution of the processes, and in accordance with the UVEs, extract values for the attributes defined by the UVEs. Virtual network controller 100 may further aggregate this data. For example, the UVE may define a manner in which to aggregate certain types of data, corresponding to the attributes, such as addition, union over sets, concatenation, list generation, or the like.

[0088] Virtual network controller 100 may then generate one or more reports that are indicative of a tier and aggregated values for one or more attributes corresponding to the tier, as defined by a corresponding UVE. This aggregation can be performed transparently to the devices executing the processes. That is, the devices executing the processes need not take any part in the aggregation. An administrator may use the generated report to diagnose various aspects of the virtual network of network 160. For example, the report may include data indicative of one or more of a quantitative failure, a fault parameter, a memory failure, a telecommunications failure, a processor failure, a packet resend, and/or a dropped communication session. The administrator may determine, using the report, whether any or all of these conditions apply and act accordingly, e.g., by reprogramming a device of network 160, replacing a device of network 160, adding, replacing, or removing links between devices, adding or upgrading software for one or more devices of network 160, or the like, based on the contents of the report.

[0089] In some examples, virtual network controller 100 includes an analytics layer, that is, an intermediate layer that acts on generic rules. The UVEs may define rules in accordance with the analytics layer. Thus, virtual network controller 100 may operate substantially automatically, that is, without user interference, to perform the techniques of this disclosure. The analytics tier may use definitions of the UVEs to extract information from communications output by the devices executing the corresponding processes and aggregate values for certain attributes, as defined by the UVEs, of the communications.

[0090] In this manner, virtual network controller 100 represents an example of a controller device configured to determine, for a virtual network, a set of two or more related processes executed by respective devices in the virtual network, receive data for the set of two or more related processes, and aggregate the data for the set of two or more related processes to form aggregated data for the set of two or more related processes.

[0091] FIG. 6 is a block diagram of a massively distributed complex system 1000, and more specifically, of a software defined networking (SDN) system to which the disclosed concepts may be applied. As an example, FIG. 6 may represent a cloud-implementing data center environment in which there is provided a large collection of network-interconnected servers (e.g., servers 210x, 210y, which may correspond to respective servers 12 of FIG. 1) that provide computer and/or storage capacity to run many different users and/or other kinds of application programs (e.g., programs 216, where these programs can include interactive video gaming support processes and/or simple text processing support processes).

[0092] Such an environment tends to be very dynamic from an applications point of view. It may be desirable to have a level of automation that insulates users from the infrastructure details and that can avoid the need for manual intervention to interconnect the physical servers to provide the computation, storage, and/or telecommunications capacities required to enable the various applications to execute to one level of sufficiency or another.

[0093] In order to enable automation and agility of the infrastructure (e.g., a physical interconnect fabric 200 as well as a scalable processes of physical and/or virtual machines), there is a growing trend to deploy either an overlay networking solution or a virtualized networking system on top of physical computer clusters, where the overlay and/or virtualizing subsystem encapsulates and automatically manages the details of keeping the many physical data processing resources (e.g., resources of servers 210x, 210y), the many physical network switches and routers (e.g., switches 206, which may correspond to devices of IP fabric 20 in FIG. 1, such as chassis switches 18 and/or TOR switches 16 of FIG. 1) and channels (e.g., channel 202) up and running at desired bandwidths (BW) and desired qualities of service (QOS), represented in FIG. 6 by element 204.

[0094] In such an environment, each of many servers (e.g., servers 210x, 210y) may be running one or more application processes (e.g., process 216) and/or guest operating systems (internals of which are not explicitly shown). In order to enable many guest operating systems (also called virtual machines (VMs) 215) on a single server, the system may utilize a virtual machines monitoring system, commonly known as hypervisor (such as ESX, Hyper-V, KVM, Xen, etc.). Hypervisor 231 of FIG. 7 represents an example of such a hypervisor. A single application (e.g., which includes a process or thread UVP1 executing inside a processes support means 216) may require many instances of computer and storage resources that may be provided by the infrastructure as multiple individual servers and/or multiple virtual machines running on one or more servers. In order for the application to share information amongst its distributed computer and storage instances, and with the outside world, a telecommunications network 200 is generally used to enable movement of this information as, for example, packet conveyed data signals (217). Every time a new application is instantiated and/or changed on the infrastructure, a respective virtual network (e.g., VNet 207v) may be created and/or changed to support the new/changed application and to allow all its computer and storage instances to share information with one another and/or the outside world.

[0095] The term "user-viewable" as used herein is to be understood as referring to a user defined partitioning of at least an inter-processes communications layer of a system into mutually exclusive sectors where all the inter-processes communications of a set of processes under investigation by the user are presumed by the user to be limited to taking place through one of the partition sectors but not any of the others and thus investigation of process interactions (e.g., for purpose of debugging a problem of such interactions) can be limited to investigating inter-process communications only occurring within the associated one of the plural sectors. The term "user-viewable" as used herein may be understood more broadly as referring not only to the one inter-processes communications sector, but also to the processes themselves and to the other system resources (in addition to the associated and dedicated sector of the communications layer) that the processes under investigation are presumed to use on an exclusive basis (e.g., dedicated virtual machines that support the processes under investigation). Thus, all the inter-process activities of the set of processes under investigation by the user can be presumed by the user to be limited to taking place only inside the user defined User-Visible Entity (UVE) and thus investigation of process actions and interactions (e.g., for purpose of debugging a problem of such interactions) can be limited to investigating operations taking place only inside the associated UVE.

[0096] An example of what could be deemed to be a UVE is all the processes of an identified user application program including inter-processes communications resources dedicated to that application program and including computer and storage resources dedicated to that application program. However, the definition is not limited to a single user and/or a single application program. A single UVE can encompass resources dedicated to multiple unrelated applications of one or more identified users, subject to appropriate authentication that the resources (e.g., a partitioned part of the system communications layer) are indeed dedicated to the identified multiple applications. In other words, more generally, a UVE may be thought of as representing some dedicated (partitioned-for-investigation) aspects of operational states of a system or of its resources where investigation can then be limited to the dedicated aspects for purpose of trying to operate, provision, troubleshoot or analyze a corresponding part of the system in some manner. The UVE, in many instances, may exclude those lower level aspects of system states and system resources that are for internal system use only, are hidden (encapsulated away) from the user processes that are under investigation and are thus not intended to represent part of the system application interface to an outside world of user applications. Making all system state and resources (including lower level ones) visible to external applications may be confusing and overwhelming to investigatory applications rather than helpful. The dedicated subset of system states and resources that are deemed to be "User Visible" may be reevaluated from time to time and changed as respective users see fit.

[0097] Each UVE may be associated with a definition file. The definition file may specify a type of aggregation for each attribute associated with the UVE (e.g., summation, concatenation, list formation, union over sets, or the like). An aggregator may use the aggregation information of the definition file. That is, processes corresponding to the UVE need not use the aggregation information. Each of the UVEs may be specified in an interface definition language file. An analytics tier may use extra attributes defined in the interface definition language file to perform aggregation. When UVEs are sent to the analytics tier, messages may mark attributes of the UVEs with aggregation tier. Thus, devices or processes executing at the analytics tier may receive both values for attributes associated with a UVE, as well as aggregation information associated with the UVE. In this manner, these devices or processes at the analytics tier may use the aggregation information to determine how to aggregate values for the attributes. In this manner, the aggregation of information can be performed without the processes that generate the information actively participating in the aggregation. That is, an aggregator may receive individual streams of information from the various processes and aggregate the information, without requiring a change on the part of the processes that generate the information to be aggregated.

[0098] Additionally, the system states and resources that are deemed to be part of a specific UVE do not each have to be directly visible to a corresponding one or more non-administrative users of the application(s) which fit inside the specific UVE. Rather the corresponding compute, storage and telecommunication resources need only be visible to each other for allowing corresponding user processes to interact with one another as required by the corresponding application and/or set of applications that are under investigation. At the same time, the corresponding compute, storage and telecommunication resources should not be visible to; and capable of being interfered by, resources of external other user applications that are not under investigation. If something goes wrong (e.g., a failure) within a given application (or set of applications), it is expected that only the "visible" compute, storage and telecommunication resources that are dedicated to that given application will be involved and thus those are the ones that should be under investigation. (Stated otherwise and referring briefly to FIG. 8, a specific User-Visible Entity (e.g., UVE(2)) may be conceptualized as a dedicated partition that cuts orthogonally across a plurality of system planes (strata), including one or more system telecommunication planes (e.g., a virtual forwarding plane).

[0099] In a virtualized or overlay network environment, the edge of the network is extended from the physical network elements (e.g., switches 206 or the like (such as routers)) to software switches (e.g., a VRouter like 232 of FIG. 7) running inside the corresponding hypervisor (231, also in FIG. 7) or inside the host operating system on the physical server (e.g., 210z). The so-virtualized and/or overlayed network that is used by the interacting applications to communicate with their respective process instances is created dynamically and managed by software switch controlling means (e.g., 240) having its own addressing and security scheme where the latter is orthogonal from the physical network (200) and its addressing scheme. There are many different methods that can be employed to transport packets (e.g., 217) within and across the virtual network(s) and over the physical network.

[0100] Network IP (and/or Ethernet) packets (e.g., 217) generated or consumed by the instances of each isolated application in the virtual networking domain are encapsulated in further IP (and/or Ethernet) packets that are transported by the physical network. Herein, the virtual network packet will be referred to as inner packet and the physical network packet will be referred to as outer packet. The function of encapsulation and/or decapsulation of the virtual network packet within physical network packet is done in the hypervisor (231) or the host O/S (not shown) running on the server 210. In addition, the encapsulation and de-capsulation function can also be performed at the edge of the network in a first-hop physical network switch (e.g., one of switches 206), a network router, or the like. This functionality is commonly called tunneling and is actively used in networking to create overlay networks. There are many different tunneling protocols used in the industry wherein different protocols are carried within another protocol, for example, IP over GRE, VxLAN, MPLS over GRE, etc.

[0101] Cloud data-center networks can constitute an example of a massively distributed complex system because the number of interconnected servers can be very large with each server presenting one or more links, each having a respective 1Gbps or 10Gbps or greater bandwidth link. In order to construct a network that can interconnect all such links, operators generally use a number of switches (or routers) each with N input (ingress) links x M output (egress) links. Each of these individual switches can act as an IP router with its own IP address(es). Plural routers may be operatively cross coupled to define CLOS networks of routers or similar multi-stage routing arrangements.

[0102] Referring to some of the specifics shown in Figs. 6-7, there can be a plurality of different kinds of components in respective "tiers" or service planes of a virtualized overlay system.

[0103] One of these planes is the virtual-to-physical forwarding plane 230 (shown in FIG. 7). It includes the so-called, virtual network routers (VNRouters, or more simply VRouters 232-239). These components can reside in the respective hypervisors (231) of the respective physical servers (e.g., 210) or they can reside on a so-called, Top of Rack switch (not shown) which is typically included in the virtual-to-physical forwarding plane 230. When the VRouter is disposed in the hypervisor, it acts as a software switch having both respective virtual ports connected to the virtual machines (VMs) and physical ports corresponding to the physical I/O ports of the respective server 210. Each VNRouter selectively routes/switches packets between its virtual ports and the physical ports and/or between its virtual ports. The VNRouters may be considered as Data/Forwarding Plane components of the Virtual Network System. In order to support scalable flexibility, some of the VRouters (e.g., 232-235) in a given hypervisor may be dedicated to servicing a first virtual network (UV-Vnet(1)), another subset of the VRouters (e.g., 236-237) may be dedicated to servicing a second virtual network (UV-Vnet(2)) and yet another subset of the VRouters (e.g., 238-239) may be held in reserve for dynamic assignment to one of the first and second user-viewable networks (e.g., UV-Vnet(1), UV-Vnet(2)) or to a dynamically instantiated other virtual network (Vnet).

[0104] Another of the plural tiers or planes within the SDN system 1000 is referred to as the Control Plane 240 and it may contain a plurality of virtual machines (VM_{cp-i}) implementing respective Controllers or Controller Processes. These are typically configured as horizontally scalable components (just as the VRouters are typically configured as horizontally scalable components) that provide dynamically scalable control functions within the Virtual Network System. The Controllers each operatively couples to a respective set of VNRouters and each distributes respective routing information signals to its dynamically scalable set of VNRouters. In one example, the relative scale of the Virtual Network System is on the order of 100s of 1000s of VNRouters (e.g., 232) and 100s of corresponding Controllers (e.g., VNcp1).

[0105] Another of the plural tiers or planes within the SDN system 1000 is referred to as the Configurations Plane 250 and it may contain a plurality of virtual machines (VM_{gp-k}) implementing respective Configuration Processes. These are typically configured as horizontally scalable components (just as the VRouters and the Controllers are typically configured as horizontally scalable components) that provide control functions with respect to interconnect and/or other configurations within the Virtual Network System. The Configuration controllers each operatively couples to a respective parts of the physical network (200) and/or to respective parts of the Control Plane 240 and each distributes respective configuration information signals to its controlled counterparts.

[0106] Yet another of the plural tiers or planes within the SDN system 1000 is referred to as the Analytics plane 280. Components (e.g., VMn1) within the Analytics plane 280 are typically charged with automatically monitoring and/or automatically collecting reported states of other parts of the Virtual Network System. In other words, the Analytics component are typically tasked with gathering information from all other components in the system so as to develop a bird's eye or big picture view of what is occurring in the system as a whole. This Big Data information is generally stored in a persistent database. This information can then be used to show the current state of the system, to help debug problems, to do historical or real-time analysis of the system and so on.

[0107] Because of the highly scalable and variable nature of the SDN System 1000, it is prone to many fault and failure modes. In other words, because of the scale and numbers of components involved, it is likely that one or more are in failure mode. On the other hand, it is desired that the SDN System 1000 provide its users (e.g., 205x, 205y, 205w, 205z) with continuously robust, reliable, wide bandwidth and high quality services. So the in-failure mode components need to be worked around, for example by drawing on the spare components that are typically held in reserve in each horizontally scalable tier. In other words, the SDN System 1000 may be resilient and continue to operate at near peak capability despite isolated failures in various ones of its components. The various components that desirably avoid failures and/or are configured to work around known or expected failure modes include the different kinds of components in the respective and different tiers or planes, including the forwarding plane 230, the control plane 240, the configuration plane 250 and even the global analytics plane 280.

[0108] Sometimes, a complex and hard-to-trace-and-debug failure mode develops in such a complex and massively distributed system. Sometimes, it is necessary for system administrators (e.g., 206z) to trace back to individual processes (e.g., UVP1, UVP2, ... UVPn) within individual user-viewable domains (e.g., user-viewable virtual networks (Vnet's), or more generally UVE's) in order to determine what went wrong.

[0109] However, a commonly shared search key that ties together the individual and local trace logs of respective processes in respective virtual and/or physical machines, a commonly shared search key that ties together the processes of specific component tiers, and a commonly shared search key that ties together the processes of specific process instances, may not be available.

[0110] In accordance with one aspect of the present disclosure, at the time of trace log generation, each such trace log or other report is automatically tagged with at least one of: (a) a unique User-Viewable Entity (UVE) identifying key (UVEKey) that identifies the corresponding dedicated virtual network (Vnet) and/or other UVE to which the process of the respective report (e.g., trace log) belongs; (b) a respective system tier identifying key (TRxKey) that identifies the corresponding system tier (TRx, e.g., Virtual-to-physical Forwarding Plane) to which the process of the respective report belongs; (c) a respective virtual and/or physical execution machine identifying key (VMKey, PMKey) that identifies the corresponding virtual machine (VM) and/or physical machine (PM) to which the process of the respective report belongs; (d) a respective process instance identifying key (PINKey) that identifies the corresponding instance PIN) of a plurally-instantiated and also identified process to which the respective report belongs; and (e) a respective current operational state indication (Op-State) that indicates a current operational state of a respective UVE, Tier, VM, PM or other such stratifying attribute with which the respective report is associated.

[0111] The so-tagged process reports (e.g., trace logs, exception reports, etc.) are then automatically relayed at or soon after the time of generation to a centralized database (e.g., in a Global Analytics Plane) so that they will not be lost due to local memory failures or faults and so that they can then be centrally queried by a system administrator (e.g., 206z) who uses one or more of the added-on tags (e.g., UVEKey, TRxKey, VMKey, PMKey, PINKey, Tier-Op-State, other strata Op-State, etc.) as part of structured queries into the centralized database (e.g., maintained in a Global Analytics Plane of the massively distributed system) for determining the more likely causes of later in time failures. The query-able database may also be used even before a failure occurs to identify likely fault conditions that may lead to a failure, where the likely fault conditions are determined based on past historical records in the database that indicate which of various strata Op-States in combination with which of various exception reports are likely to lead to process failures.

[0112] More specifically, the here disclosed teachings may be applied to a Distributed System (e.g., a software defined network (SDN) system) made up of multiple tiers, each having a respective different functionality. Each tier is meant to be independently horizontally scalable, consisting of multiple processes running on different machines, with each process carrying out the same basic operations but on different instance of respective data. No one process within a tier may manage the entire tier. In other words, the processes are peers, and the tier is designed not to have a single point of failure that brings down the whole tier.

[0113] For sake of operations reliability and system maintenance, the System Administrator ("Admin") is empowered by the present disclosure to see the system as a collection of unique User-Visible Entities (UVEs). Each UVE has per-tier attributes, which help the Admin to confirm that the tiers are working correctly together or not. But the UVE alone does not have any per-process representations. When normal operations are taking place, the Admin does not need to be aware how many processes exist in a given tier or what their individual statuses are.

[0114] However, the actual operations of the system are happening on a per-tier, per-instance basis. Investigation of some types of complex problems may need examination of execution traces from the individual processes. The present disclosure empowers the Admin to efficiently query process execution traces by use of various UVE, tier and/or other tagging data contained in the traces. The present disclosure empowers the Admin to easily correlate process execution traces to respective UVEs. The present disclosure empowers the Admin to programmatically access UVE state changes and process execution traces and run analysis algorithms that will allow the Admin to catch and/or predict problems automatically, and/or trigger the collection of more information.

[0115] In accordance with one aspect of the present disclosure, a special "Analytics Tier" is provided, which the user can connect to for looking at the dedicated UVEs and the massively distributed processes that belong to the respective UVE's. More specifically, the following Data Structure and method may be used:

[0116] In the special Analytics Tier, there is automatically defined one Op-State object per UVE that represents the aggregated operational state of the object, and which contains the following:

[0117] - key (A Unique Key)

[0118] - list of Tier-Op-State (the Op state of this UVE may be provided in that Tier)

[0119] Individual Processes in various tiers are not allowed to generate free-form text messages for their process execution trace, in some examples. Instead, in such examples, they are forced to automatically generate objects containing the following information, and send them up to the Analytics Tier:

[0120] - key: (Key of the UVE which this execution trace message refers to)

[0121] - Tier-Op-State: (Tier-Op-State for this UVE, as seen on this process of the tier)

[0122] The Tier-Op-State can be considered to be list of attributes. The value of an attribute can be:

[0123] - A basic data type

[0124] - A structure (consisting of a list of sub-attributes and/or other sub-structures and sub-containers)

[0125] - A container holding multiple items of basic data types, sub-structures or sub-containers.

[0126] The schema of "Tier-Op-State" can be different on a per-UVE-per-Tier basis. When a respective process sends its process execution trace, it may choose to fill in only a subset of the attributes rather than all. The reason is that place in the code where the process execution trace is being generated from may not have easy access to all attributes.

[0127] Once the respective processes reports are relayed to the centralized Analytics Tier, Analytics Processing may proceed as follows. Different processes in the Analytics Tier may be made responsible for tracking the Operational States of different UVEs, so that the Analytics layer is horizontally scalable. When an analytics process receives a process execution trace object, it updates its view of the aggregated state of the given UVE. This process execution trace object can arrive as an event, or batches of trace objects can be periodically read from a log.

[0128] In one example, a Virtual Network System (1000) has at least 3 tiers (in addition to the Analytics Tier). Tier 1 is the Config-Tier (configurators plane 250 in FIG. 7) with a respective one or more virtual machines therein and for sake of this example, 3 processes (A1,A2 and A3) executing in that tier. Tier 2 is ControlPlane-Tier (240) with a corresponding 5 processes (B1-B5) executing in that tier for the sake of this example. Tier 3 is the SDN Forwarding-Tier (230) with 20 processes (C1-C20) executing in that tier for the sake of this example.

[0129] Consider now a specific UVE, say one representing a Virtual-Network having the identification of being UV-VNet(1) among a plurality of otherwise identified UVE's (see 207v1-207vn of FIG. 7).

[0130] The Tier 3 representation of this example UVE (UV-VNet(1)) may have the following attributes:

[0131] int bytes_received;

[0132] list<string> virtual_machine_names;

[0133] The corresponding Virtual-Network exists on processes C1, C4, C10 and C15 (of the SDN Forwarding-Tier 230); and each sends their versions of these attributes as part of their respective execution traces. For example, some traces report a change in "bytes_received". Other traces report that an element has been added to or deleted from "virtual_machine_names". In response, the analytics process responsible for the identified Virtual-Network (e.g., 207v1) gets these traces. It maintains and updates 4 different Tier-3 snapshots of the respective Virtual-Network (e.g., 207v1). Then, when the analytics process gets a "bytes_received" trace for process C4, it just needs to replace the "bytes_received" attribute for corresponding snapshot C4. But when it gets a "virtual_machine_names" item addition or deletion for process C4, it needs to add or delete from its "virtual_machine_names" attribute for snapshot C4. Thus workload on the Analytics Tier may be minimized for normal process operations.

[0134] During process failures or error conditions, it is possible that some process execution traces are "lost". To mitigate this, the method uses sequence numbers on a per-UVE basis for traces sent from a process up to the Analytics layer. If there is a gap in sequence numbers, the analytics layer can ask the process to replay the entire current state of that UVE on that process. Also, in one example, processes explicitly send a trace when a UVE disappears from the process.

[0135] Interactions between Admins and/or other users and the Analytics layer (280) may include the following: When the system user asks for the Tier-3 state of this UVE, the request is forwarded to the analytics process responsible for the respective Virtual-Network (e.g., 207v1). This analytics process may present the users with one single view by aggregating the 4 pieces of Op-State snapshots of process C1, C4, C10 and C15 for example. This aggregation method may involve simple addition across these process views (e.g. for "bytes_received"), or a union of sets (e.g. for "virtual_machine_names"), or other operations as well. The Analytics tier can do this on demand (when a user or another program asks for this UVE), or it can do this proactively and periodically.

[0136] In view of the above it is seen that a method is provided for realizing the goal of tying together with one or more commonly shared search keys such as a UVEKey, a TRxKey, a PINKey, a VMKey, a PMKey and/or a strata Op-State indicator individual trace logs and/or other automatically generated reports of processes spread across a massively distributed system (e.g., a software defined network (SDN) system 1000) so that those of the reports that are associated with one another by virtue of commonality to a specific UVE and/or Tier and/or virtual machine and/or strata Op-State, etc., may be logically linked together for analysis purposes. The centralized and cross-correlated reports that are automatically created by this method may be used to analyze complex failure modes and even to predict likely failures of particular components before the failures actually happen and to then responsively replace and/or restart the likely-to-fail components and/or to reconfigure resource capacities (e.g., number of VM's, number of PM's, amount of physical memory etc.), to reconfigure interconnects for getting around the likely-to-fail components before the latter actually fail. For instance, this prediction ability may allow system operators to systematically bring down corresponding parts of the system during off-peak hours and to replace and/or fix the likely-to-fail components before actual failure thus minimizing the impact of likely failures on the overall system.

[0137] In accordance with the present disclosure, a method is provided for globally analyzing down to the processes level, the components of a massively distributed system and identifying likely at-fault components in such a massively distributed complex system. The method includes one or more of the following steps:

[0138] (a) subdividing the system into a plurality of tiers (e.g., 230, 240, 250, 250, 280) each having alike components (e.g., VRouters) within that tier;

[0139] (b) subdividing system operations into a plurality of User-Visible Entities (UVE's; e.g., virtual networks or Vnets 207) each having respective processes and other resources dedicated to serving needs of the respective UVE's;

[0140] (c) for each respective UVE and tier, identifying respective process reports that cross correlate with a corresponding UVE Key and a corresponding Tier key where the reports may include quantitative failure or fault parameters such as memory failures, telecommunications failures, processor failures, packet resends and/or drops, etc.) and relaying the UVE and Tier tagged reports to a centralized and query-able database;

[0141] (d) for each respective process report that is locally generated, automatically tagging the report with one or more linking keys including a UVEKey;

[0142] (e) for each respective tier, automatically determining what part of its resources are used by each of respective UVE's and automatically determining if the allocated resources of any UVE are insufficient due to repeated component failures (e.g., lost packets);

[0143] (f) for each respective UVE and its detected component failures, logically associating the detected component failures with one or more of the respective captured parameter snapshots that immediately preceded the respective component failures for that UVE;

[0144] (g) investigating those of the UVE associated reports that were correlated to failure as being likely to point to the at-fault components and/or tiers of that UVE; and

[0145] (h) taking preemptive corrective and/or work-around measures for those of the respective tier components and UVEs that were determined to be more highly likely to enter a failure mode based on the investigation.

[0146] Referring to FIG. 8, shown here is a block diagram of an SDN system 1000" that includes, for a respective one of its tiers (e.g., the VRouters tier), a corresponding reports classifier 270 that is coupled to automatically repeatedly (e.g., periodically) receive parameter snapshots 271 indicative of corresponding operating modes of the components (e.g., virtual processes (not shown) in respective ones of the VRouters 232-239) and to automatically tag them. More specifically, during tagging mode each of the parameters snapshots 271 is accompanied has added to it one or more of a respective UVE Key 272, Tier Key 273, VM Key 274, PM key 275 and/or one or more Strata Op-State indicators (e.g., Tier Op State) indicating whether the sample belongs to a failure Op State or a non-failure Op State for example. The tagged reports 279 from the various resources (e.g., servers) of the massively distributed system are then transmitted to a more centralized Analytics engine 285 for structured aggregation (290) according to respective UVE identifications and strata identifications. The aggregated reports may include data that classifies them as belonging to either a normal operations (good) class or as a distressed of failed (bad, e.g., as measured up from a 0% likely to be bad plane to a 100% likely to be bad plane along the Z axis). These aggregated outputs 298 are stored in and used by the corresponding analytics engine 285 to determine what is happening for each UVE and/or tier on a big picture basis. In one example, the corresponding analytics engine 285 is coupled to a re-configuration engine 255 that, in the case where a subsequently received and analyzed parameter snapshots 279 indicate likelihood of failure, re-configures the system so as to preemptively try to avoid failure.

[0147] In one example, the Analytics plane collects respective snapshot data relevant to likelihood of failure from various components within the respective UVE's, tiers, planes, physical resources of the system. Respective snapshot data may include for example, parameters like CPU utilization levels, memory utilization levels, alarm levels in the various system parts and so on. These collected respective and likely to be relevant snapshots (279) could be early indicators of growing faults and/or upcoming failures in respective tiers and/or for respective UVE's (e.g., ones that have greater demand for system bandwidths).

[0148] While FIG. 8 shows by way of example, the collecting of snapshots from the VRouters tier 232-239 of a respective one server 210z, it is understood that similar collections of respectively relevant and tagged parameter snapshots may be taking place for other tiers and/or system planes and/or servers across the massively distributed system and aggregated into the Analytics engine 285. The XYZ frame work 290 shown in FIG. 8 is for sake of simple illustration of aggregated and classified parameters and it is within the contemplation of the disclosure to have N-dimensional mappings with each axis (e.g., U, V, X, Y, etc.) representing a respective one of the monitored parameters as distributed relative to UVE, relative to tier, relative to physical machine (PM) and so on. Part of the analytic investigation may include that of determining for each tier and UVE what parameters are best indicators of growing faults and/or predictable failures. Trained classification algorithms may afterwards be used to predict the likelihood of failure of the respective components on a continuous basis as the data is being collected by the Analytics for newly instantiated UVE's and virtual processes.

[0149] FIG. 9 is a flowchart illustrating an example method 300 that may be carried out, e.g., in the system of FIG. 8. Although generally described with respect to the example of FIG. 8, it should be understood that other devices may be configured to perform any or all of the steps in the method of FIG. 9. For example, virtual network controller 22 may be configured to perform any or all of the steps of the method of FIG. 9. For purposes of explanation, analytics engine 285 of FIG. 8 is explained as performing the steps of FIG. 9.

[0150] Initially, analytics engine 285 may receive object trace data for a User-Visible Entity (UVE) with, e.g., key 'X' from instance 'Y' in tier 'Z' (301). That is, the UVE may specify an identifier of 'X' for a key, an identifier of 'Y' for an instance, and an identifier of 'Z' for a tier, where the identifiers X, Y, and Z may comprise respective numeric values (e.g., integer values. Thus, there may be a plurality of tiers, and Z represents the Z^{th} tier, Y represents a Y^{th} instance within tier Z, and X represents a key in the Y^{th} instance of tier Z, for a particular trace. Analytics engine 285 may then store an object trace in a database using keys X, Y, and Z (302). In this manner, keys X, Y, and Z can act as index values for uniquely identifying data for the trace in the database, e.g., for updating, querying, retrieving, or otherwise accessing data for the trace.

[0151] Analytics engine 285 may then determine whether key 'X' belongs to a current analysis instance (303). When analytics engine 285 determines that key 'X' for the trace does not belong to the current analysis instance ("NO" branch of 303), analytics engine 285 may forward the created object trace to an analytics instance that owns key 'X' (304). On the other hand, assuming that the current analysis instance owns key 'X,' ("YES" branch of 303), analytics engine 285 may determine whether the object trace is a full snapshot or deletion of a UVE on 'Y' (310), after receiving an object trace for UVE with key 'X' of instance 'Y' (309).

[0152] When the object trace is a full snapshot or deletion of the UVE on 'Y' ("YES" branch of 310), analytics engine 285 may update snapshot 'Y' with data of received object 'X' (311). That is, for a full snapshot, analytics engine 285 may replace snapshot 'Y' with the new contents from the object trace. Alternatively, for deletion, analytics engine 285 may remove snapshot 'Y.' In either case, analytics engine 285 may update a sequence number for snapshot 'Y' of Object X. Furthermore, analytics engine 285 may build an aggregated state of object 'X' for tier 'Z' (315). This may involve iterating over all snapshots for Object X and doing appropriate calculations (e.g., taking a sum of values, a union of sets, or the like), to generate aggregate data for Object X. Analytics engine 285 may then display the aggregated state for Object X.

[0153] On the other hand, when the object trace is not a full snapshot or deletion ("NO" branch of 310), analytics engine 285 may determine whether there was a gap in sequence numbers for data of the object with key 'X' in instance 'Y' (316). If analytics engine 285 determines that there is such a gap ("YES" branch of 316), analytics engine 285 may request, for instance 'Y' in tier 'Z', a full snapshot of UVE 'X' (317). In this manner, in response to detecting a gap in the sequence numbers for a process of a tier, analytics engine 285 may send instructions to the device that is executing the process to replay a current state for the UVE.

[0154] Alternatively, when there is not such a gap ("NO" branch of 316), analytics engine 285 may update snapshot 'Y' of object 'X' (318). This may include, for atomic types of attributes associated with object X, replacing values of the atomic types with new values of the new snapshot. For add or delete notification container types, analytics engine 285 may add, delete, or modify a local copy of the container. For all cases, analytics engine 285 may update the sequence number for snapshot

'Y' of object 'X.' Furthermore, analytics engine 285 may build an aggregated state of object 'X' for tier 'Z' (315). This may involve iterating over all snapshots for Object X and doing appropriate calculations (e.g., taking a sum of values, a union of sets, or the like), to generate aggregate data for Object X. Analytics engine 285 may then display the aggregated state for Object X.

[0155] FIG. 10 is a block diagram illustrating an example computing device 350 for aggregating data of various processes, in accordance with one or more techniques of this disclosure. FIG. 10 illustrates only one particular example of computing device 350, and many other examples of computing device 350 may be used in other instances. Computing device 350 may correspond to a virtual network controller. That is, virtual network controllers 22, 100 may include components substantially similar to those illustrated in FIG. 10. Similarly, analytics engine 285 of FIG. 8 may include components substantially similar to those illustrated in FIG. 10. Computing device 350 may be configured to perform any of the various techniques described in this disclosure, e.g., the method of FIG. 9.

[0156] As shown in the specific example of FIG. 10, computing device 350 includes one or more processors 352, one or more communication units 356, one or more input devices 354, one or more output devices 358, and one or more storage devices 360. Computing device 350, in the specific example of FIG. 10, further includes operating system 362, virtualization module 364, and one or more applications 366A-366N (collectively "applications 366"). Each of components 352, 356, 354, 358, and 360 may be interconnected (physically, communicatively, and/or operatively) for inter-component communications. As one example in FIG. 10, components 352, 356, 354, 358, and 360 may be coupled by one or more communication channels 370. In some examples, communication channels 370 may include a system bus, network connection, interprocess communication data structure, or any other channel for communicating data. Virtualization module 364 and applications 366, as well as operating system 362 may also communicate information with one another as well as with other components in computing device 350.

[0157] Processors 352, in one example, are configured to implement functionality and/or process instructions for execution within computing device 350. For example, processors 352 may be capable of processing instructions stored in storage devices 360. Examples of processors 352 may include, any one or more of a microprocessor, a controller, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field-programmable gate array (FPGA), or equivalent discrete or integrated logic circuitry.

[0158] One or more storage devices 360 may be configured to store information within computing device 350 during operation. Storage devices 360, in some examples, are described as a computer-readable storage medium. In some examples, storage devices 360 are a temporary memory, meaning that a primary purpose of storage devices 360 is not long-term storage. Storage devices 360, in some examples, are described as a volatile memory, meaning that storage devices 360 do not maintain stored contents when the computer is turned off. Examples of volatile memories include random access memories (RAM), dynamic random access memories (DRAM), static random access memories (SRAM), and other forms of volatile memories known in the art. In some examples, storage devices 360 are used to store program instructions for execution by processors 352. Storage devices 360, in one example, are used by software or applications running on computing device 350 (e.g., operating system 362, virtualization module 364 and the like) to temporarily store information during program execution.

[0159] Storage devices 360, in some examples, also include one or more computer-readable storage media. Storage devices 360 may be configured to store larger amounts of information than volatile memory. Storage devices 360 may further be configured for long-term storage of information. In some examples, storage devices 360 include non-volatile storage elements. Examples of such non-volatile storage elements include magnetic hard discs, tape cartridges or cassettes, optical discs, floppy discs, flash memories, or forms of electrically programmable memories (EPROM) or electrically erasable and programmable memories (EEPROM).

[0160] Computing device 350, in some examples, also includes one or more communication units 356. Communication units 356 represent examples of network interfaces for communicating with external devices, e.g., devices of an SDN that execute various processes, e.g., processes conforming to various tiers, as discussed above. Computing device 350, in one example, utilizes communication units 356 to communicate with external devices. Communication units 356 may communicate, in some examples, by sending data packets over one or more networks, such as one or more wireless networks, via inbound and outbound links. Communication units 356 may include one or more network interface cards (IFCs), such as an Ethernet card, an optical transceiver, a radio frequency transceiver, or any other type of device that can send and receive information. Other examples of such network interfaces may include Bluetooth, 3G and WiFi radio components. In some examples, computing device 350 utilizes communication units 356 to receive data regarding processes executed by external devices, which processors 352 may aggregate in accordance with the techniques of this disclosure.

[0161] Computing device 350, in one example, also includes one or more input devices 354. Input devices 354, in some examples, are configured to receive input from a user through tactile, audio, or video feedback. Examples of input devices 354 include a presence-sensitive display, a mouse, a keyboard, a voice responsive system, video camera, microphone or any other type of device for detecting a command from a user. In some examples, a presence-sensitive display includes a touch-sensitive screen.

[0162] One or more output devices 358 may also be included in computing device 350. Output devices 358, in some examples, are configured to provide output to a user using tactile, audio, or video stimuli. Output devices 358, in one example, include a presence-sensitive display, a sound card, a video graphics adapter card, or any other type of device for converting a signal into an appropriate form understandable to humans or machines. Additional examples of output devices 358 include a speaker, a cathode ray tube (CRT) monitor, a liquid crystal display (LCD), or any other type of device that can generate intelligible output to a user.

[0163] Computing device 350 may include operating system 364. Operating system 364, in some examples, controls the operation of components of computing device 350. For example, operating system 364, in one example, facilitates the communication of modules applications 366 with processors 352, communication units 356, input devices 354, output devices 358, and storage devices 362. Applications 366 may each include program instructions and/or data that are executable by computing device 350. As one example, application 366A may include instructions that cause computing device 350 to perform one or more of the operations and actions described in the present disclosure.

[0164] In accordance with techniques of the present disclosure, computing device 350 may be configured to aggregate data for a set of two or more related processes, to form aggregated data for the set of two or more related processes. In particular, computing device 350 may determine the set of two or more related processes executed by respective devices in a virtual network, and receive data for the set of two or more related processes. In general, the set of processes may correspond to a common "tier," e.g., a common network plane, and each of the processes in a particular set may be substantially similar.

[0165] More particularly, in accordance with the techniques of this disclosure, computing devices communicatively coupled to computing device 350 via communication units 356, and processes executed by the computing devices, may be divided into various tiers. Within each tier there may be a set of related (e.g., substantially similar) processes. Furthermore, computing device 350 may define User-Visible Entities (UVEs) for the various tiers. The UVEs may define various data for monitoring processes of the various tiers. For example, the UVEs may define attributes of processes to retrieve. Computing device 350 may receive data output during execution of the processes, and in accordance with the UVEs, extract values for the attributes defined by the UVEs. Computing device 350 may further aggregate this data. For example, the UVE may define a manner in which to aggregate certain types of data, corresponding to the attributes, such as addition, union over sets, concatenation, list generation, or the like.

[0166] Computing device 350 may then generate one or more reports that are indicative of a tier and aggregated values for one or more attributes corresponding to the tier, as defined by a corresponding UVE. This aggregation can be performed transparently to the devices executing the processes. That is, the devices executing the processes need not take any part in the aggregation. An administrator may use the generated report to diagnose various aspects of the virtual network. For example, the report may include data indicative of one or more of a quantitative failure, a fault parameter, a memory failure, a telecommunications failure, a processor failure, a packet resend, and/or a dropped communication session. The administrator may determine, using the report, whether any or all of these conditions apply and act accordingly, e.g., by reprogramming a device communicatively coupled to computing device 350 via communication units 356, adding, replacing, or removing links between devices, adding or upgrading software for one or more devices, or the like, based on the contents of the report.

[0167] In some examples, computing device 350 includes an analytics layer, that is, an intermediate layer that acts on generic rules. The UVEs may define rules in accordance with the analytics layer. Thus, computing device 350 may operate substantially automatically, that is, without user interference, to perform the techniques of this disclosure. The analytics tier may use definitions of the UVEs to extract information from communications output by the devices executing the corresponding processes and aggregate values for certain attributes, as defined by the UVEs, of the communications.

[0168] In this manner, computing device 350 represents an example of a controller device configured to determine, for a virtual network, a set of two or more related processes executed by respective devices in the virtual network, receive data for the set of two or more related processes, and aggregate the data for the set of two or more related processes to form aggregated data for the set of two or more related processes.

[0169] FIG. 11A is a block diagram of a massively distributed complex system 1200, and more specifically, of a software defined networking (SDN) system that operates according to techniques described in this disclosure. System 1200 may represent an example instance of network 8 of FIG. 1. That is, system 1200 may represent a cloud-implementing data center environment in which there is provided a large collection of network-interconnected servers (e.g., 1210x, 1210y) that provide compute and/or storage capacity to run many different user and/or other kinds of application programs (e.g., user visible process(es) 1216). Such an environment tends to be very dynamic from an applications point of view. System 1200 may include level of automation that, at least to some extent, insulates users from the infrastructure details and that avoids need for manual intervention to interconnect the physical servers to provide the compute or storage capacity required to enable the various applications to execute to one level of sufficiency or another.

[0170] In order to enable automation and agility of the infrastructure (e.g., the physical interconnect fabric 1180), there is a growing trend to deploy either an overlay networking solution or a virtualized networking system on top of physical compute clusters where the overlay and/or virtualizing subsystem encapsulates and automatically manages the details of keeping the many physical network switches and routers (e.g., 1185, 1187) and channels (e.g., 1186) up and running at desired bandwidths (BW) and desired qualities of service (QoS) represented here by 1110. Fabric 1180 may represent an example of fabric 14 of FIG. 1 and may include physical telecom channels, routers, gates, etc.

[0171] In such an environment, a server (e.g., 1210x) may run one or more applications and/or guest operating systems. In order to enable many guest operating systems (also called virtual machines (VMs) 1215) on a single server 1210, there may be usage of a virtual machines monitoring system commonly known as hypervisor (such as ESX, Hyper-V, KVM, Xen, etc.). Examples of hypervisors are illustrated as hypervisor 31 of FIG. 1 and 1231 of FIG. 11B. A single application (e.g., user visible process UVP1 1216) executing on a VM 215 may require many instances of compute and storage resources that may be provided by the infrastructure as multiple individual servers 1210 or multiple virtual machines 1215 running on one or more servers 1210. In order for the application to share information amongst its distributed compute and storage instances and with the outside world, a telecommunications network 1180 enables movement of this information as; for example, packet conveyed data signals 1217. Every time a new application is instantiated and/or changed on the infrastructure, a respective virtual network (e.g., VNet 1207v) may be created and/or changed to support the new/changed application and to allow all its compute and storage instances to share information with one another and/or the outside world. Each virtual network user 1205, or VUser 1205, may experience his/her/its own Virtual Network (VNet) 1207 with its respective resources and issues, etc.

[0172] In a virtualized or overlay network environment, the edge of the network is extended from the physical network element (e.g., switch or a router 1185) to a software switch (e.g., VRouter 1232 shown in FIG. 11B) running inside the hypervisor (1231) or inside the host operating system on the physical server (e.g., 1210z) to provide a telecom virtualizing interface (VTI) 1220. VRouter 1232 may represent an example instance of software switches 30 of FIG. 2. The virtualized and/or overlayed network that is used by the application to communicate with its instances is created dynamically and managed by software switch controlling means (e.g., control plane VMs 1112 of FIG. 5 or control plane 1240 of FIG. 11B) having its own addressing and security scheme where the latter is orthogonal from the physical network 1180 and its addressing scheme. There are many different methods that can be employed to transport packets (e.g., 1217) within and across the virtual network(s) and over the physical network.

[0173] Network IP (and/or Ethernet) packets (e.g., 1217) generated or consumed by the instances of the application in the virtual network domain may be encapsulated in another IP (and/or Ethernet) packet that is transported by the physical network. Herein, the virtual network packet will be referred to as inner packet and the physical network packet will be referred to as outer packet. The function of encapsulation and/or de-capsulation of the virtual network packet within physical network packet is done in the hypervisor 1231 or the host O/S (not shown) running on the server 1210. In addition, the encapsulation and de-capsulation function can also be performed at the edge of the network in a first-hop physical network switch router (e.g., 1185).

[0174] Cloud data-center networks can constitute an example of a massively distributed complex system because the number of interconnected servers can be very large with each server presenting one or more links, each having a respective 1Gbps or 10Gbps or greater bandwidth link. In order to construct a network that can interconnect all such links, operators generally use a number of switches (or routers) with N input (ingress) links x M output (egress) links. Each of these individual switches can act as an IP router with its own IP address(es).

[0175] Referring to some of the specifics shown in FIGS. 11A-11B, there can be a plurality of different kinds of components in respective "tiers" or service planes of a virtualized overlay system. One of these planes is the virtual-to-physical forwarding plane 1230. It includes the virtual network routers (VNRouters, or more simply VRouters 1232-1239). These components can reside in the respective hypervisors 231 of the respective physical servers (e.g., 1210) or they can reside in a Top-of-Rack switch (not shown) which is typically included in the virtual-to-physical forwarding plane 1230. When the VRouter is disposed in a hypervisor 1231, it acts as a software switch having both respective virtual ports connected to the virtual machines (VMs) and physical ports corresponding to the physical I/O ports of the respective server 1210. Each VNRouter selectively routes/switches packets between its virtual ports and the physical ports and/or between its virtual ports. The VNRouters may be considered as Data/Forwarding Plane components of the Virtual Network System.

[0176] Another of the plural tiers or planes within system 1200 is referred to as the Control Plane 1240 and it may contain a plurality of virtual machines (VMcp-i) implementing respective Controllers or Controller Processes. Controllers may represent instances of control plane VMs 112 of FIG. 5 that provide control functions within the Virtual Network System. The Controllers each operatively couples to a respective set of VNRouters and each distributes respective routing information signals to its VNRouters. In one embodiment, the relative scale of the Virtual Network System is on the order of 100s of 1000s of VNRouters (e.g., 1232) and 100s of corresponding Controllers (e.g., VNcp1).

[0177] Another of the plural tiers or planes within system 1200 is referred to as the Configuration Plane 1250 and it may contain a plurality of virtual machines (VMgp-k) implementing respective Configuration Processes. Controllers may represent instances of configuration VMs 108 of FIG. 5 that provide control functions with respect to interconnect and/or other configurations within the Virtual Network System. The Configuration controllers each operatively couples to a respective parts of the physical network (1180) and/or to respective parts of the Control Plane 1250 and each distributes respective configuration information signals to its controlled counterparts.

[0178] Yet another of the plural tiers or planes within the system 1200 is referred to as the Analytics plane 1280. Components (e.g., VMn1) within the Analytics plane 1280 are typically charged with automatically monitoring and/or automatically collecting reported states of other parts of the Virtual Network System. Components within the Analytics plane 1280 may represent instances of analytics VMs 104 of FIG. 5. The Analytics components are tasked with gathering information from all other components in the system so as to develop a high-level view of what is occurring in the system as a whole. This "Big Data" information may be stored in a persistent database, e.g., analytics VM 106 of FIG. 5. This information can then be used to show the current state of the system, to help debug problems, to do historical or real-time analysis of the system and so on.

[0179] Because of the highly scalable and variable nature of system 1200, it may be prone to many fault and failure modes. However, an administrator(s) of system 1200 seeks to provide its users (e.g., 1205x, 1205y, 1205w, 1205z) with continuously robust, reliable, high bandwidth, and high quality services. In other words, the system 1200 should be resilient and continue to operate at near peak capability despite isolated failures in various ones of its components. The various components that desirably remain failure free and/or are configured to work around known or expected failure modes include the different kinds of components in the respective and different tiers or planes, including the forwarding plane 1230, the control plane 1240, the configuration plane 1250 and even the global analytics plane 1280.

[0180] To realize these goals, it would be useful to have an ability to predict likely failures of particular components before the failures actually happen and to responsively replace and/or restart the likely-to-fail components and/or reconfigure interconnects around the likely-to-fail components before the latter actually fail. For instance, this prediction ability may allow system operators to systematically bringing down corresponding parts of the system during off-peak hours and to replace and/or fix the likely-to-fail components before actual failure thus minimizing the impact of likely failures on the overall system.

[0181] In accordance with the present disclosure, a method is provided for identifying likely faulty components in a massively distributed complex system that includes one or more of the following steps:

(a) subdividing the system into a plurality of tiers (e.g., 1230, 1240, 1250, 1280) each having alike components (e.g., VRouters) within that tier;

(b) for each respective tier, identifying respective quantitative parameters (e.g., memory failures per unit time, processor failures per unit time, channel failures per unit time, packet resends and/or drops per unit time, etc.) of respective components of the respective tier whose quantitative values are likely to act as indicators of component fault and/or failure in that respective tier;

(c) for each respective tier, automatically repeatedly capturing sample snapshots of the identified respective quantitative parameters of the tier component (s);

(d) for each respective tier, automatically repeatedly detecting component failures (e.g., lost packets);

(e) for each respective detected component failure, logically associating the detected component failure with one or more of the respective captured parameter snapshots that immediately preceded the respective component failure;

(f) automatically repeatedly training a trainable automated classifier to develop a classifying structure that distinguishes between first component parameter sets that logically associate with one or more detected failures and second component parameter sets that do not logically associate with the one or more detected failures;

(g) after said training, placing the trained classifier in a prediction mode wherein the trained classifier is automatically repeatedly fed with the more recent and automatically repeatedly captured sample snapshots and wherein the trained classifier uses its developed classifying structure (e.g., class separation surface described below) to classify the in-prediction-mode sample snapshots as correlating to failure or as correlating to non-failure;

(h) investigating those of the in-prediction-mode sample snapshots that were correlated to failure as being likely to be fault-indicating parameter sets; and

(i) taking preemptive corrective and/or work-around measures for those of the respective tier components that were determined to be more highly likely to enter a failure mode based on the in-prediction-mode indication that the corresponding sample snapshots correlate to failure.

[0182] Also in accordance with techniques of this disclosure, a massively distributed complex system is provided as having a plurality of tiers and having a fault and/or failure predicting mechanism, the predicting mechanism comprising one or more of:

(a) a subdividing mechanism that subdivides the system into a plurality of tiers each having alike components;

(b) a parameters identifying mechanism that, for each respective tier, identifies respective quantitative parameters of respective components of the respective tier whose quantitative values are likely to act as indicators of likely component fault and/or failure;

(c) a sampling mechanism that, for each respective tier, automatically repeatedly captures sample snapshots of the identified respective quantitative parameters of the tier component(s);

(d) a failure detecting mechanism that, for each respective tier, automatically repeatedly detects component failures;

(e) a failure to parameters associating mechanism that, for each respective detected component failure, logically associates (e.g., flags) the detected component failure with one or more of the respective captured parameter snapshots that immediately preceded the respective component failure;

(f) a training mechanism that automatically repeatedly trains a trainable automated classifier to develop a classifying structure that distinguishes between first component parameter sets that logically associate with a detected failure and second component parameter sets that do not logically associate with a detected failure;

(g) a predictions generating mechanism that, after said training, places the trained classifier in a prediction mode wherein the trained classifier is automatically repeatedly fed with the automatically repeatedly captured sample snapshots and wherein the trained classifier uses its developed classifying structure to classify the in-prediction-mode sample snapshots as correlating to likely failure or as correlating to likely non-failure;

(h) a likely fault and/or failure investigating mechanism that follows up on those of the in-prediction-mode sample snapshots that were correlated to failure as being likely to be fault-indicating parameter sets; and

(i) an action taking mechanism that preemptively takes corrective and/or work-around measures for those of the respective tier components that were determined to be more highly likely to enter a failure mode based on the in-prediction-mode indication that the corresponding sample snapshots correlate to failure.

[0183] There are various kinds of trainable automated classifiers that can be trained to classify input data sets as belonging to one of a plurality of distinct (e.g., mutually exclusive) classes. One example is neural nets. Another example is that of so-called, Support Vector Machines (SVMs). These automated machines include supervised learning models with associated learning algorithms that analyze supplied sample data and recognize patterns of distinction in the supplied data samples (e.g., reference sets) and use the analysis for developing classification and regression analysis models. A basic SVM takes in a first set of reference input data together with predetermined classification for the first set of reference input data and produces one or more classifying models for the supplied reference input data. Then after such a learning mode, the SVM takes in a second set of non-referenced input data (data that generally does not come with predetermined classification therefor) and it predicts, for each given one of the second input data sets, which of two or more possible classes the input data belongs to. In the case of the present disclosure, it is assumed that there are two mutually exclusive classes, one being that of highly likely to fail (e.g., due to a growing fault) and the second being that of not highly likely to fail. Such an SVM can be viewed as being a non-probabilistic binary linear classifier. Given a set of training examples, each marked as belonging to one of two categories, an SVM training algorithm builds a model that subsequently (after training) assigns new examples into one category (e.g., likely to fail) or the other (e.g., not likely to fail).

[0184] FIG. 12 is a block diagram of an system 1200" that includes, for a respective one of its tiers (e.g., the VRouters tier), a corresponding trainable classifier (e.g., SVM) 1270 that is coupled to automatically repeatedly (e.g., periodically) receive parameter sets or "snapshots," e.g., VR parameter snapshots 1271, indicative of corresponding operating modes of the components (e.g., the VRouters 1232-1239) that are being watched for possible entry into a significant fault or highly likely failure mode. More specifically, during a training mode (signaled on line 1275 signaling either training mode or prediction mode for trainable classifier 1270), each parameters snapshot 1271 is accompanied by a training-mode classification signal 1272 indicating whether the sample belongs to the failure class or the non-failure class. In response to repeated training sessions, the trainable classifier 1270 develops an internal algorithm (represented by classification separation surface 1295) that classifies subsequently received parameter snapshots 1271 (T2) as belonging to either the likely good class (1293 as measured down from the 100% likely bad plane to surface 1295) or the likely bad class (1291 as measured up from the 0% likely bad plane to surface 1295), where the TH plane can be disposed above troughs of surface 1295 by Tolerance amount TOL 1294). This output 1298 (e.g., a binary signal indicating surface 1295 is above or below the TH plane 1292) is coupled to a corresponding analytics engine 1285 that determines what to do in response to the classification determination. On framework 1290, spot 1297 denotes a recent input spot and spot 1296 denotes a trained bad spot. The corresponding analytics engine 1285 may be coupled to a re-configuration engine 1255 that, in the case where a subsequently received parameter snapshots 1271 (T2) indicates likelihood of failure, re-configures the system so as to try to avoid the failure.

[0185] In some examples, the Analytics plane includes analytics engine 1285 to collect respective snapshot data relevant to likelihood of failure from various components within the respective tiers and/or planes of the system. Respective snapshot data may include for example, parameters like CPU utilization levels, memory utilization levels, alarm levels in the various system parts, number of peers of a protocol session, number of protocol sessions for a component, and so on. These collected respective and likely to be relevant snapshots 1271 could be early indicators of growing faults and/or upcoming failures. The Analytics plane will also collect the failure data of various components where the latter are training reference points. For instance, a connection failure to a component and a subsequent reconnection with a restart data would indicate to the Analytics plane that the respective component has gone down (failed) and needed to be restarted or replaced.

[0186] Analytics plane may collect respective snapshot data from various components using SDN techniques. Examples of SDN techniques are described in SOFTWARE-DEFINED MOBILE CORE, U.S. Patent Appl. No. 13/724,975, filed December 21, 2012, the contents of which being incorporated by reference herein. As described above with VNCs 22, 100, a distributed network controller may operate as a control plane for at least some control plane functionality of components, such as servers and chassis/TOR switches, and receive snapshot data by a SDN communication protocol that also transports control plane configuration information. Examples of the SDN communication protocol include XMPP, described for instance with respect to FIG. 5, and OpenFlow.

[0187] While FIG. 12 shows, by way of example, the collecting of snapshots from the VRouters tier 1232-1239 of a respective one server 1210z, it is to be understood that similar collections of respectively relevant parameter snapshots and development of classification surfaces 1295 for each will be taking place for other tiers and/or system planes and/or servers. It is to be appreciated that the developed classification surfaces 1295 of each monitored component tier may not be accessible in certain kinds of classifiers such as neural nets. As the above input data samples 1271, 1272 are input as training and/or prediction parameters to the respective SVM algorithms, the latter learn and/or indicate whether the respective component falls in one of two categories - likely good 1293 or likely failing 1291. The shape of the classification surface 1295 may be a function of a predetermined binary threshold level TH 1292 and/or a partitioning (not shown) of the XY plane. The XYZ framework 1290 shown in FIG. 12 is for the sake of simple illustration and other frameworks according to this disclosure may have N-dimensional mappings with each axis (e.g., U, V, X, Y, etc.) representing a respective one of the monitored parameters. Part of learning is that of determining for each tier those parameters that are best indicators of growing faults and/or predictable failures. The trained classification algorithm (e.g., one that uses classification surface 1295) is afterwards used to predict the likelihood of failure of the respective components on a continuous basis as the data is being collected by the Analytics plane. The learning algorithms can also be enhanced on a continuous basis by adding/changing input parameters, thresholds, parameter space partitionings, etc.

[0188] FIGS. 13A-13B provide a flowchart of a process 1300 that may be carried out in the system of FIG. 12. Portion 1310 corresponds to the training mode/phase. Analytics engine 1285 receives parameter snapshots data 1271 for components of system 1200 (1311). Analytics engine 1285 provides parameter snapshots data 1271 and classification flags of respective components, e.g., training-mode classification signal 1272, to trainable classifier 1270 while trainable classifier 1270 is in training mode (1315).

[0189] Portion 1320 corresponds to the prediction mode. Analytics engine 1285 receives parameter snapshots data 1271 for components of system 1200 (1321). Analytics engine 1285 provides parameter snapshots data 1271 and classification flags of respective components, e.g., training-mode classification signal 1272, to trainable classifier 1270 while trainable classifier 1270 is in classifying mode (1325).

[0190] Portion 1330 corresponds to a confidence building and action mode. Upon a prediction, if a class flag is present and the prediction is not correct (NO branch of 1331), analytics engine 1285 may switch trainable classifier 1270 to retraining mode (1332). If (YES branch of 1331), if the confidence in trainable classifier 1270 prediction is not sufficiently large due to many correct predictions (NO branch of 1335), the analytics engine 1285 and trainable classifier 1270 repeat the confidence build phase (1336). Otherwise (YES branch of 1335), if the prediction indicates likely fault or failure, then analytics engine 1285 takes appropriate action, which may include generating an alarm, sending a message to an administrator, etc. (1337). Analytics engine 1285 then waits a predetermined amount of time (1341) to determine whether the fault/failure prediction was correct within the time (1343). If not (NO branch of 1343), analytics engine 1285 may switch trainable classifier 1270 to retraining mode (1332). If the prediction was correct (YES branch of 1343), the process moves to step 1335.

[0191] FIG. 14 is a block diagram illustrating an example device that participates in identifying likely faulty components according to techniques described in this disclosure. FIG. 14 illustrates only one particular example of computing device 1401, and many other examples of computing device 1401 may be used in other instances.

[0192] As shown in the specific example of FIG. 14, computing device 1401 includes one or more processors 1400, one or more communication units 1402, one or more input devices 1404, one or more output devices 1406, and one or more storage devices 1408. Computing device 1401, in the specific example of FIG. 14, further includes operating system 1410, virtualization module 1412, and one or more applications 1414A-1414N (collectively "applications 1414"). Each of components 1400, 1402, 1404, 1406, and 1408 may be interconnected (physically, communicatively, and/or operatively) for inter-component communications. As one example in FIG. 14, components 1400, 1402, 1404, 1406, and 1408 may be coupled by one or more communication channels 1416. In some examples, communication channels 1416 may include a system bus, network connection, inter-process communication data structure, or any other channel for communicating data. Virtualization module 1412 and applications 1414, as well as operating system 1410 may also communicate information with one another as well as with other components in computing device 1401.

[0193] Processors 1400, in one example, are configured to implement functionality and/or process instructions for execution within computing device 1401. For example, processors 1400 may be capable of processing instructions stored in storage devices 1408. Examples of processors 1400 may include, any one or more of a microprocessor, a controller, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field-programmable gate array (FPGA), or equivalent discrete or integrated logic circuitry.

[0194] One or more storage devices 1408 may be configured to store information within computing device 1401 during operation. Storage devices 1408, in some examples, are described as a computer-readable storage medium. In some examples, storage devices 1408 are a temporary memory, meaning that a primary purpose of storage devices 1408 is not long-term storage. Storage devices 1408, in some examples, are described as a volatile memory, meaning that storage devices 1408 do not maintain stored contents when the computer is turned off. Examples of volatile memories include random access memories (RAM), dynamic random access memories (DRAM), static random access memories (SRAM), and other forms of volatile memories known in the art. In some examples, storage devices 1408 are used to store program instructions for execution by processors 1400. Storage devices 1408, in one example, are used by software or applications running on computing device 1401 (e.g., operating system 1410, virtualization module 1412 and the like) to temporarily store information during program execution.

[0195] Storage devices 1408, in some examples, also include one or more computer-readable storage media. Storage devices 1408 may be configured to store larger amounts of information than volatile memory. Storage devices 1408 may further be configured for long-term storage of information. In some examples, storage devices 1408 include non-volatile storage elements. Examples of such non-volatile storage elements include magnetic hard discs, tape cartridges or cassettes, optical discs, floppy discs, flash memories, or forms of electrically programmable memories (EPROM) or electrically erasable and programmable memories (EEPROM).

[0196] Computing device 1401, in some examples, also includes one or more communication units 1402. Computing device 1401, in one example, utilizes communication units 1402 to communicate with external devices. Communication units 1402 may communicate, in some examples, by sending data packets over one or more networks, such as one or more wireless networks, via inbound and outbound links. Communication units 1402 may include one or more network interface cards (IFCs), such as an Ethernet card, an optical transceiver, a radio frequency transceiver, or any other type of device that can send and receive information.

[0197] Computing device 1401, in one example, also includes one or more input devices 1404. Input devices 1404, in some examples, are configured to receive input from a user through tactile, audio, or video feedback. Examples of input devices 1404 include a presence-sensitive display, a mouse, a keyboard, a voice responsive system, video camera, microphone or any other type of device for detecting a command from a user. In some examples, a presence-sensitive display includes a touch-sensitive screen.

[0198] One or more output devices 1406 may also be included in computing device 1401. Output devices 1406, in some examples, are configured to provide output to a user using tactile, audio, or video stimuli. Output devices 1406, in one example, include a presence-sensitive display, a sound card, a video graphics adapter card, or any other type of device for converting a signal into an appropriate form understandable to humans or machines. Additional examples of output devices 1406 include a speaker, a cathode ray tube (CRT) monitor, a liquid crystal display (LCD), or any other type of device that can generate intelligible output to a user.

[0199] Computing device 1401 may include operating system 1412. Operating system 1412, in some examples, controls the operation of components of computing device 1401. For example, operating system 1412, in one example, facilitates the communication of modules applications 1414 with processors 1400, communication units 1402, input devices 1404, output devices 1406, and storage devices 1410. Applications 1414 may each include program instructions and/or data that are executable by computing device 1401. As one example, application 1414A may include instructions that cause computing device 1401 to perform one or more of the operations and actions described in the present disclosure.

[0200] In accordance with techniques of the present disclosure, computing device 1401 may include an analytics engine 1418 application to identify likely faulty components. Analytics engine 1418 may represent an example instance of analytics engine 1285. Analytics engine 1418 may include a trainable classifier that receives parameter snapshots indicative of corresponding operating modes of the components that are being watched for possible entry into a significant fault or highly likely failure mode. More specifically, during a training mode, each parameters snapshot is accompanied by a training-mode classification signal indicating whether the sample belongs to the failure class or the non-failure class. In response to repeated training sessions, the trainable classifier develops an internal algorithm that classifies subsequently received parameter snapshots as belonging to either the likely good class or the likely bad class, where the TH plane can be disposed above troughs of surface by a tolerance amount. Analytics engine 1418 determines an appropriate response to the classification determination. Computing device 1401 may be coupled to a re-configuration engine that, in the case where a subsequently received parameter snapshots indicates likelihood of failure, re-configures the system so as to try to avoid the failure in response to direction or component fault indications from analytics engine 1418.

[0201] The techniques described herein may be implemented in hardware, software, firmware, or any combination thereof. Various features described as modules, units or components may be implemented together in an integrated logic device or separately as discrete but interoperable logic devices or other hardware devices. In some cases, various features of electronic circuitry may be implemented as one or more integrated circuit devices, such as an integrated circuit chip or chipset.

[0202] If implemented in hardware, this disclosure may be directed to an apparatus such a processor or an integrated circuit device, such as an integrated circuit chip or chipset. Alternatively or additionally, if implemented in software or firmware, the techniques may be realized at least in part by a computer-readable data storage medium comprising instructions that, when executed, cause a processor to perform one or more of the methods described above. For example, the computer-readable data storage medium may store such instructions for execution by a processor.

[0203] A computer-readable medium may form part of a computer program product, which may include packaging materials. A computer-readable medium may comprise a computer data storage medium such as random access memory (RAM), read-only memory (ROM), non-volatile random access memory (NVRAM), electrically erasable programmable read-only memory (EEPROM), Flash memory, magnetic or optical data storage media, and the like. In some examples, an article of manufacture may comprise one or more computer-readable storage media.

[0204] In some examples, the computer-readable storage media may comprise non-transitory media. The term "non-transitory" may indicate that the storage medium is not embodied in a carrier wave or a propagated signal. In certain examples, a non-transitory storage medium may store data that can, over time, change (e.g., in RAM or cache).

[0205] The code or instructions may be software and/or firmware executed by processing circuitry including one or more processors, such as one or more digital signal processors (DSPs), general purpose microprocessors, application-specific integrated circuits (ASICs), field-programmable gate arrays (FPGAs), or other equivalent integrated or discrete logic circuitry. Accordingly, the term "processor," as used herein may refer to any of the foregoing structure or any other structure suitable for implementation of the techniques described herein. In addition, in some aspects, functionality described in this disclosure may be provided within software modules or hardware modules.

[0206] In addition to or as an alternative to the above, the following embodiments are described. The features described in any of the following embodiments may be utilized with any of the other embodiments described herein.

[0207] One embodiment is directed to a method comprising determining, by a controller device for a virtual network, a set of two or more related processes executed by respective devices in the virtual network; receiving, by the controller device, data for the set of two or more related processes from the respective devices; and aggregating, by the controller device, the data for the set of two or more related processes to form aggregated data for the set of two or more related processes.

[0208] In some embodiments, the method may also comprise presenting the aggregated data to a user.

[0209] In some embodiments, the aggregated data comprises data for a User-Visible Entity (UVE).

[0210] In some embodiments, the UVE defines one or more attributes for which values are to be extracted from the received data for the set of two or more related processes, and aggregating comprises: extracting values for the one or more attributes defined by the UVE; and aggregating the values for the one or more attributes.

[0211] In some embodiments, the UVE defines the one or more attributes for a tier in which the set of two or more related processes are executed.

[0212] In some embodiments, the tier comprises a respective service plane.

[0213] In some embodiments, the tier comprises one of a plurality of tiers, and wherein each of the plurality of tiers is associated with a respective UVE.

[0214] In some embodiments, the plurality of tiers include one or more of a control plane tier, an analytics tier, a configuration tier, and a software defined network (SDN) forwarding tier.

[0215] In some embodiments, the UVE comprises a UVE for the SDN forwarding tier, and wherein the UVE defines a bytes received attribute and a virtual machine names attribute.

[0216] In some embodiments, the plurality of tiers are arranged in a hierarchical fashion.

[0217] In some embodiments, each of the tiers includes a respective set of processes, and each of the processes for a common one of the tiers is substantially similar.

[0218] In some embodiments, the method may further comprise: for each of the tiers, determining resources of the virtual network used by the respective UVEs; and automatically determining whether the resources for one of the UVEs are insufficient based on a number of repeated failures associated with the one of the UVEs.

[0219] In some embodiments, the method may further comprise: for each of the UVEs, in response to detecting a failure of a component associated with the UVE, logically associating the failed component with values for one or more of the attributes associated with the UVE that preceded the failure of the component.

[0220] In some embodiments, the UVE defines a respective aggregation method for each of the attributes, wherein the respective aggregation methods comprise one of addition, union over sets, concatenation, and list formation.

[0221] In some embodiments, the UVE corresponds to a virtual network including the respective devices that execute the set of two or more processes.

[0222] In some embodiments, the method may further comprise: analyzing sequence numbers of packets of the received data for the UVE; and in response to detecting a gap in the sequence numbers for one of the processes, sending instructions to the device that is executing the one of the processes to replay a current state for the UVE.

[0223] In some embodiments, the method may further comprise generating a report including the aggregated data, wherein the report is associated with the UVE.

[0224] In some embodiments, the report includes data indicative of one or more of a quantitative failure, a fault parameter, a memory failure, a telecommunications failure, a processor failure, a packet resend, and a dropped communication session.

[0225] In some embodiments, the method may further comprise forwarding the report and an identifier for the UVE to a centralized, queryable database.

[0226] In some embodiments, the virtual network comprises a software defined network (SDN).

[0227] On embodiment is directed to a controller device comprising: one or more network interfaces communicatively coupled to one or more devices of a virtual network; and a processor configured to determine, for the virtual network, a set of two or more related processes executed by respective devices in the virtual network, receive via the network interfaces data for the set of two or more related processes, and aggregate the data for the set of two or more related processes to form aggregated data for the set of two or more related processes.

[0228] In some embodiments, the processor is further configured to present the aggregated data to a user.

[0229] In some embodiments, the aggregated data comprises data for a User-Visible Entity (UVE).

[0230] In some embodiments, the UVE defines one or more attributes for which values are to be extracted from the received data for the set of two or more related processes, and the processor is further configured to: extract values for the one or more attributes defined by the UVE; and aggregate the values for the one or more attributes.

[0231] In some embodiments, the UVE defines the one or more attributes for a tier in which the set of two or more related processes are executed.

[0232] In some embodiments, the tier comprises a respective service plane.

[0233] In some embodiments, the tier comprises one of a plurality of tiers, and wherein each of the plurality of tiers is associated with a respective UVE.

[0234] In some embodiments, the plurality of tiers include one or more of a control plane tier, an analytics tier, a configuration tier, and a software defined network (SDN) forwarding tier.

[0235] In some embodiments, the UVE comprises a UVE for the SDN forwarding tier, and wherein the UVE defines a bytes received attribute and a virtual machine names attribute.

[0236] In some embodiments, the plurality of tiers are arranged in a hierarchical fashion.

[0237] In some embodiments, each of the tiers includes a respective set of processes, and wherein each of the processes for a common one of the tiers is substantially similar.

[0238] In some embodiments, the processor is further configured to, for each of the tiers, determine resources of the virtual network used by the respective UVEs, and automatically determine whether the resources for one of the UVEs are insufficient based on a number of repeated failures associated with the one of the UVEs.

[0239] In some embodiments, the processor is further configured to, for each of the UVEs, in response to detecting a failure of a component associated with the UVE, logically associating the failed component with values for one or more of the attributes associated with the UVE that preceded the failure of the component.

[0240] In some embodiments, the UVE defines a respective aggregation device for each of the attributes, wherein the respective aggregation devices comprise one of addition, union over sets, concatenation, and list formation.

[0241] In some embodiments, the UVE corresponds to a virtual network including the respective devices that execute the set of two or more processes.

[0242] In some embodiments, the processor is further configured to analyze sequence numbers of packets of the received data for the UVE, and, in response to detecting a gap in the sequence numbers for one of the processes, send instructions to the device that is executing the one of the processes to replay a current state for the UVE.

[0243] In some embodiments, the processor is further configured to generate a report including the aggregated data, wherein the report is associated with the UVE.

[0244] In some embodiments, the report includes data indicative of one or more of a quantitative failure, a fault parameter, a memory failure, a telecommunications failure, a processor failure, a packet resend, and a dropped communication session.

[0245] In some embodiments, the processor is further configured to forward, via the network interfaces, the report and an identifier for the UVE to a centralized, queryable database.

[0246] In some embodiments, the virtual network comprises a software defined network (SDN).

[0247] One embodiment is directed to a computer-readable storage medium having stored thereon instructions that, when executed, cause a processor to: determine, by a controller device for a virtual network, a set of two or more related processes executed by respective devices in the virtual network; receive, by the controller device, data for the set of two or more related processes; and aggregate, by the controller device, the data for the set of two or more related processes to form aggregated data for the set of two or more related processes.

[0248] One embodiment is directed to a method of predicting component failure, the method comprising receiving, by a communication protocol and with a virtual network controller that includes an analytics plane to analyze operations of a plurality of components in one or more virtual networks, a first parameter set from each of the components, wherein a parameter set from a component includes one or more quantitative parameters that each describes a state of the component; receiving, by the communication protocol and with the virtual network controller, an indication of detected component failure for one or more of the components; training, with the virtual network controller and using the first parameter sets and the indication of detected component failure, a trainable automated classifier to develop a classifying structure that distinguishes between component parameter sets that logically associate with a detected component failure and component parameter sets that do not logically associate with a detected component failure; receiving, by the communication protocol and with the virtual network controller, a second parameter set from each of the components; and predicting, with the virtual network controller using the trainable automated classifier and the classifying structure, a failure of a first one of the components.

[0249] In some embodiments, predicting a failure of a first one of the components comprises classifying the second parameter set for the first one of the components to a likely bad class according to the classifying structure.

[0250] In some embodiments, the classifying structure comprises one or more classification separation surfaces, and predicting a failure of a first one of the components comprises classifying the second parameter set for the first one of the components to a likely bad class according to one of the classification separation surfaces.

[0251] In some embodiments, the one of the classification separation surfaces is associated with a tolerance amount, and classifying the second parameter set for the first one of the components to a likely bad class comprises determining the second parameter set exceeds the tolerance amount.

[0252] In some embodiments, the trainable automated classifier comprises one or more support vector machines, and training the trainable automated classifier comprises inputting the first parameter sets and the indication of detected component failure to the support vector machines to produce the classifying structure.

[0253] In some embodiments, the virtual network controller is a distributed virtual network controller comprising a plurality of virtual network controller nodes, and each of the virtual network controller nodes comprises an analytics virtual machine that exchanges at least some analytics information to implement the analytics plane.

[0254] In some embodiments, the plurality of components includes virtual network elements that include one or more of servers, top-of-rack (TOR) switches, or chassis switches.

[0255] In some embodiments, the virtual network controller uses a software-defined network protocol to receive the first parameter set from each of the components.

[0256] In some embodiments, the components execute one of a forwarding plane, control plane, or configuration plane for the virtual networks.

[0257] One embodiment is directed to a virtual network controller comprising: an analytics plane; a control plane; one or more processors configured to execute the analytics plane to analyze operations of a plurality of components in one or more virtual networks, wherein the control plane receives, by a communication protocol, a first parameter set from each of the components, wherein a parameter set from a component includes one or more quantitative parameters that each describe a state of the component, wherein the control plane receives, by the communication protocol, an indication of detected component failure for one or more of the components, and wherein the control plane provides the first parameter sets and the indication of detected component failure to the analytics plane; a trainable automated classifier, wherein the analytics plane trains, using the first parameter sets and the indication of detected component failure, the trainable automated classifier to develop a classifying structure that distinguishes between first component parameter sets that logically associate with a detected component failure and second component parameter sets that do not logically associate with a detected component failure, wherein the control plane receives, by the communication protocol, a second parameter set from each of the components and provides the second parameter sets to the analytics plane, and wherein the analytics plane predicts, using the trainable automated classifier and the classifying structure, a failure of a first one of the components.

[0258] In some embodiments, predicting a failure of a first one of the components comprises classifying the second parameter set for the first one of the components to a likely bad class according to the classifying structure.

[0259] In some embodiments, the classifying structure comprises one or more classification separation surfaces, and the analytics plane predicts the failure of a first one of the components by classifying the second parameter set for the first one of the components to a likely bad class according to one of the classification separation surfaces.

[0260] In some embodiments, the one of the classification separation surfaces is associated with a tolerance amount, and classifying the second parameter set for the first component to a likely bad class comprises determining the second parameter set exceeds the tolerance amount.

[0261] In some embodiments, the trainable automated classifier comprises one or more support vector machines, and the analytics plane trains the trainable automated classifier by inputting the first parameter sets and the indication of detected component failure to the support vector machines to produce to the classifying structure.

[0262] In some embodiments, the virtual network controller comprises a plurality of virtual network controller nodes that implement a distributed virtual network controller, wherein each of the virtual network controller nodes comprises an analytics virtual machine that exchange at least some analytics information to implement the analytics plane.

[0263] In some embodiments, the plurality of components include virtual network elements that include one or more of servers, top-of-rack (TOR) switches, or chassis switches.

[0264] In some embodiments, the virtual network controller uses a software-defined network protocol to receive the first parameter set from each of the components.

[0265] In some embodiments, the components execute one of a forwarding plane, control plane, or configuration plane for the virtual networks.

[0266] One embodiment is directed to a non-transitory computer-readable medium comprising instructions that, when executed, cause one or more programmable processors to: receive, by a communication protocol and with a virtual network controller that includes an analytics plane to analyze operations of a plurality of components in one or more virtual networks, a first parameter set from each of the components, wherein a parameter set from a component includes one or more quantitative parameters that each describes a state of the component; receive, by the communication protocol and with the virtual network controller, an indication of detected component failure for one or more of the components; train, with the virtual network controller and using the first parameter sets and the indication of detected component failure, a trainable automated classifier to develop a classifying structure that distinguishes between component parameter sets that logically associate with a detected component failure and component parameter sets that do not logically associate with a detected component failure; receive, by the communication protocol and with the virtual network controller, a second parameter set from each of the components; and predict, with the virtual network controller using the trainable automated classifier and the classifying structure, a failure of a first one of the components.

[0267] In one example, a controller device includes one or more network interfaces communicatively coupled to one or more devices of a virtual network, and a processor configured to determine, for the virtual network, a set of two or more related processes executed by respective devices in the virtual network, receive via the network interfaces data for the set of two or more related processes, and aggregate the data for the set of two or more related processes to form aggregated data for the set of two or more related processes.

[0268] Further examples of feature combinations taught by the present disclosure are set out in the following numbered clauses:

[0269] Clause 1. A method comprising: determining, by a controller device for a virtual network, a set of two or more related processes executed by respective devices in the virtual network; receiving, by the controller device, data for the set of two or more related processes from the respective devices; and aggregating, by the controller device, the data for the set of two or more related processes to form aggregated data for the set of two or more related processes.

[0270] Clause 2. The method of clause 1, wherein the UVE defines one or more attributes for which values are to be extracted from the received data for the set of two or more related processes, and wherein aggregating comprises: extracting values for the one or more attributes defined by the UVE; and aggregating the values for the one or more attributes.

[0271] Clause 3. The method of clause 2, wherein the UVE defines the one or more attributes for a tier in which the set of two or more related processes are executed.

[0272] Clause 4. The method of clause 3, wherein the tier comprises one of a plurality of tiers, and wherein each of the plurality of tiers is associated with a respective UVE.

[0273] Clause 5. The method of clause 4, wherein the plurality of tiers include one or more of a control plane tier, an analytics tier, a configuration tier, and a software defined network (SDN) forwarding tier.

[0274] Clause 6. The method of clause 4 or 5, wherein the UVE comprises a UVE for the SDN forwarding tier, and wherein the UVE defines a bytes received attribute and a virtual machine names attribute.

[0275] Clause 7. The method of clause 4, 5 or 6, wherein each of the tiers includes a respective set of processes, and wherein each of the processes for a common one of the tiers is substantially similar.

[0276] Clause 8. The method of any of clauses 4 to 7, further comprising: for each of the tiers, determining resources of the virtual network used by the respective UVEs; and automatically determining whether the resources for one of the UVEs are insufficient based on a number of repeated failures associated with the one of the UVEs.

[0277] Clause 9. The method of any of clauses 4 to 8, further comprising: for each of the UVEs, in response to detecting a failure of a component associated with the UVE, logically associating the failed component with values for one or more of the attributes associated with the UVE that preceded the failure of the component.

[0278] Clause 10. The method of any of clauses 3 to

9, wherein the UVE defines a respective aggregation method for each of the attributes, wherein the respective aggregation methods comprise one of addition, union over sets, concatenation, and list formation.

[0279] Clause 11. The method of any preceding clause, wherein the UVE corresponds to a virtual network including the respective devices that execute the set of two or more processes.

[0280] Clause 12. The method of any preceding clause, further comprising: analyzing sequence numbers of packets of the received data for the UVE; and in response to detecting a gap in the sequence numbers for one of the processes, sending instructions to the device that is executing the one of the processes to replay a current state for the UVE.

[0281] Clause 13. The method of any preceding clause, wherein the report includes data indicative of one or more of a quantitative failure, a fault parameter, a memory failure, a telecommunications failure, a processor failure, a packet resend, and a dropped communication session.

[0282] Clause 14. A controller device comprising: one or more network interfaces communicatively coupled to one or more devices of a virtual network; and a processor configured to determine, for the virtual network, a set of two or more related processes executed by respective devices in the virtual network, receive via the network interfaces data for the set of two or more related processes, and aggregate the data for the set of two or more related processes to form aggregated data for the set of two or more related processes.

[0283] Clause 15. A controller device comprising: means for performing any of the methods of clauses 1-13.

[0284] A computer-readable storage medium having stored thereon instructions that, when executed, cause a processor to perform the method recited by any of clauses 1-13.

[0285] Moreover, any of the specific features set forth in any of the embodiments described above may be combined into a beneficial embodiment of the described techniques. That is, any of the specific features are generally applicable to all embodiments of the present disclosure. Various embodiments have been described.

[0286] Various embodiments have been described. These and other embodiments are within the scope of the following examples.

Claims

1. A method comprising:

   determining, by a controller device for a virtual network, a set of two or more related processes executed by respective devices in the virtual network;
   receiving, by the controller device, data for the set of two or more related processes from the respective devices; and
   aggregating, by the controller device, the data for the set of two or more related processes to form aggregated data for the set of two or more related processes.

2. The method of claim 1,
   wherein the aggregated data comprises data for a User-Visible Entity (UVE),
   wherein the UVE defines one or more attributes for which values are to be extracted from the received data for the set of two or more related processes, and wherein aggregating comprises:

   extracting values for the one or more attributes defined by the UVE; and
   aggregating the values for the one or more attributes.

3. The method of claim 2, wherein the UVE defines the one or more attributes for a tier in which the set of two or more related processes are executed.

4. The method of claim 3, wherein the tier comprises one of a plurality of tiers, and wherein each of the plurality of tiers is associated with a respective UVE.

5. The method of claim 4 or 5, wherein the plurality of tiers include one or more of a control plane tier, an analytics tier, a configuration tier, and a software defined network (SDN) forwarding tier.

6. The method of claim 4, 5 or 6, wherein the UVE comprises a UVE for the SDN forwarding tier, and wherein the UVE defines a bytes received attribute and a virtual machine names attribute.

7. The method of claims 4 to 6, wherein each of the tiers includes a respective set of processes, and wherein each of the processes for a common one of the tiers is substantially similar.

8. The method of any of claims 4 to 7, further comprising:

   for each of the tiers, determining resources of the virtual network used by the respective UVEs; and
   automatically determining whether the resources for one of the UVEs are insufficient based on a number of repeated failures associated with the one of the UVEs.

9. The method of any of claims 4 to 8, further comprising:

   for each of the UVEs, in response to detecting a failure of a component associated with the

UVE, logically associating the failed component with values for one or more of the attributes associated with the UVE that preceded the failure of the component.

10. The method of any of claims 3 to 9, wherein the UVE defines a respective aggregation method for each of the attributes, wherein the respective aggregation methods comprise one of addition, union over sets, concatenation, and list formation.

11. The method of any preceding claim,
wherein the aggregated data comprises data for a User-Visible Entity (UVE),
wherein the UVE corresponds to a virtual network including the respective devices that execute the set of two or more processes.

12. The method of any preceding claim,
wherein the aggregated data comprises data for a User-Visible Entity (UVE), the method further comprising:

analyzing sequence numbers of packets of the received data for the UVE; and
in response to detecting a gap in the sequence numbers for one of the processes, sending instructions to the device that is executing the one of the processes to replay a current state for the UVE.

13. The method of any preceding claim, wherein the aggregated data comprises data for a User-Visible Entity (UVE), the method further comprising:

generating a report including the aggregated data, wherein the report is associated with the UVE, and wherein the report includes data indicative of one or more of a quantitative failure, a fault parameter, a memory failure, a telecommunications failure, a processor failure, a packet resend, and a dropped communication session.

14. The method of any preceding claim,
wherein the data for the set of two or more related processes from the respective devices comprises a first parameter set from each of the devices, wherein a parameter set from a device includes one or more quantitative parameters that each describes a state of one of the set of two or more related processes, the method further comprising:

receiving, by the controller device, an indication of detected component failure for one or more of the set of two or more related processes;
training, with the controller device and using the first parameter sets and the indication of detected component failure, a trainable automated classifier to develop a classifying structure that distinguishes between parameter sets that logically associate with a detected component failure and parameter sets that do not logically associate with a detected component failure;
receiving, with the controller device, a second parameter set from each of the devices; and
predicting, with the controller device using the trainable automated classifier and the classifying structure, a failure of a first one of the set of two or more related processes.

15. A controller device comprising:

one or more network interfaces communicatively coupled to one or more devices of a virtual network; and
a processor configured to determine, for the virtual network, a set of two or more related processes executed by respective devices in the virtual network, receive via the network interfaces data for the set of two or more related processes, and aggregate the data for the set of two or more related processes to form aggregated data for the set of two or more related processes.

16. A controller device comprising:

means for performing any of the methods of claims 1-14.

17. A computer-readable storage medium having stored thereon instructions that, when executed, cause a processor to perform the method recited by any of claims 1-14.

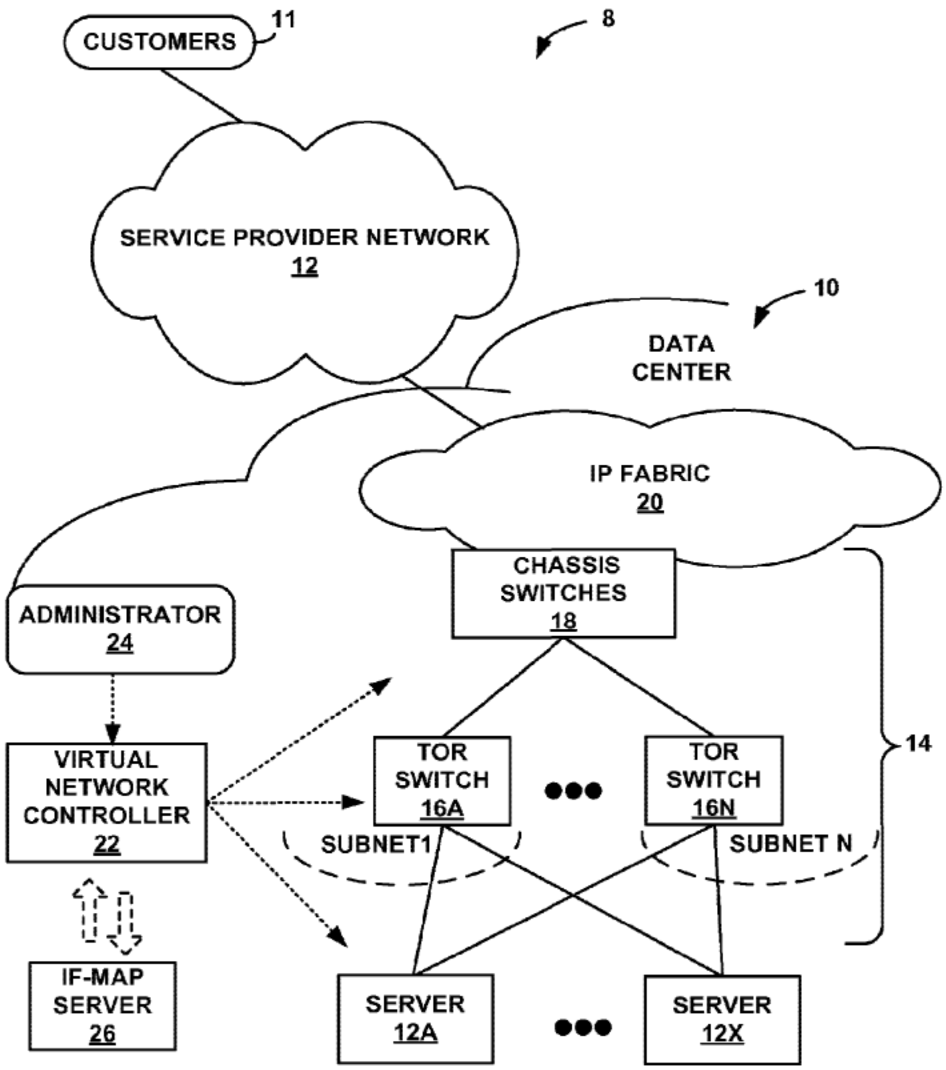
CUSTOMERS
11
8
SERVICE PROVIDER NETWORK
12
10
DATA CENTER
IP FABRIC
20
CHASSIS SWITCHES
18
ADMINISTRATOR
24
14
VIRTUAL NETWORK CONTROLLER
22
TOR SWITCH
16A
TOR SWITCH
16N
SUBNET1
SUBNET N
IF-MAP SERVER
26
SERVER
12A
SERVER
12X

FIG. 1

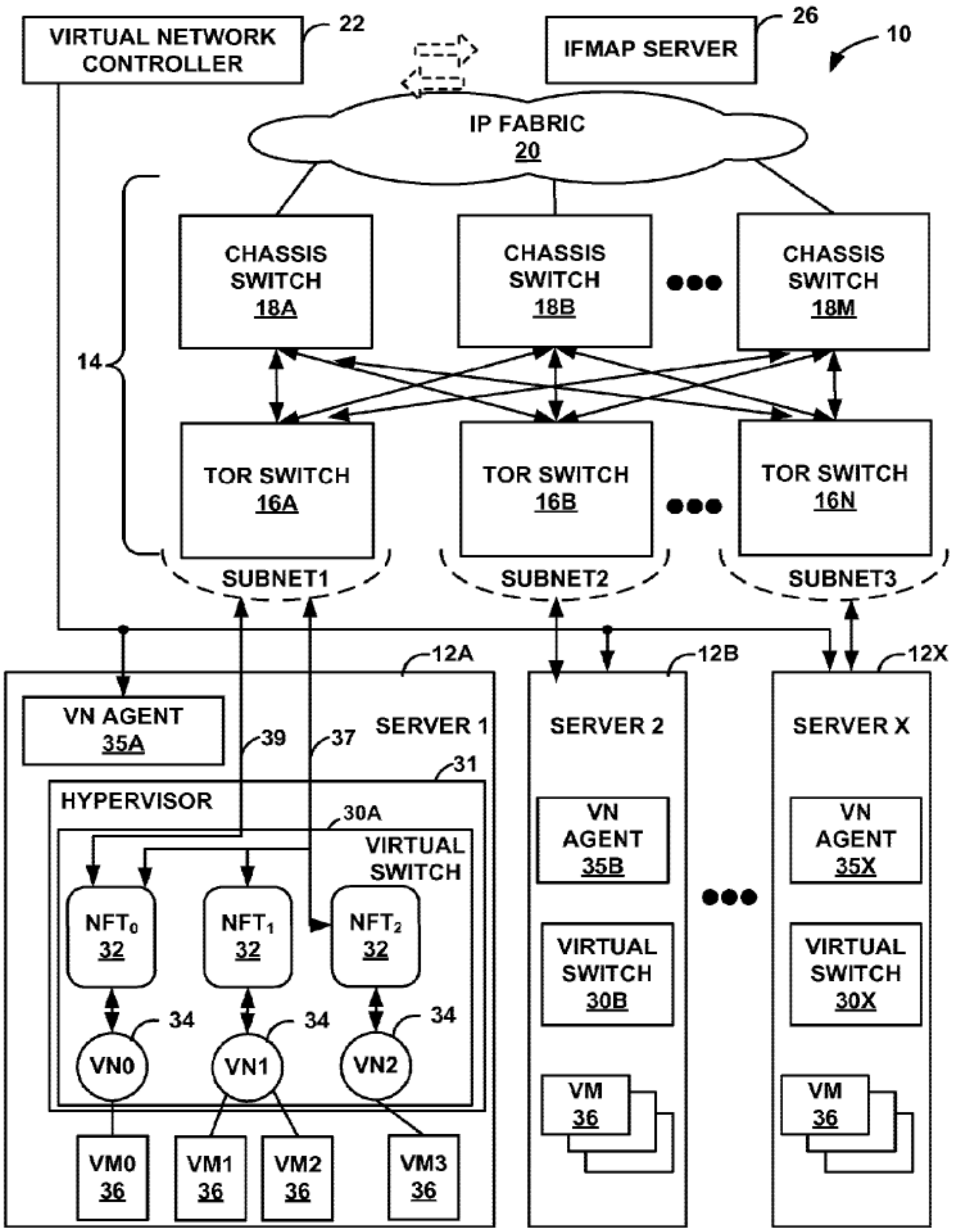
VIRTUAL NETWORK CONTROLLER
22
IFMAP SERVER
26
10
IP FABRIC
20
14
CHASSIS SWITCH
18A
CHASSIS SWITCH
18B
CHASSIS SWITCH
18M
TOR SWITCH
16A
TOR SWITCH
16B
TOR SWITCH
16N
SUBNET1
SUBNET2
SUBNET3
12A
12B
12X
VN AGENT
35A
SERVER 1
39
37
31
HYPERVISOR
30A
VIRTUAL SWITCH
NFT0
32
NFT1
32
NFT2
32
34
34
34
VN0
VN1
VN2
VM0
36
VM1
36
VM2
36
VM3
36
SERVER 2
VN AGENT
35B
VIRTUAL SWITCH
30B
VM
36
SERVER X
VN AGENT
35X
VIRTUAL SWITCH
30X
VM
36

FIG. 2

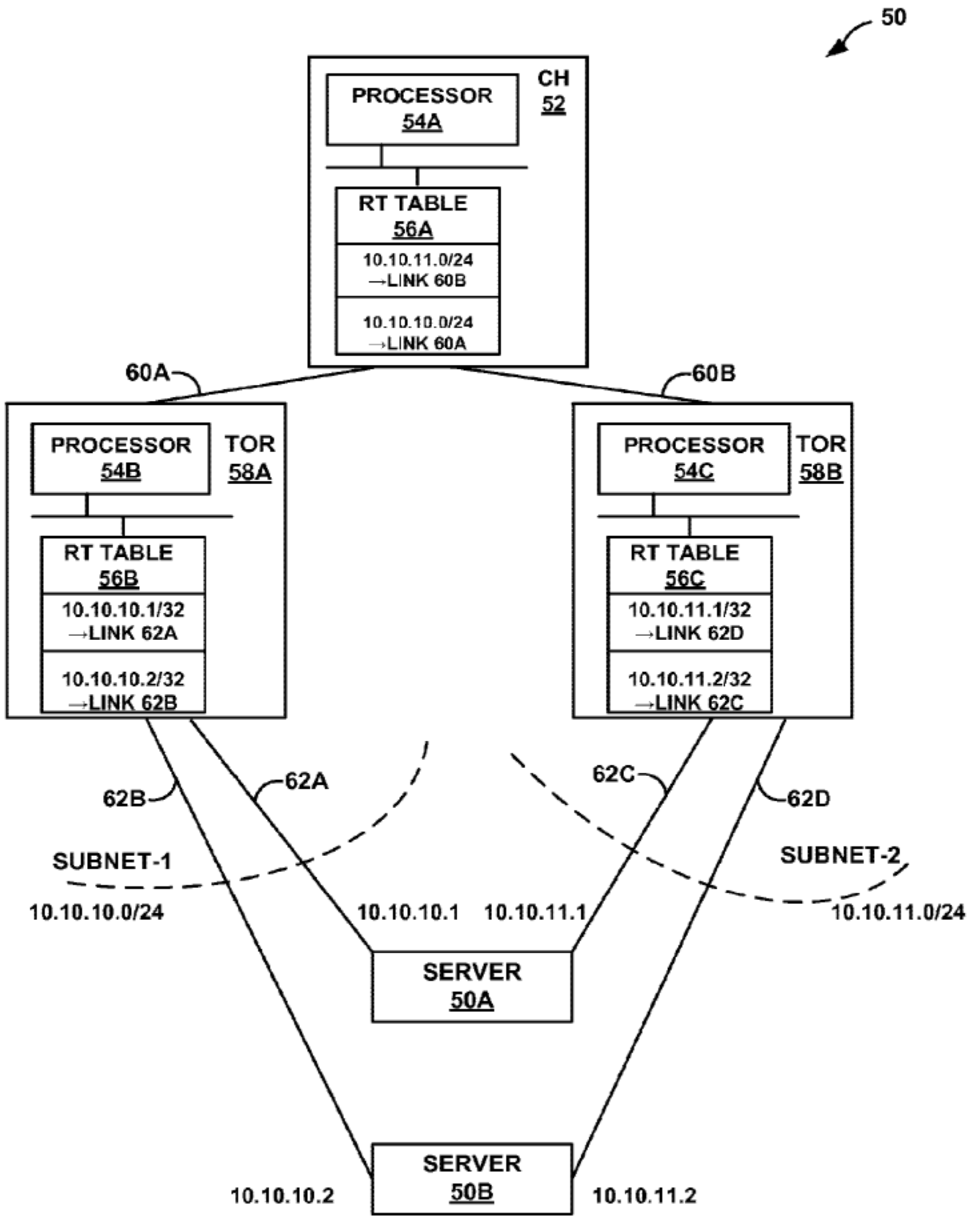
50
PROCESSOR
54A
CH
52
RT TABLE
56A
10.10.11.0/24
→LINK 60B
10.10.10.0/24
→LINK 60A
60A
60B
PROCESSOR
54B
TOR
58A
RT TABLE
56B
10.10.10.1/32
→LINK 62A
10.10.10.2/32
→LINK 62B
PROCESSOR
54C
TOR
58B
RT TABLE
56C
10.10.11.1/32
→LINK 62D
10.10.11.2/32
→LINK 62C
62B
62A
62C
62D
SUBNET-1
10.10.10.0/24
SUBNET-2
10.10.11.0/24
10.10.10.1
10.10.11.1
SERVER
50A
SERVER
50B
10.10.10.2
10.10.11.2

FIG. 3

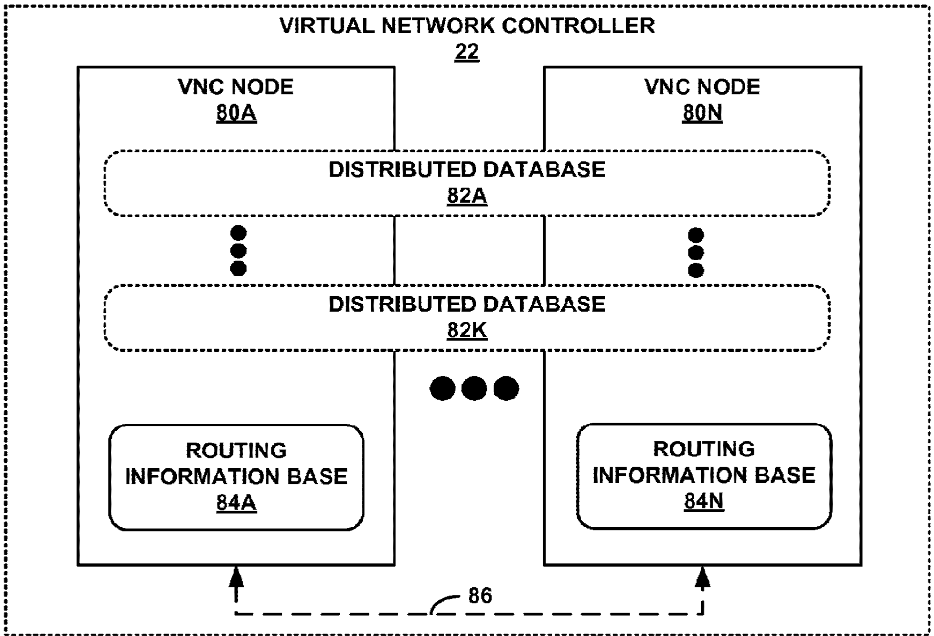
VIRTUAL NETWORK CONTROLLER
22
VNC NODE
80A
VNC NODE
80N
DISTRIBUTED DATABASE
82A
DISTRIBUTED DATABASE
82K
ROUTING
INFORMATION BASE
84A
ROUTING
INFORMATION BASE
84N
86

FIG. 4

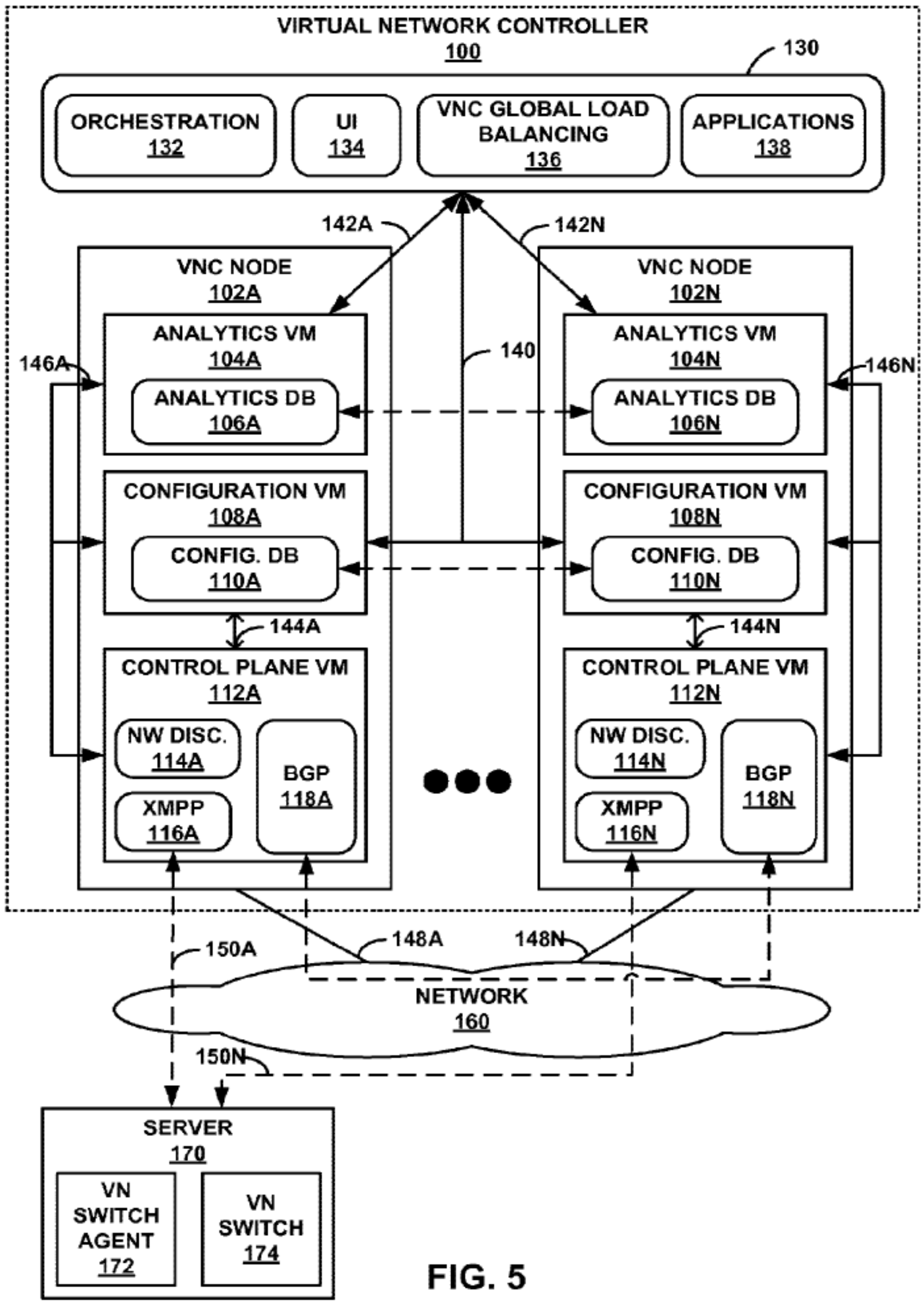
VIRTUAL NETWORK CONTROLLER
100
130
ORCHESTRATION
132
UI
134
VNC GLOBAL LOAD BALANCING
136
APPLICATIONS
138
142A
142N
VNC NODE
102A
ANALYTICS VM
104A
ANALYTICS DB
106A
CONFIGURATION VM
108A
CONFIG. DB
110A
144A
CONTROL PLANE VM
112A
NW DISC.
114A
XMPP
116A
BGP
118A
146A
140
VNC NODE
102N
ANALYTICS VM
104N
ANALYTICS DB
106N
CONFIGURATION VM
108N
CONFIG. DB
110N
144N
CONTROL PLANE VM
112N
NW DISC.
114N
XMPP
116N
BGP
118N
146N
148A
148N
150A
NETWORK
160
150N
SERVER
170
VN SWITCH AGENT
172
VN SWITCH
174

FIG. 5

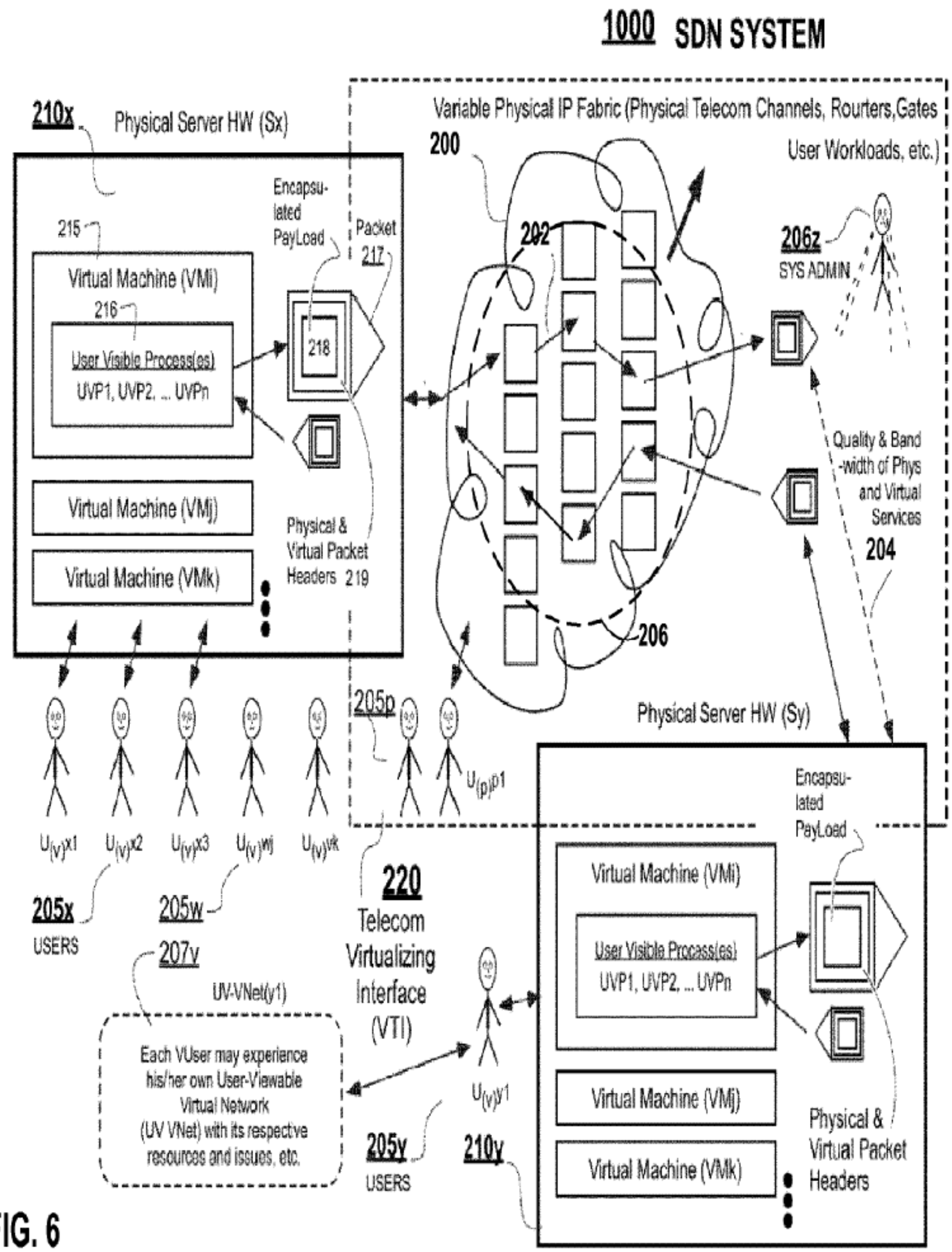
1000 SDN SYSTEM
210x
Physical Server HW (Sx)
Variable Physical IP Fabric (Physical Telecom Channels, Rourters,Gates
User Workloads, etc.)
200
215
Virtual Machine (VMi)
216
User Visible Process(es)
UVP1, UVP2, ... UVPn
Encapsu-
lated
PayLoad
Packet
217
218
202
206z
SYS ADMIN
Quality & Band
-width of Phys
and Virtual
Services
204
Virtual Machine (VMj)
Virtual Machine (VMk)
Physical &
Virtual Packet
Headers 219
206
205p
Physical Server HW (Sy)
U(p)p1
U(v)x1
U(v)x2
U(v)x3
U(v)wj
U(v)vk
205x
USERS
205w
207v
UV-VNet(y1)
220
Telecom
Virtualizing
Interface
(VTI)
Encapsu-
lated
PayLoad
Virtual Machine (VMi)
User Visible Process(es)
UVP1, UVP2, ... UVPn
Each VUser may experience
his/her own User-Viewable
Virtual Network
(UV VNet) with its respective
resources and issues, etc.
U(v)y1
205y
USERS
210y
Virtual Machine (VMj)
Virtual Machine (VMk)
Physical &
Virtual Packet
Headers

FIG. 6

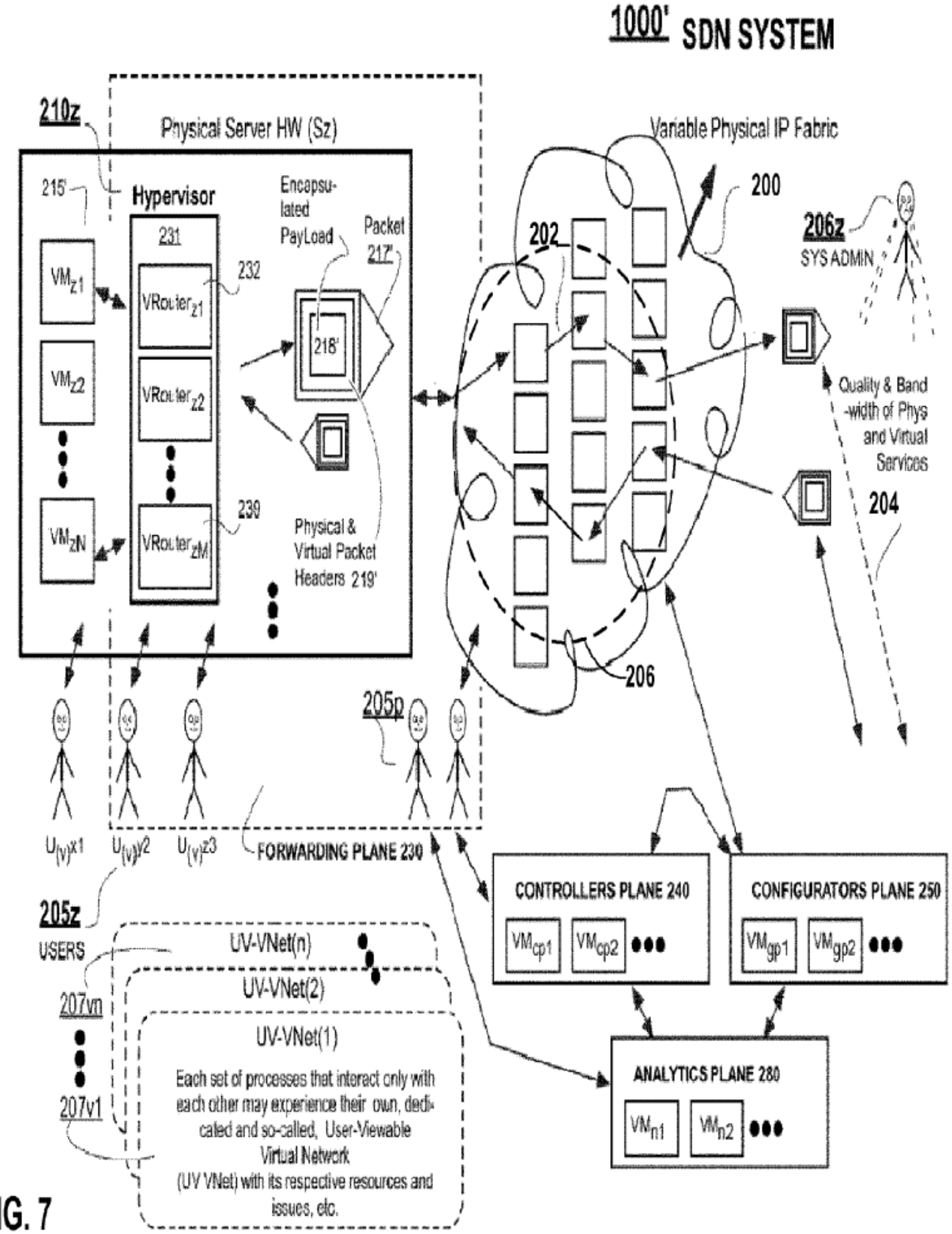
1000' SDN SYSTEM
210z
Physical Server HW (Sz)
215'
Hypervisor
231
VM_{z1}
VM_{z2}
VM_{zN}
$VRouter_{z1}$
$VRouter_{z2}$
$VRouter_{zM}$
232
239
Encapsulated PayLoad
Packet 217"
218'
Physical & Virtual Packet Headers 219'
Variable Physical IP Fabric
200
202
206
206z
SYS ADMIN
Quality & Band -width of Phys and Virtual Services
204
205p
$U_{(v)}x1$
$U_{(v)}y2$
$U_{(v)}z3$
FORWARDING PLANE 230
205z
USERS
207vn
207v1
UV-VNet(n)
UV-VNet(2)
UV-VNet(1)
Each set of processes that interact only with each other may experience their own, dedicated and so-called, User-Viewable Virtual Network (UV VNet) with its respective resources and issues, etc.
CONTROLLERS PLANE 240
VM_{cp1}
VM_{cp2}
CONFIGURATORS PLANE 250
VM_{gp1}
VM_{gp2}
ANALYTICS PLANE 280
VM_{n1}
VM_{n2}

FIG. 7

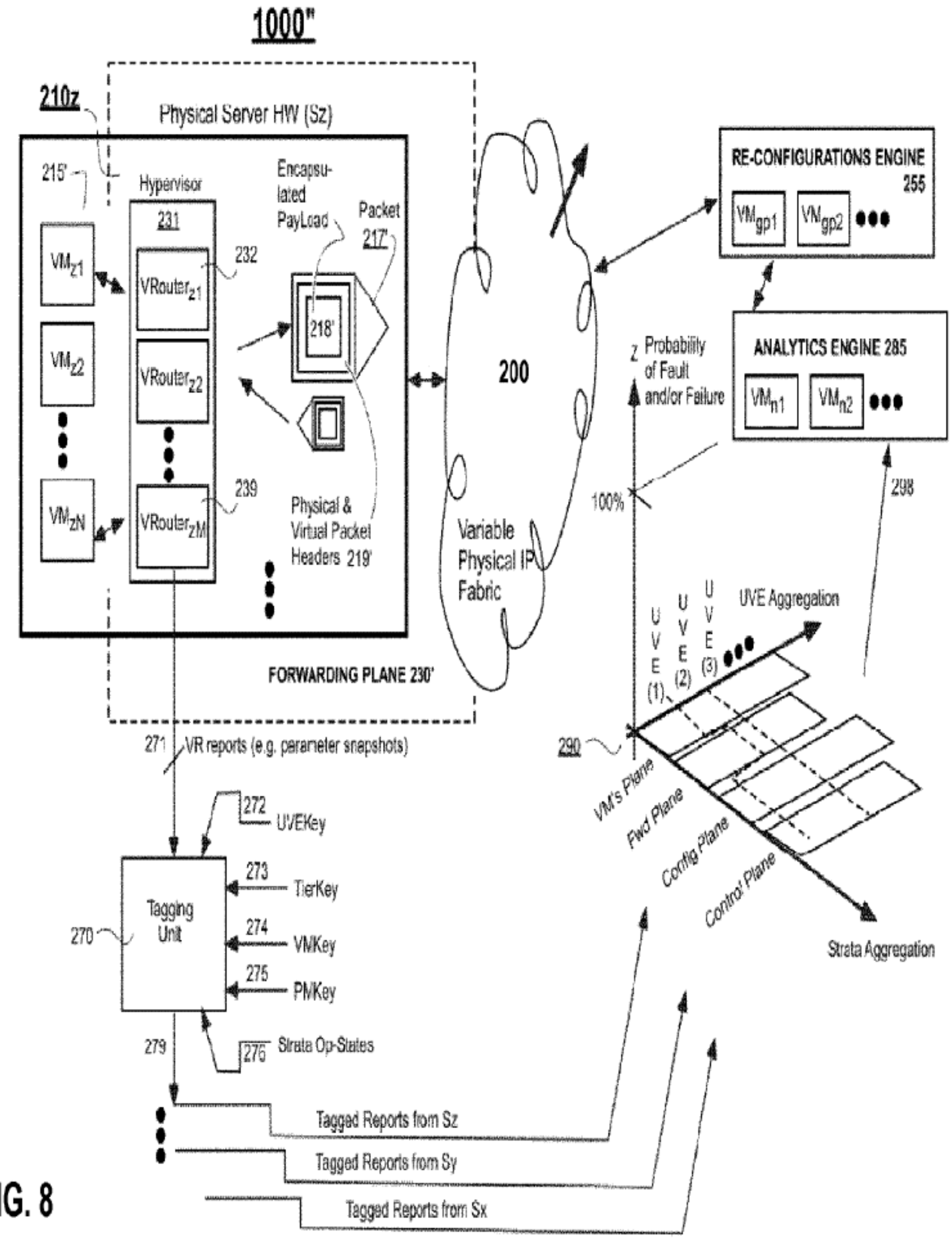
1000"
210z
Physical Server HW (Sz)
215'
Hypervisor
231
Encapsu-
lated
PayLoad
Packet
217'
232
VM$_{z1}$
VRouter$_{z1}$
218'
VM$_{z2}$
VRouter$_{z2}$
VM$_{zN}$
VRouter$_{zM}$
239
Physical &
Virtual Packet
Headers 219'
FORWARDING PLANE 230'
200
Variable
Physical IP
Fabric
RE-CONFIGURATIONS ENGINE
255
VM$_{gp1}$
VM$_{gp2}$
ANALYTICS ENGINE 285
VM$_{n1}$
VM$_{n2}$
z
Probability
of Fault
and/or Failure
100%
298
UVE Aggregation
UVE (1)
UVE (2)
UVE (3)
290
VM's Plane
Fwd Plane
Config Plane
Control Plane
Strata Aggregation
271
VR reports (e.g. parameter snapshots)
272
UVEKey
273
TierKey
274
VMKey
275
PMKey
276
Strata Op-States
Tagging
Unit
270
279
Tagged Reports from Sz
Tagged Reports from Sy
Tagged Reports from Sx

FIG. 8

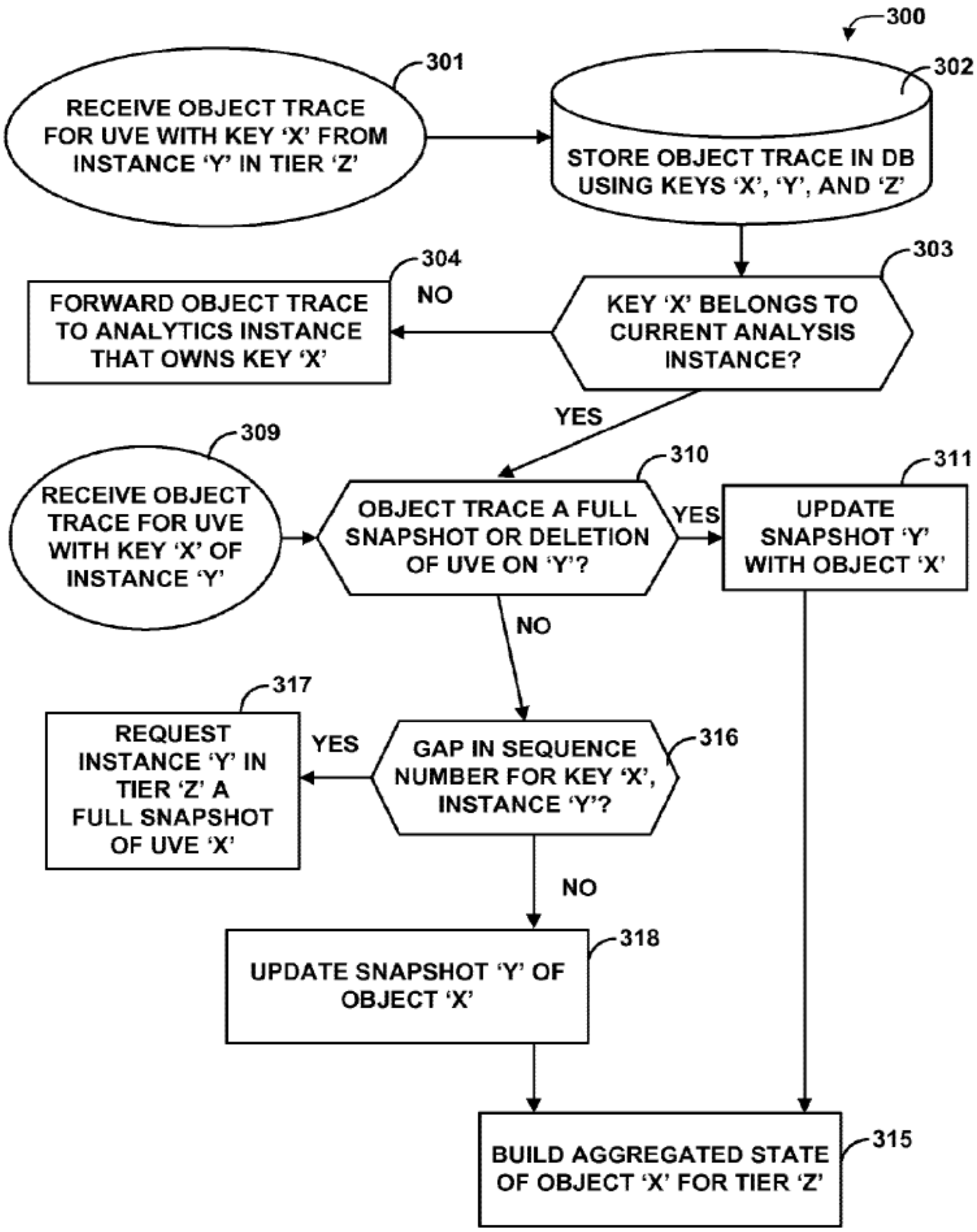
300
RECEIVE OBJECT TRACE FOR UVE WITH KEY 'X' FROM INSTANCE 'Y' IN TIER 'Z'
301
STORE OBJECT TRACE IN DB USING KEYS 'X', 'Y', AND 'Z'
302
FORWARD OBJECT TRACE TO ANALYTICS INSTANCE THAT OWNS KEY 'X'
304
NO
KEY 'X' BELONGS TO CURRENT ANALYSIS INSTANCE?
303
YES
RECEIVE OBJECT TRACE FOR UVE WITH KEY 'X' OF INSTANCE 'Y'
309
OBJECT TRACE A FULL SNAPSHOT OR DELETION OF UVE ON 'Y'?
310
YES
UPDATE SNAPSHOT 'Y' WITH OBJECT 'X'
311
NO
REQUEST INSTANCE 'Y' IN TIER 'Z' A FULL SNAPSHOT OF UVE 'X'
317
YES
GAP IN SEQUENCE NUMBER FOR KEY 'X', INSTANCE 'Y'?
316
NO
UPDATE SNAPSHOT 'Y' OF OBJECT 'X'
318
BUILD AGGREGATED STATE OF OBJECT 'X' FOR TIER 'Z'
315

FIG. 9

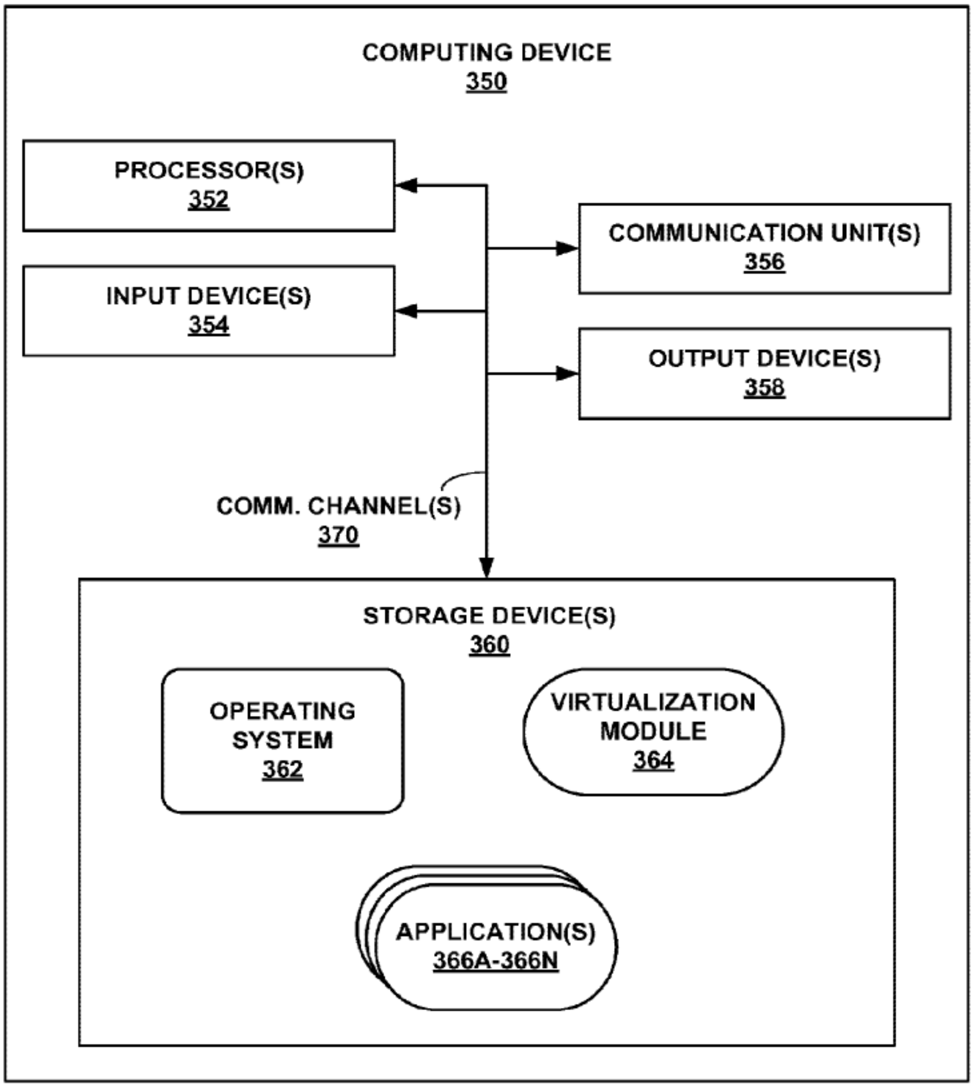
COMPUTING DEVICE
350
PROCESSOR(S)
352
INPUT DEVICE(S)
354
COMMUNICATION UNIT(S)
356
OUTPUT DEVICE(S)
358
COMM. CHANNEL(S)
370
STORAGE DEVICE(S)
360
OPERATING SYSTEM
362
VIRTUALIZATION MODULE
364
APPLICATION(S)
366A-366N

FIG. 10

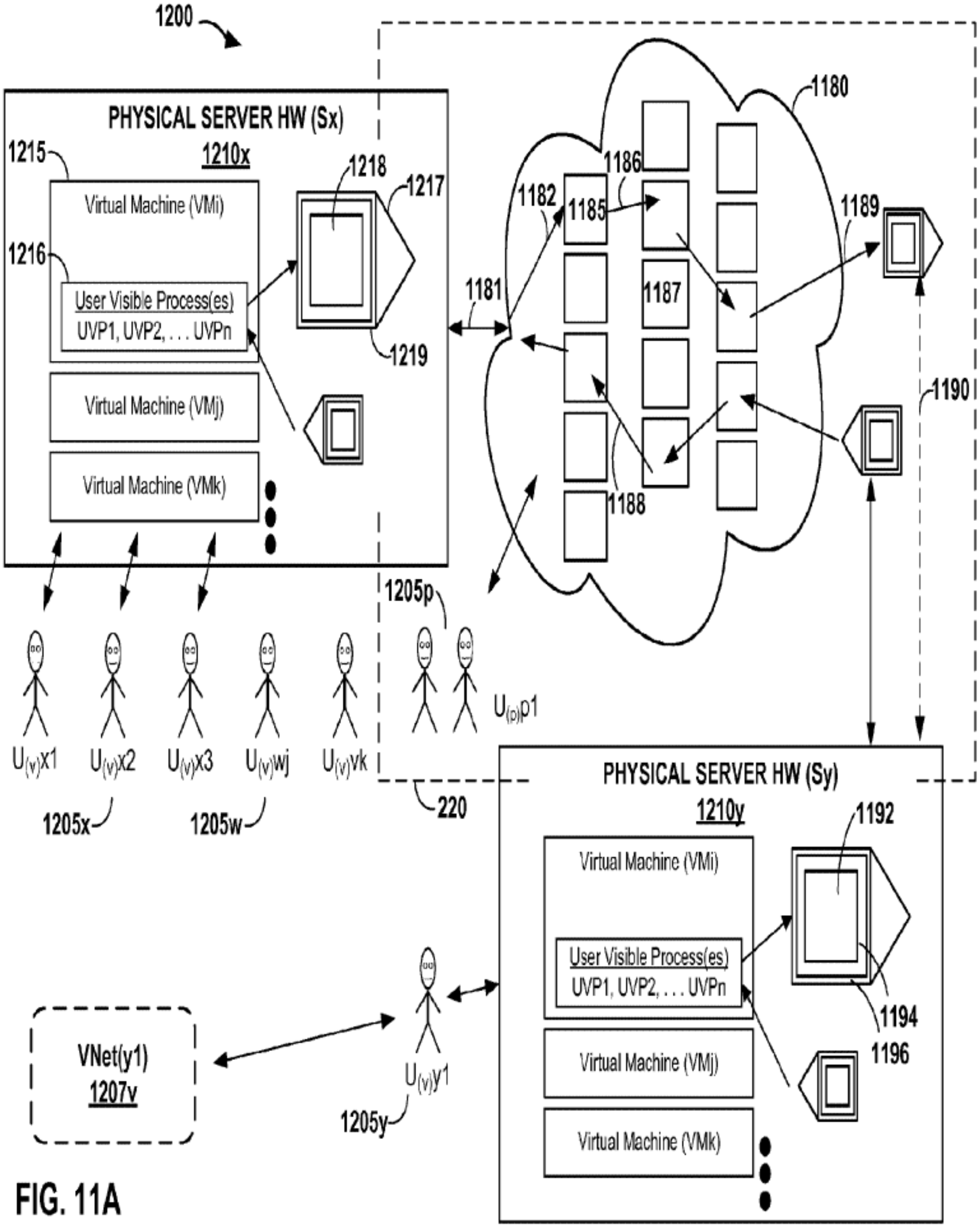
1200
PHYSICAL SERVER HW (Sx)
1210x
1215
Virtual Machine (VMi)
1216
User Visible Process(es)
UVP1, UVP2, . . . UVPn
1218
1217
1219
Virtual Machine (VMj)
Virtual Machine (VMk)
1181
1182
1185
1186
1187
1188
1180
1189
1190
1205p
$U_{(p)}p1$
$U_{(v)}x1$
$U_{(v)}x2$
$U_{(v)}x3$
$U_{(v)}wj$
$U_{(v)}vk$
1205x
1205w
220
PHYSICAL SERVER HW (Sy)
1210y
Virtual Machine (VMi)
User Visible Process(es)
UVP1, UVP2, . . . UVPn
1192
1194
1196
Virtual Machine (VMj)
Virtual Machine (VMk)
VNet(y1)
1207v
$U_{(v)}y1$
1205y

FIG. 11A

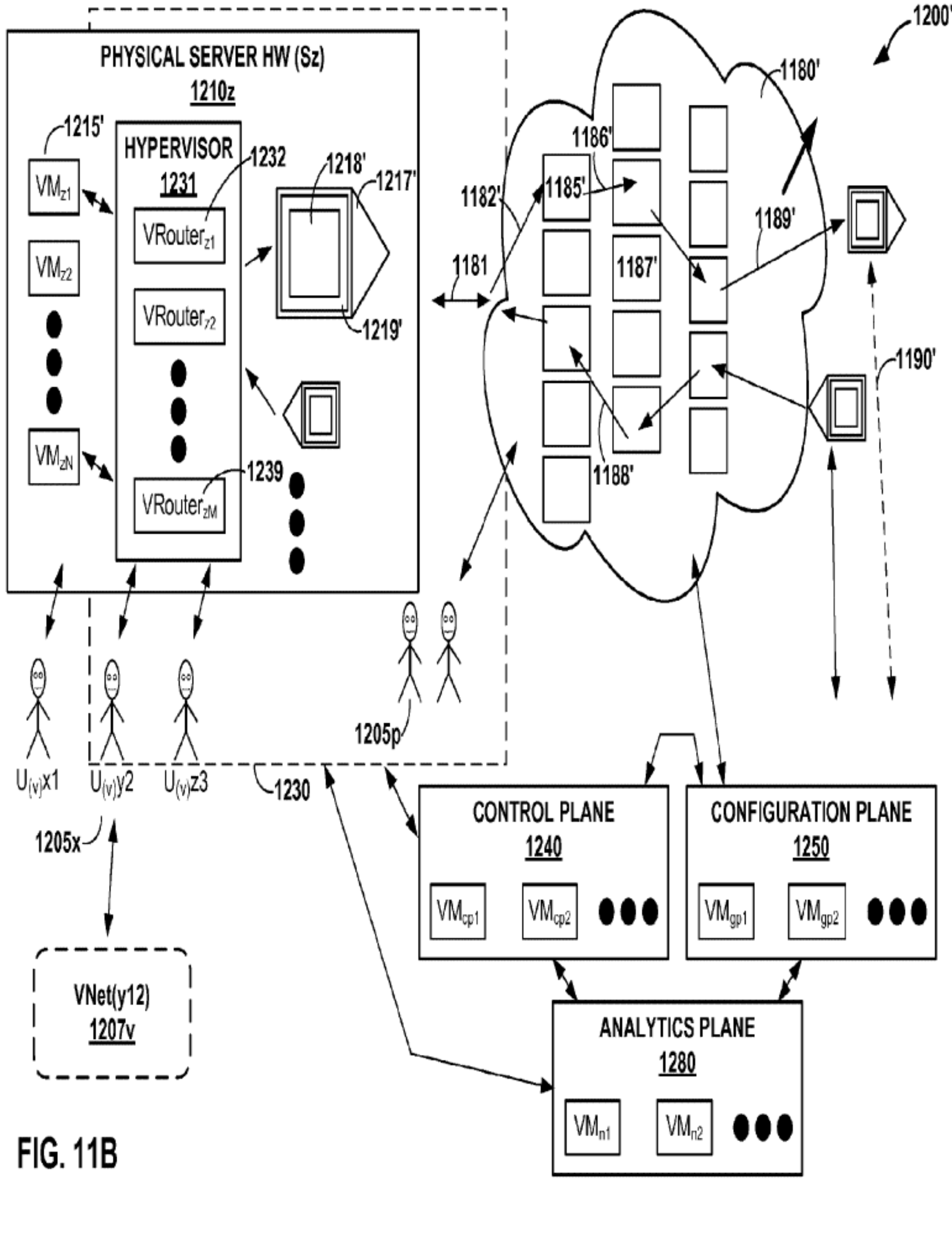
1200'
PHYSICAL SERVER HW (Sz)
1210z
1215'
VM_{z1}
VM_{z2}
VM_{zN}
HYPERVISOR
1231
1232
$VRouter_{z1}$
$VRouter_{z2}$
$VRouter_{zM}$
1239
1218'
1217'
1219'
1181
1182'
1180'
1186'
1185'
1187'
1188'
1189'
1190'
1205p
$U_{(v)}x1$
$U_{(v)}y2$
$U_{(v)}z3$
1205x
1230
VNet(y12)
1207v
CONTROL PLANE
1240
VM_{cp1}
VM_{cp2}
CONFIGURATION PLANE
1250
VM_{gp1}
VM_{gp2}
ANALYTICS PLANE
1280
VM_{n1}
VM_{n2}

FIG. 11B

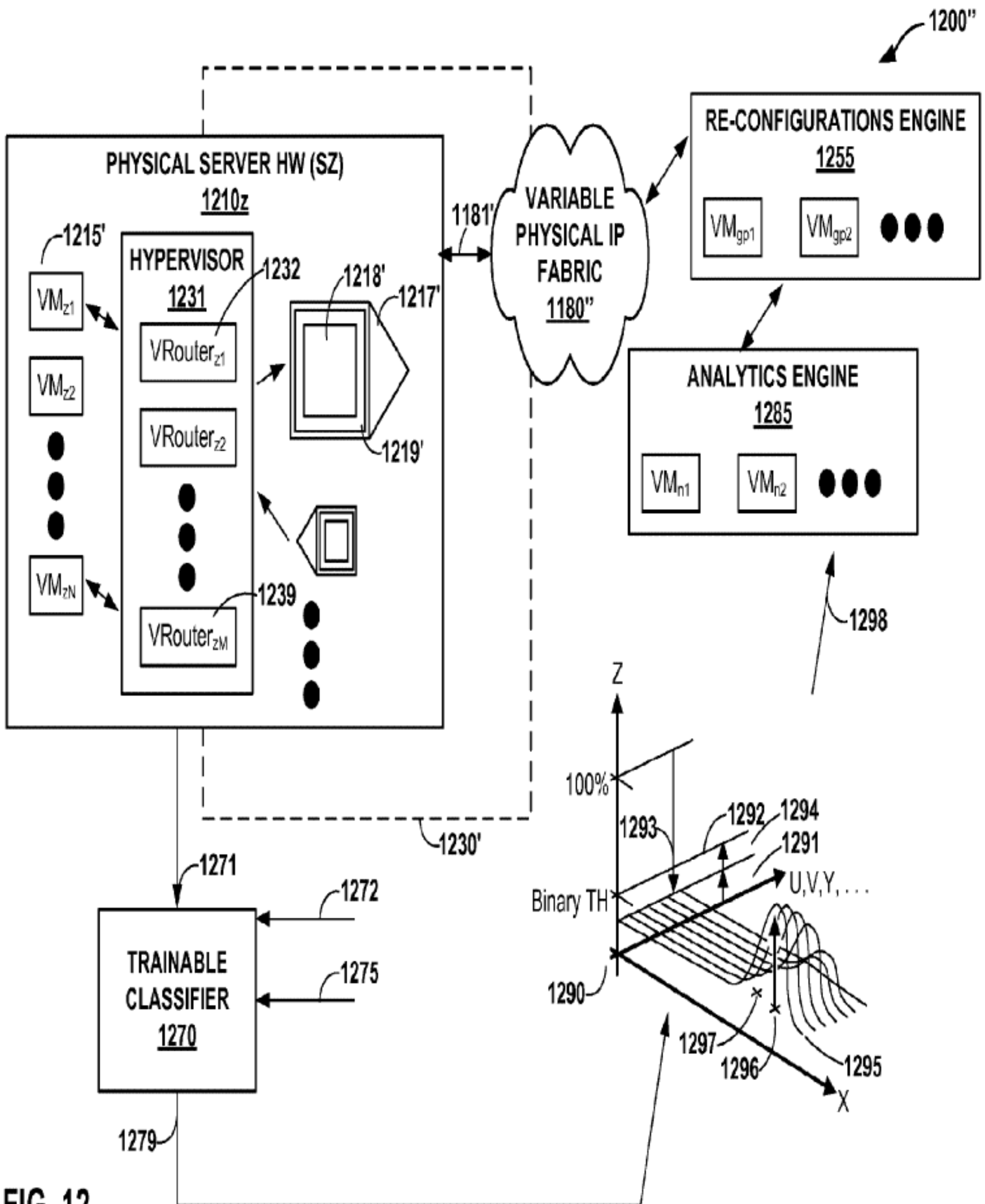
1200"
PHYSICAL SERVER HW (SZ)
1210z
1215'
HYPERVISOR
1231
1232
1218'
1217'
VM$_{z1}$
VRouter$_{z1}$
VM$_{z2}$
VRouter$_{z2}$
1219'
VM$_{zN}$
VRouter$_{zM}$
1239
1181'
VARIABLE
PHYSICAL IP
FABRIC
1180"
RE-CONFIGURATIONS ENGINE
1255
VM$_{gp1}$
VM$_{gp2}$
ANALYTICS ENGINE
1285
VM$_{n1}$
VM$_{n2}$
1298
1230'
1271
1272
TRAINABLE
CLASSIFIER
1270
1275
1279
Z
100%
1293
1292
1294
1291
Binary TH
U,V,Y, . . .
1290
1297
1296
1295
X

FIG. 12

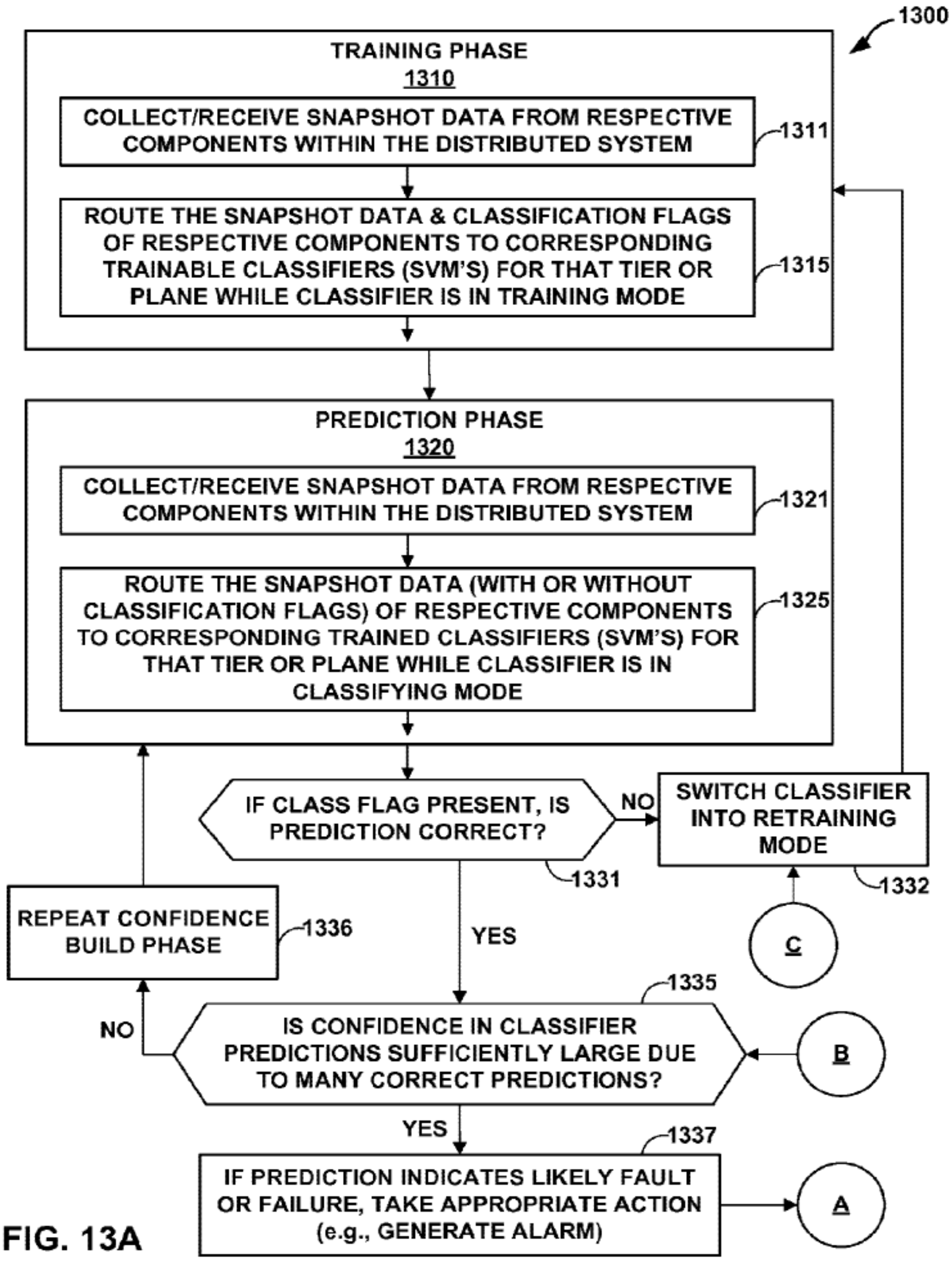
1300
TRAINING PHASE
1310
COLLECT/RECEIVE SNAPSHOT DATA FROM RESPECTIVE COMPONENTS WITHIN THE DISTRIBUTED SYSTEM
1311
ROUTE THE SNAPSHOT DATA & CLASSIFICATION FLAGS OF RESPECTIVE COMPONENTS TO CORRESPONDING TRAINABLE CLASSIFIERS (SVM'S) FOR THAT TIER OR PLANE WHILE CLASSIFIER IS IN TRAINING MODE
1315
PREDICTION PHASE
1320
COLLECT/RECEIVE SNAPSHOT DATA FROM RESPECTIVE COMPONENTS WITHIN THE DISTRIBUTED SYSTEM
1321
ROUTE THE SNAPSHOT DATA (WITH OR WITHOUT CLASSIFICATION FLAGS) OF RESPECTIVE COMPONENTS TO CORRESPONDING TRAINED CLASSIFIERS (SVM'S) FOR THAT TIER OR PLANE WHILE CLASSIFIER IS IN CLASSIFYING MODE
1325
IF CLASS FLAG PRESENT, IS PREDICTION CORRECT?
1331
NO
SWITCH CLASSIFIER INTO RETRAINING MODE
1332
C
YES
REPEAT CONFIDENCE BUILD PHASE
1336
NO
IS CONFIDENCE IN CLASSIFIER PREDICTIONS SUFFICIENTLY LARGE DUE TO MANY CORRECT PREDICTIONS?
1335
B
YES
IF PREDICTION INDICATES LIKELY FAULT OR FAILURE, TAKE APPROPRIATE ACTION (e.g., GENERATE ALARM)
1337
A

FIG. 13A

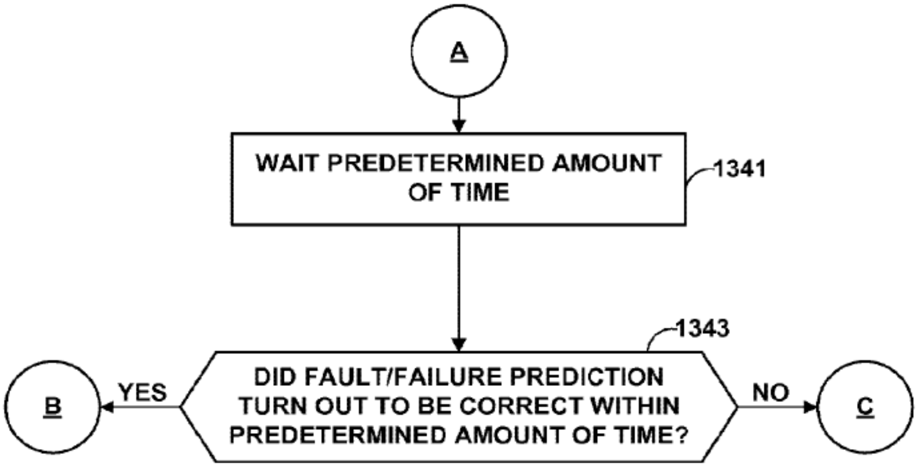
A
WAIT PREDETERMINED AMOUNT OF TIME
1341
1343
DID FAULT/FAILURE PREDICTION TURN OUT TO BE CORRECT WITHIN PREDETERMINED AMOUNT OF TIME?
YES
B
NO
C

FIG. 13B

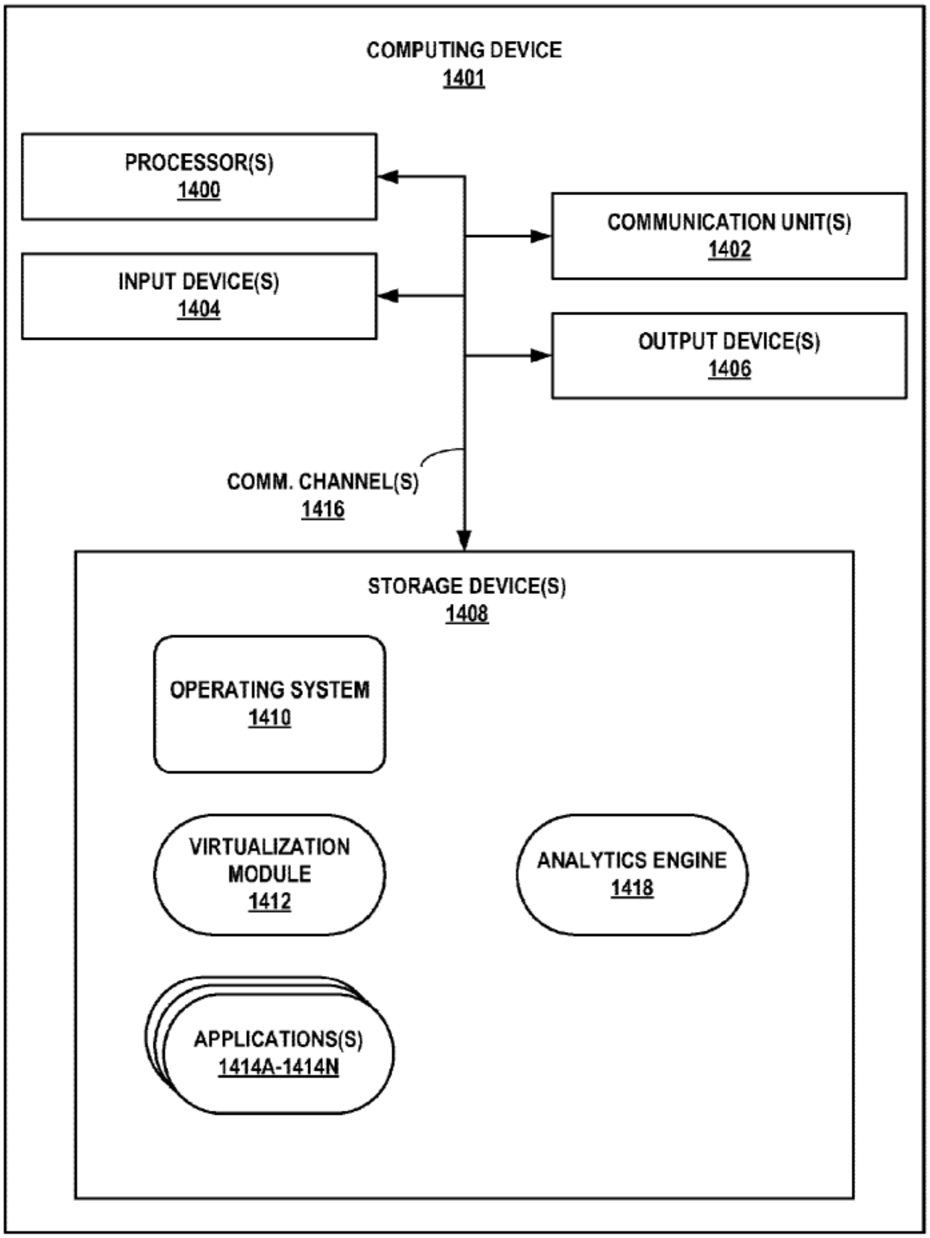
COMPUTING DEVICE
1401
PROCESSOR(S)
1400
COMMUNICATION UNIT(S)
1402
INPUT DEVICE(S)
1404
OUTPUT DEVICE(S)
1406
COMM. CHANNEL(S)
1416
STORAGE DEVICE(S)
1408
OPERATING SYSTEM
1410
VIRTUALIZATION
MODULE
1412
ANALYTICS ENGINE
1418
APPLICATIONS(S)
1414A-1414N

FIG. 14

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 13 17 0817

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	"Amazon CloudWatch Developer Guide API Version 2010-08-01", , 1 January 2011 (2011-01-01), XP055080786, Retrieved from the Internet: URL:http://web.archive.org/web/20111009080335/http://awsdocs.s3.amazonaws.com/AmazonCloudWatch/latest/acw-dg.pdf [retrieved on 2013-09-24] * page 3 * * page 5 * * page 9 * * page 26 * * page 36 * * page 83 - page 84 * * page 98 * * page 38 * * page 91 * -----	1-13, 15-17 14	INV. H04L12/733 H04L12/24
X	Nikhil Handigol ET AL: "Aster*x: Load-Balancing Web Traffic over Wide-Area Networks", 9th GENI Engineering Conference (GEC9), 2 November 2010 (2010-11-02), XP055080468, Retrieved from the Internet: URL:http://www.stanford.edu/~nikhilh/pubs/handigol-gec9.pdf [retrieved on 2013-09-23] * page 2, left-hand column * * page 3, left-hand column * -----	1,15-17	TECHNICAL FIELDS SEARCHED (IPC) H04L
Y	US 2010/057649 A1 (LEE CHANG EUN [KR] ET AL) 4 March 2010 (2010-03-04) * paragraph [0065] - paragraph [0072] * -----	14	

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	27 September 2013	Dely, Peter

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 17 0817

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The members are as contained in the European Patent Office EDP file on
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27-09-2013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010057649 A1	04-03-2010	KR 20100028360 A	12-03-2010
		US 2010057649 A1	04-03-2010

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 83548313 A **[0001]**
- US 84290913 A **[0001]**
- US 61729474 A **[0001]**
- US 61723684 A **[0001]**
- US 61723685 A **[0001]**
- US 61722696 A **[0001]**
- US 61721979 A **[0001]**
- US 61721994 A **[0001]**
- US 61718633 A **[0001]**
- US 61656468 A **[0001]**
- US 61656469 A **[0001]**
- US 61656471 A **[0001]**
- US 7184437 B **[0055]**
- US 72497512 A **[0186]**

PATENT COOPERATION TREATY PCT/US2015/026869

ADVANCE E-MAIL

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92*bis*.1 and Administrative Instructions, Section 422)

To:

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11 Shu'alei Shimshon St.
P.O.Box 7230
Ramat-Gan 5217102
ISRAËL

Date of mailing *(day/month/year)* 08 June 2016 (08.06.2016)	
Applicant's or agent's file reference ORCKIT-001-PCT	**IMPORTANT NOTIFICATION**
International application No. PCT/US2015/026869	International filing date *(day/month/year)* 21 April 2015 (21.04.2015)

1. The following indications appeared on record concerning:

☐ the applicant ☒ the inventor ☐ the agent ☐ the common representative

Name and Address	State of Nationality	State of Residence
BARSHESHET, Yossi Orckit-corrigent Ltd. 126 Yigal Allon Street 67443 Tel-aviv Israel		
	Telephone No.	
	Facsimile No.	
	E-mail address	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☐ the name ☒ the address ☐ the nationality ☐ the residence

Name and Address	State of Nationality	State of Residence
BARSHESHET, Yossi 19 Shevet Levi St., Ashdod (IL); Israel		
	Telephone No.	
	Facsimile No.	
	E-mail address ☐ Notifications by e-mail authorized	

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office
☐ the International Searching Authority
☐ the Authority(ies) specified for supplementary search
☐ the International Preliminary Examining Authority
☒ the designated Offices concerned
☐ the elected Offices concerned
☐ other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 71 30	Authorized officer Ben-Mansour Naceur e-mail pt09.pct@wipo.int Telephone No. +41 22 338 74 09

700095

THE UNITED STATES OF AMERICA

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UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

April 29, 2015

THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A FILING DATE.

APPLICATION NUMBER: ***61/982,358***
FILING DATE: ***April 22, 2014***
RELATED PCT APPLICATION NUMBER: ***PCT/US15/26869***

THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS ***US61/982,358***

Certified by

David J. Kappos

Under Secretary of Commerce
for Intellectual Property
and Director of the United States
Patent and Trademark Office

Provisional Application for Patent Cover Sheet

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c)

Inventor(s)

Inventor 1 — Remove

Given Name	Middle Name	Family Name	City	State	Country i
Ronen		Solomon	Ramat Gan		IL

Inventor 2 — Remove

Given Name	Middle Name	Family Name	City	State	Country i
Simhon		Doctori	Gan Yavne		IL

All Inventors Must Be Listed – Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Title of Invention	Deep packet inspection for cloud based networks utilizing SDN architecture
Attorney Docket Number (if applicable)	

Correspondence Address

Direct all correspondence to (select one):

◯ The address corresponding to Customer Number	◉ Firm or Individual Name
Firm or Individual Name 1	Orckit -Corrigent LTD
Firm or Individual Name 2	

Mailing Address of Applicant:

Address 1	126 Yigal Alon St.		
Address 2			
City	Tel Aviv	State/Province	
Postal Code		Country i	IL
Phone	+972-54-4941748		

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.
◉ No.
○ Yes, the invention was made by an agency of the United States Government. The U.S. Government agency name is:
○ Yes, the invention was under a contract with an agency of the United States Government. The name of the U.S. Government agency and Government contract number are:

Doc Code: **TR.PROV**
Document Description: Provisional Cover Sheet (SB16)

Entity Status
Applicant asserts small entity status under 37 CFR 1.27 or applicant certifies micro entity status under 37 CFR 1.29

- (●) Applicant asserts small entity status under 37 CFR 1.27
- ( ) Applicant certifies micro entity status under 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
- ( ) No

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Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

Signature

Please see 37 CFR 1.4(d) for the form of the signature.

Signature	/Yossi Barchichat/			Date (YYYY-MM-DD)	2014-04-22
First Name	Yossi	Last Name	Barchichat	Registration Number (If appropriate)	

This collection of information is required by 37 CFR 1.51. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **This form can only be used when in conjunction with EFS-Web. If this form is mailed to the USPTO, it may cause delays in handling the provisional application.**

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The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, t o a n other federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Patent application

Deep packet inspection for cloud based networks utilizing SDN architecture

General

Deep packet inspection technology is a form of network packet scanning technique that allows specific data patterns to be extracted from a data communication channel. These extracted data patterns can then be used by various applications in order to scan viruses, security threats detection, intrusion detection, data analytics or any other application that requires data communication channel Meta data gathering.

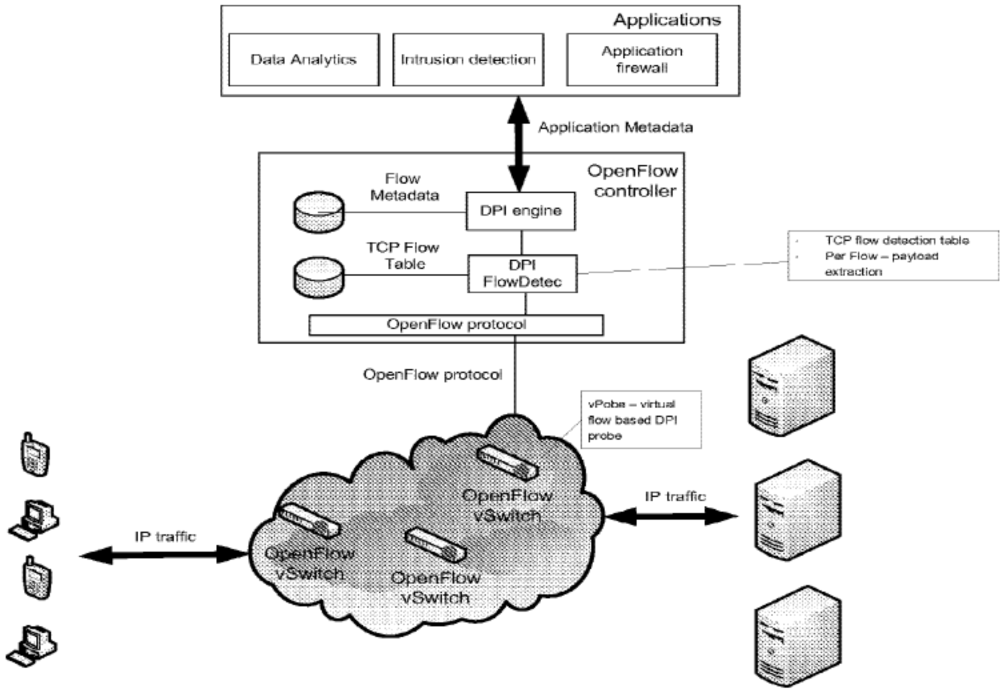
With the growing demand for cloud based infrastructure, the ONF (Open network foundation) which is a user-driven organization dedicated to the promotion and adoption of Software-Defined Networking (SDN) through open standards development, have initiated a new approach to networking in which network control is decoupled from the data forwarding function and is directly programmable. The OpenFlow™ Standard, driven by the ONF, describes a framework in which controllers request switch forwarding behavior by applying forwarding rules at runtime. The Hardware abstraction Layer (HAL) is capable of mapping individual forwarding rules to the underlying hardware platform.

The existing open flow specification defines a way to parse and extract packet headers (but not generic data patterns) from packet flowing via the flow switch. These packet headers are extractable from OSI Layer 2 through Layer 4 with specific visible fields. The headers are extracted using parsing technique that allows only well known standard protocol headers to be analyzed. This, however, does not allow arbitrary data pattern extraction from Layer 4 to Layer 7.

In order to allow deep packet inspection there is a need to perform data pattern scanning and extraction from the whole packet OSI layer 2 through Layer 7. Furthermore, in some cases such as security threats detection, intrusion detection or data analytics, the deep packet inspection engine is required to scan and extract data patterns from only several packets from each TCP session initiated in the data communication channel.

The present invention relates to a system that allows a standard vSwitch as defined in the OpenFlow 1.3.x specification to supply such DPI enabling infrastructure such that any application stated above could benefit from the extracted metadata in a cloud environment.

The following diagram depicts the overall SDN enabled DPI system.



The problem to be resolved

As stated, the Openflow defines three-tier architecture: Tier 1 is the vSwtich that is responsible of forwarding the actual IP traffic based on run-time configurable flows. Tier 2 is the Opneflow controller that is responsible to abstract the network topology from the applications and allow a standard open flow protocol of defining new flow entries in the vSwtich. Tier 3 is the application layer. These are the network applications that have the logic of performing networking functions such as, security applications, routing applications, etc.

In order to allow security application , or any other type of data analytics application to take action on the IP traffic flowing inside the cloud , IP data packets needs to be analyzed by the deep packet inspection engine to extract metadata , which then feeds the security application with the required input to allow action to take place. IP data traffic can be re-routed from the cloud, via the OpenFlow controller to the application and back to the cloud. This obviously creates several issues: 1) Increases end-to-end traffic delays between the client and the server. 2) Redirect all traffic via the controller and hence overflows the controller capability to perform other networking functions. 3) Creates a single point of failure for the re-routed IP traffic, such that the controller becomes a critical data forwarding device.

In order to solve these issues the present invention adds two new component into the openflow controller “DPI FlowDetect” that connects between the cloud and the DPI engine and acts as a pre-DPI engine flow detector that selectively re-direct the desired IP packets from the cloud and sends these packets to the DPI engine to allow security means. There is also a vProbe element that resides in the vSwitch logic and responsible to probe the TCP traffic type to either redirect the traffic to the DPI FlowDetect or mirror the traffic to it.

This system automatically detects new TCP flows and traps specific amount of IP data traffic to the DPI engine to extract application metadata. The vPorbe function within the vSwitch is designed such that other data application flows are not influenced. The vPorbe is fully transparent to all other flows exiting in the vSwitch tables.

Method

The present invention is composed of two main software components 1) **DPI FlowDetect**, and 2) **vPorbe**.

The **DPI FlowDetect** is part of the openflow controller (or optionally as a separate software component) that is responsible to detect all TCP flows and maintain them in a TCP flow table. It is also responsible to manage the vProbe.

The vProbe is responsible to redirect any new TCP connection state initiation packets to the DPI flowDetect engine, as well as to extract several packets from each detected TCP flow and mirror them to the DPI FlowDetct engine.

The following diagram illustrates the DPI FlowDetect and vProbe operation for detecting new flows and extracting N bytes/packets from each detected flow.

Deep packet inspection for cloud based networks utilizing SDN architecture

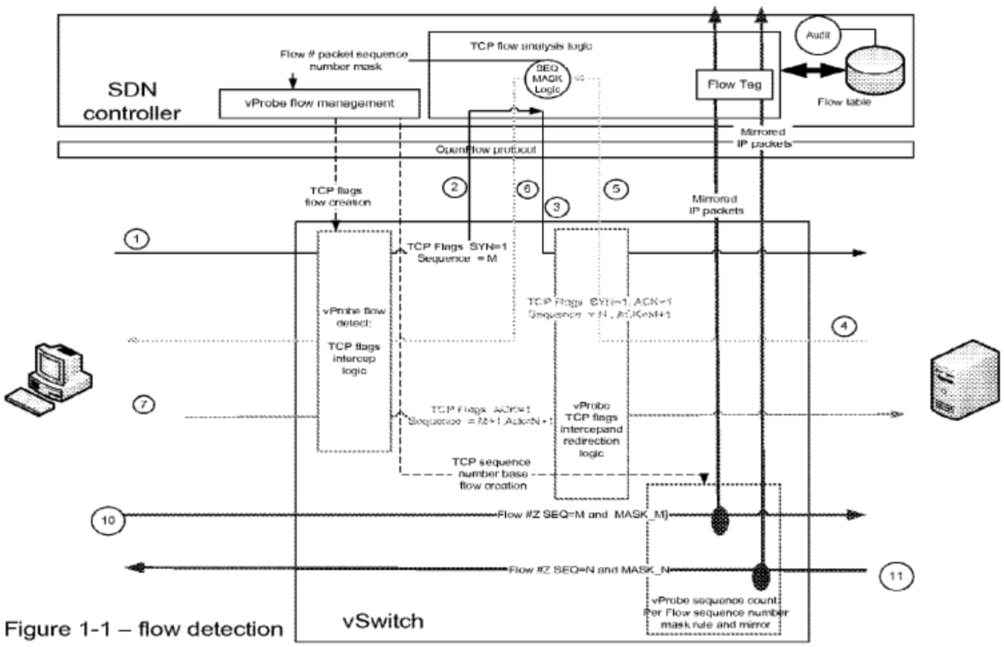


Figure 1-1 – flow detection

Flow detection description

To allow vProbe flow detect logic and vProbe sequence number count logic to be performed we define new ***experimenter TLVs,*** these are new type-length-value structures that may be applied to any standard defined openflow 1.3.x for parsing and identifying any arbitrary fields within a packet.

The new ***experimenter TLVs*** are:

1. **OXM_OF_ORKT_TCP_FLG OXM_HEADER (0x80FE, 2, 1)** – this is a new TVL that may allow identification of the TCP header flags. 0x80Fe represent a unique vendor ID, 2 represent a unique Type=2 value for this TLV, 1-byte total length that stores the TCP flags header.
2. **OXM_OF_ORKT_TCP_SEQ OXM_HEADER (0x80FE, 1, 4)** - this is a new TLV that may allow identification of the TCP sequence number field. 0x80FE represent a unique vendor ID, 1 represent a unique Type=1 value for this TLV, 4-byte total length that stores the TCP sequence number.

Details description of figure 1-1:

The vProbe flow management pre-configures new flows into the vSwitch to identify and re-direct TCP connection initiation packets to the SDN controller. The rules are agnostic to the port these packets arrive and will re-direct any of the following packets to the SDN controller: if (TCP FLAG SYN=1 or (TCP FLAG SYN=1 and ACK=1)) than re-direct packet to controller.

STEP 1, a packet arrives from a client with [TCP FLAG SYN=1, SEQUENCE = M] at the vSwitch port , it is classified by the pre-configured rule and is re-directed (STEP 2) to the SDN controller. The TCP flow analysis logic traps the packet and creates a new FLOW-ID in its flow table DB and marks this FLOW-ID as “syn”. It also stores that the initial sequence from client to server number equals M. STEP 3 the TCP flow analysis logic continue processing of the packet and sends it to the vSwitch for further processing by other application as-if the packet had not been re-directed to the SDN controller.

STEP 4, a response packet arrives from a server with [TCP FLAG SYN=1, TCP FLAG ACK=1, SEQUENCE = N] at the vSwitch port, it is classified by the pre-configured rule and is re-directed (STEP 5) to the SDN controller. The TCP flow analysis logic traps the packet and searches for a pre-allocated corresponding FLOW-ID in its flow table DB and updates this FLOW-ID state as “syn/ack”. It also stores that the initial sequence number from server to client equals N. Now that there is a new bi-directional FLOW-ID with M and N sequence number identified, the sequence mask logic is calculated.

Example of the flow table:

KEY					DATA									
Client IP address	Server IP address	Client source TCP port	Server destination TCP port	IP protocol number	Flow ID	Client→Server sequence number M	Server→ Client sequence number N	state	Creation timestamp	Client→Server Hit counter X [bytes]	Server →Client Hit counter Y [bytes]	Client→Server data buffer	Server→ Client buffer	Age bit
192.1.1.1	209.1.4.4	15431	21	6	1	0xf46d5c34	0x3c98b9ab	ACK	15:32:13					

The ***sequence mask logic*** is responsible of calculating a mask for the initial trapped sequence number [M and N] to be used for a new flow to be configured into the vSwitch to allow mirroring of number of bytes from the TCP session in both directions. The mask filed is defined in the openflow standard "A.2.3.5 Flow Match Field Masking". We define a new value TCP_DATA_SIZE_DPI, which specifies the number of bytes the vSwtich would be required to mirror from the TCP session.

The following calculation is used to extract the mask:

1. temp_mask_val=M *XOR* (M+ TCP_DATA_SIZE_DPI); // *returns a number where the MSB bit set to one indicate the first bit of the mask.*
2. seq_msb = (int32_t)msb32(temp_Mask_val); ***// msb32 function returns the MSB place of*** temp_Mask_val
3. mask = (int32_t)(0 - ((0x1 << seq_msb))); ***// this is the mask: negate of 1 shift by the value of the seq_msb***

Example: assume M= 0xf46d5c34, TCP_DATA_SIZE_DPI = 16384

1. temp_mask_val = 0xf46d5c34 XOR (0xf46d5c34 + 16384) = 0xc000

2. seq_msb = (int32_t)msb32(0xf46d9c34) = 16

3. mask = (int32_t)(0 - (0x1 << 16)) = **0xFFFF8000**

The mask is defined such that a 0 in a given bit position indicates a "don't care" match for the same bit in the corresponding field, whereas a 1 means match the bit exactly.
In this example all data packets containing sequence number in the range of {0xf46d5c34 to 0xf46d9c34} will be mirrored to the SDN controller.

This ***sequence mask logic*** is done for both sequences M and N and result in **mask_M** and **mask_N**. Now that the MASK is calculated, the TCP flow analysis logic cerates two openflow rules in the ***vProbe sequence count***. One rule identified the client to server flow traffic, including the **OXM_OF_ORKT_TCP_SEQ** to identify the initial sequence number of the flow with the mask_M calculated**.** The action of the flow is to **mirror** all packets that the rule applies, which will results in the TCP_DATA_SIZE_DPI number of byte from the client to server direction to be mirrored to the flow analysis logic buffering and further analysis. The second rule identifies the server-to-client flow traffic, including the **OXM_OF_ORKT_TCP_SEQ** to identify the initial sequence number of the flow with the mask_N calculated**.** The action of the flow is to **mirror** all packets that the rule applies, which will results in the TCP_DATA_SIZE_DPI number of byte from the server to client direction to be mirrored to the flow analysis logic buffering and further analysis.

The openflow rules that reside in the ***vProve sequence logic*** would be as follows:

Match							result	
Source IP address	destination IP address	source TCP port	destination TCP port	IP protocol number	TCP sequence	TCP sequence mask	action	Count byte
192.1.1.1	209.1.4.4	15431	21	6	0xf46d5c34	0xFFFF8000	Mirror	X
209.1.4.4	192.1.1.1	21	15431	6	0x3c98b9ab	0xFFFF8000	Mirror	Y

STEP 6 the TCP flow analysis logic continue processing of the packet and sends the TCP SYN/ACK to the vSwitch for further processing by other application as-if the packet had not been re-directed to the SDN controller.

STEP 7, a response TCP ACK packet with [TCP FLAG ACK=1] at the vSwitch port and is switched directly to the server. An audit mechanism that scans the flow table once every t_{sec} deletes all flows from the *vProve sequence logic* that there state is NOT Syn/Ack and at least T seconds have passed since connection timestamp. Furthermore, an aging mechanism deletes all entries that their age bit equal = 1. Age bit is initialized to 0 upon flow FLOW-ID creation and is set to one in the first audit pass if buffer length is ZERO. When a FLOW-Id is deleted from the flow table it is also removed from the ***vProbe sequence count.***

STEP 10 and STEP 11 packets arrive from either the client or server with their sequence number that match the ***sequence mask logic*** rule and are **mirrored** to the SDN controller for buffering and for further analysis. Note that each rule hit increments a counter Client➔Server hit counter X [bytes] and Server ➔Client hit counter Y [bytes]. The flow table audit mechanism that scans the flow table once every t_{sec} updates the mask to 0x00000000 and the ACTION to "no Action" of all entries that their Client➔Server buffer length = TCP_DATA_SIZE_DPI OR Server ➔Client buffer length = TCP_DATA_SIZE_DPI.

Flow termination description

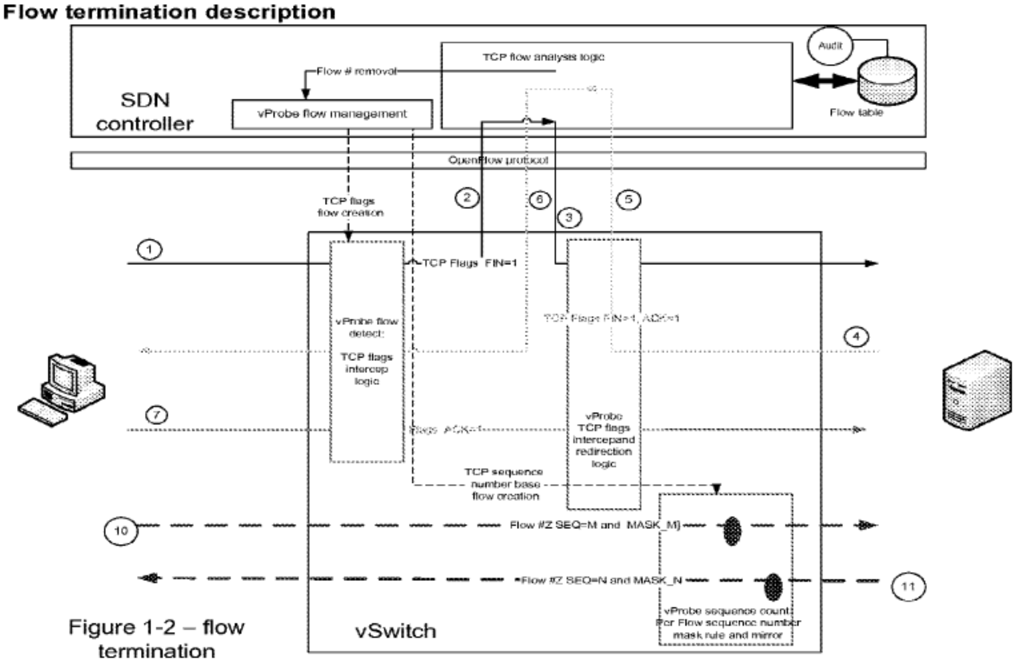


Figure 1-2 – flow termination

In this flow termination stage the TCP flow analysis logic follows a termination of a TCP flow and is responsible to remove the exiting flow from the flow table as well as remove the classification rules that are configured into the ***vProbe sequence count*** logic.
The standard defines the procedure of a TCP flow termination procedure and therefore the ***TCP flow analysis*** logic should be able to rack this procedure and remove the flows accordingly.

Details description of figure 1-2:

The vProbe flow management pre-configures new flows into the vSwitch to identify and re-direct TCP connection termination packets to the SDN controller. The rules are agnostic to the port these packets arrive and will re-direct any of the following packets to the SDN controller: if (TCP FLAG FIN=1 or (TCP FLAG FIN=1 and ACK=1) or TCP FLAG RST=1) than re-direct packet to controller.

STEP 1, a packet arrives from a client with [TCP FLAG FIN=1] at the vSwitch port, it is classified by the pre-configured ruled and is re-directed (STEP 2) to the SDN controller. The TCP flow analysis logic traps the packet and marks the corresponding FLOW-ID in its flow table DB as state=FIN. STEP 3 the TCP flow analysis logic continue processing of the packet and sends it to the vSwitch for further processing by other application as-if the packet had not been re-directed to the SDN controller.

STEP 4, a response packet arrives from a server with [TCP FLAG FIN=1, ACK=1] at the vSwitch port, it is classified by the pre-configured ruled and is re-directed (STEP 5) to the SDN controller. The TCP flow analysis logic traps the packet and marks the corresponding FLOW-ID in its flow table DB as state=FIN/FIN/ACK.

STEP 6 the TCP flow analysis logic continue processing of the packet and sends the TCP FIN/ACK to the vSwitch for further processing by other application as-if the packet had not been re-directed to the SDN controller.

STEP 7, a response TCP ACK packet arrives from a client with [TCP FLAG ACK=1] and is switched directly to the server.

Should a re-directed packet arrived with TCP FLAG RST=1, the flow analysis logic should mark its FLOW ID state as RST.

The audit mechanism scans the flow table once every t_{sec} and deletes all flows from the *vProve sequence logic* and from the flow table, that there state is one of the following: FIN, FIN/ACK, FIN/FIN/ACK, or RST.

vProbe tables

The vProbe tables are populated via the openflow protocol to the vSwitch. The following diagrams deptics the organization of the flows to allow functionality of both the vProbe **flowDetect** and **vProbe sequence count**.

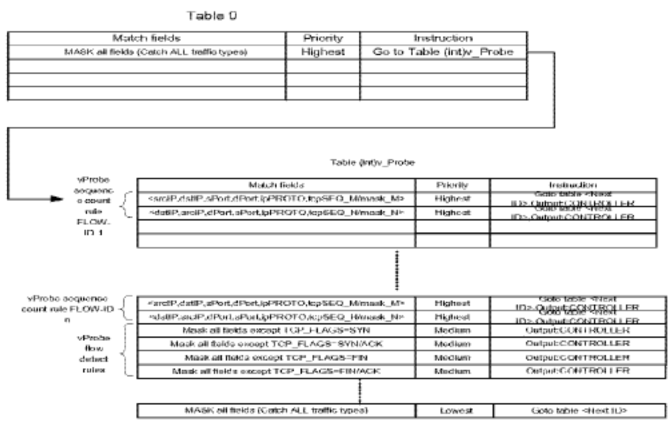


Table 0 is updated with a general rule to match all traffic type with instruction to Goto table (int)v_Probe. The rule is set to the highest priority, unless the controller requires pre-processing of other rules. All packets are caught by this rule and are than processed in the (int)v_Probe table.

The v_Probe table is populated with Medium priority vProbe flowDeetct rules to catch all SYN , SYN/ACK , FIN , FIN/ACK that are the TCP connection initiation packets. These rules allows the TCP flow analysis logic to update its flow table and as a consequences create new rules for mirroring N bytes from each TCP connection setup. The v_Probe table is also populated with Highest priority rules , these are two bi-direction al rules per FLOW-ID that match the 5 tupple flow headers including the TCP sequence number as calculated by the sequence mask logic. These rules instruction is to send the packet to the CONTROLLER and also to perform Goto table ID <next table ID> which will send the packet to continue switching processing. The instructions ***GoTo*** and ***Output*** combined are similarly to ***Mirror*** functionality. Each of these bi-directional flows shall copy several bytes from the TCP stream to the TCP flow analysis logic to be stored for further DPI engine metadata analysis.
The final rule placed in the v_Probe table is in the LOWEST priority to catch all and proceed with the switch functionality. All traffic which does not correspond to the TCP initiation packets, nor a specific detected flow and the corresponding TCP sequence number shall continue regular processing.

Electronic Acknowledgement Receipt

EFS ID:	18821507
Application Number:	61982358
International Application Number:	
Confirmation Number:	4598
Title of Invention:	Deep packet inspection for cloud based networks utilizing SDN architecture
First Named Inventor/Applicant Name:	Ronen Solomon
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Filer:	Yossi Barchichat
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Application Type:	Provisional

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Payment Type	Credit Card
Payment was successfully received in RAM	$260

RAM confirmation Number	7546
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Provisional Cover Sheet (SB16)	ProvisionalSB.pdf	1477255 4830915d5edb01a665fb252ed413ed85d79d62d0	no	4
Warnings:					
Information:					
2	Specification	Deep_packet_inspection_for_cloud_based_networks_utilizing_SDN_architecture.pdf	552731 419aa8ae510f31e1b0e0d29aab1cdc3f238951a0	no	10
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	29246 cc05826387fc04669d41b0036b1e068f8c66b290	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	2059232		

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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DOCUMENT MADE AVAILABLE UNDER THE PATENT COOPERATION TREATY (PCT)

International application number:		**PCT/US2015/026869**
International filing date:		**21 April 2015 (21.04.2015)**
Document type:		**Certified copy of priority document**
Document details:	Country/Office:	**US**
	Number:	**61/982,358**
	Filing date:	**22 April 2014 (22.04.2014)**
Date of receipt at the International Bureau:		**30 April 2015 (30.04.2015)**

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a),(b) or (b-*bis*)

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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44*bis*)

Applicant's or agent's file reference ORCKIT-001-PCT	**FOR FURTHER ACTION**	See item 4 below
International application No. PCT/US2015/026869	International filing date *(day/month/year)* 21 April 2015 (21.04.2015)	Priority date *(day/month/year)* 22 April 2014 (22.04.2014)
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant ORCKIT IP, LLC		

1. This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 *bis*.1(a).

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.

3. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44*bis*.3(c) and 93*bis*.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44*bis* .2).

	Date of issuance of this report 25 October 2016 (25.10.2016)
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70	Authorized officer Simin Baharlou e-mail: pt09.pct@wipo.int

Form PCT/IB/373 (January 2004)

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (PCT Rule 43*bis*.1)	To: BEN-SHIMON Michael MYERS Brian S., M&B IP Analysts, LLC, 45 S. Park Place #262 Morristown NJ 07960 United States of America
Date of mailing *(day/month/year)* 06 August 2015 (06.08.2015)	
Applicant's or agent's file reference ORCKP0406PCT	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US 2015/026869	21 April 2015 (21.04.2015)	22 April 2014 (22.04.2014)

International Patent Classification (IPC) or both national classification and IPC
H04L 12/26 *(2006.01)*
H04L 12/741 *(2013.01)*

Applicant
ORCKIT-CORRIGENT LTD. et al.

1. This opinion contains indications relating to the following items:

- [X] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [X] Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/RU:	Date of completion of this opinion	Authorized officer
Federal Institute of Industrial Property, Berezhkovskaya nab., 30-1, Moscow, G-59, GSP-3, Russia, 125993 Facsimile No: (8-495) 531-63-18, (8-499) 243-33-37	27 July 2015 (27.07.2015)	A. Tokarev Telephone No. (499) 240-25-91

Form PCT/ISA/237 (cover sheet) (January 2015)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/US 2015/026869

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   [X] the international application in the language in which it was filed.

   [ ] a translation of the international application into ______________ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. [ ] This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:

   a. [ ] forming part of the international application as filed:

      [ ] in the form of an Annex C/ST.25 text file.

      [ ] on paper or in the form of an image file.

   b. [ ] furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

   c. [ ] furnished subsequent to the international filing date for the purposes of international search only:

      [ ] in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

      [ ] on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. [ ] In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY	International application No. PCT/US 2015/026869

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-19	YES
	Claims		NO
Inventive step (IS)	Claims		YES
	Claims	1-19	NO
Industrial applicability (IA)	Claims	1-19	YES
	Claims		NO

2. Citations and explanations:

D1: US 2010/0208590 A1
D2: EP 2672668 A1
D3: US 2011/0264802 A1

Claims 1, 10, 11: D1 discloses a method for deep packet inspection (DPI) in a network and a non-transitory computer readable medium having stored thereon instructions for causing one or more processing units to execute the computerized method for deep packet inspection (DPI) in a network (D1, abstract, [0030]). The known solution comprises: a processor; a memory connected to the processor and configured to contain a plurality of instructions (D1, [0030]) that when executed by the processor configure the system to: set a plurality of network nodes operable in the network with at least one probe instruction (D1, [0048]); receive from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first field value (D1, [0012], [0075]); receive from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second field value, wherein the second packet is a response of the first packet (D1, [0012], [0075]); compute a mask value respective of at least the first and second field values (D1, [0012], [0014], [0044], [0075]), wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected (D1, [0013], [0045], [0046]); generate at least one action instruction based on at least the mask value (D1, [0034], [0045], [0046], [0056], [0057]); and configure the plurality of network nodes with at least one action instruction (D1, [0034], [0045], [0046], [0056], [0057]).

The solution of independent claims 1, 10, 11 differs from the solution from D1 in that the network is a software defined network (SDN), the field values of packets are sequence numbers of packets, and the action instruction is a mirror instruction.

The invention of independent claims 1, 10, 11 meets the criterion of novelty.

However, from the art it is known a method for automatically tracing back from a central location, disclosing employing software defined network (SDN) systems (D2, [0006]) and using fields of packets which are sequence numbers of packets (D2, [0222]).

From the art it is known a method for management of traffic in a telecommunications network (D3, [0002]) disclosing using mirror instructions (D3, abstract, [0043]).

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of V:

Therefore the invention of independent claims 1, 10, 11 is known from combination of solutions D1, D2 and D3.

Therefore the invention of independent claims 1, 10, 11 does not meet the criterion of inventive step.

Claims 2-9, 12-19 do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, the reasons being as follows:

claims 2, 12: inspecting the mirrored bytes using a DPI engine, is known from D3 ([0043]);

claims 3, 13: maintaining and updating a flow table, is known from D1 ([0051]-[0055]);

claims 4, 14: using termination instructions and removing all entries from the flow table for each flow matching the at least one termination instruction, is known from D1 ([0070]);

claims 5-7, 15-17: using particular fields for instructions, is known from D3 ([0044]-[0048]);

claims 8, 18: mirroring portions of packets, is known from D3 ([0043]);

claims 9, 19: performing communication between central controller and the plurality of network nodes using the OpenFlow standard, is known from D2 ([0186]).

The inventions of all the claims meet the criterion of industrial applicability.

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only
PCT/US15/26869 International Application No.
21 APRIL 2015 (21.04.15) International Filing Date
PCT INTERNATIONAL APPLICATION RO/US Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* ORCK P0406PCT

Box No. I TITLE OF INVENTION

A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS

Box No. II APPLICANT ☐ This person is also inventor

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*	Telephone No.
Orckit-Corrigent Ltd. 126 Yigal Allon Street Tel-Aviv 67443 ISRAEL	Facsimile No. Applicant's registration No. with the Office

E-mail authorization: Marking one of the check-boxes below authorizes the receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority to use the e-mail address indicated in this Box to send, notifications issued in respect of this international application to that e-mail address if those offices are willing to do so.

☐ as advance copies followed by paper notifications; or ☒ exclusively in electronic form (no paper notifications will be sent).

E-mail address: pair@mb-ip.com

State *(that is, country)* of nationality:	State *(that is, country)* of residence:
IL	IL

This person is applicant for the purposes of: ☒ all designated States ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*	Telephone No. 1-908-655-6864
BEN-SHIMON, Michael MYERS, Brian S. M&B IP Analysts, LLC 45 S. Park Place #262 Morristown NJ 07960 UNITED STATES	Facsimile No. 1-908-325-0276 Agent's registration No. with the Office 69610

E-mail authorization: Marking one of the check-boxes below authorizes the receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority to use the e-mail address indicated in this Box to send, notifications issued in respect of this international application to that e-mail address if those offices are willing to do so.

☐ as advance copies followed by paper notifications; or ☒ exclusively in electronic form (no paper notifications will be sent).

E-mail address: pair@mb-ip.com

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address	This person is
Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)* M&B IP Analysts, LLC 45 S. Park Place #262 Morristown NJ 07960 UNITED STATES	This person is: ☒ applicant only ☐ applicant and inventor ☐ inventor only *(If this check-box is marked, do not fill in below.)* Applicant's registration No. with the Office
State *(that is, country)* of nationality: US	State *(that is, country)* of residence: US
This person is applicant for the purposes of: ☐ all designated States	☒ the States indicated in the Supplemental Box
Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)* BARSHESHET, Yossi ORCKIT-CORRIGENT LTD. 126 Yigal Allon Street Tel-Aviv 67443 ISRAEL	This person is: ☐ applicant only ☐ applicant and inventor ☒ inventor only *(If this check-box is marked, do not fill in below.)* Applicant's registration No. with the Office
State *(that is, country)* of nationality:	State *(that is, country)* of residence:
This person is applicant for the purposes of: ☐ all designated States	☐ the States indicated in the Supplemental Box
Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)* DOCTORI, Simhon ORCKIT-CORRIGENT LTD. 126 Yigal Allon Street Tel-Aviv 67443 ISRAEL	This person is: ☐ applicant only ☐ applicant and inventor ☒ inventor only *(If this check-box is marked, do not fill in below.)* Applicant's registration No. with the Office
State *(that is, country)* of nationality:	State *(that is, country)* of residence:
This person is applicant for the purposes of: ☐ all designated States	☐ the States indicated in the Supplemental Box
Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)* SOLOMON, Ronen ORCKIT-CORRIGENT LTD. 126 Yigal Allon Street Tel-Aviv 67443 ISRAEL	This person is: ☐ applicant only ☐ applicant and inventor ☒ inventor only *(If this check-box is marked, do not fill in below.)* Applicant's registration No. with the Office
State *(that is, country)* of nationality:	State *(that is, country)* of residence:
This person is applicant for the purposes of: ☐ all designated States	☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.

Supplemental Box *If the Supplemental Box is not used, this sheet should not be included in the request.*

1. *If, in any of the Boxes, except Boxes Nos. VIII(i) to (v) for which a special continuation box is provided,* ***the space is insufficient*** *to furnish all the information: in such case, write "Continuation of Box No...." (indicate the number of the Box) and furnish the information in the same manner as required according to the captions of the Box in which the space was insufficient, in particular:*

   (i) ***if more than one person is to be indicated as applicant and/or inventor*** *and no "continuation sheet" is available: in such case, write "Continuation of Box No. III" and indicate for each additional person the same type of information as required in Box No. III. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below;*

   (ii) *if, in Box No. II or in any of the sub-boxes of Box No. III, the indication* ***"the States indicated in the Supplemental Box"*** *is checked: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the applicant(s) involved and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is applicant;*

   (iii) *if, in Box No. II or in any of the sub-boxes of Box No. III,* ***the inventor or the inventor/applicant is not inventor for the purposes of all designated States****: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the inventor(s) and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is inventor;*

   (iv) *if, in addition to the agent(s) indicated in Box No. IV, there are* ***further agents****: in such case, write "Continuation of Box No. IV" and indicate for each further agent the same type of information as required in Box No. IV;*

   (v) *if, in Box No. VI, there are* ***more than three earlier applications whose priority is claimed****: in such case, write "Continuation of Box No. VI" and indicate for each additional earlier application the same type of information as required in Box No. VI.*

2. *If the applicant intends to make an indication of the wish that the international application be treated, in certain designated States, as an application for a patent of addition, certificate of addition, inventor's certificate of addition or utility certificate of addition: in such case, write the name or two-letter code of each designated State concerned and the indication "****patent of addition,****" "****certificate of addition,****" "****inventor's certificate of addition****" or "****utility certificate of addition,****" the number of the parent application or parent patent or other parent grant and the date of grant of the parent patent or other parent grant or the date of filing of the parent application (Rules 4.11(a)(i) and 49bis.1(a) or (b)).*

3. *If the applicant intends to make an indication of the wish that the international application be treated, in the United States of America, as a continuation or continuation-in-part of an earlier application: in such case, write "United States of America" or "US" and the indication "****continuation****" or "****continuation-in-part****" and the number and the filing date of the parent application (Rules 4.11(a)(ii) and 49bis.1(d)).*

M&B IP Analysts, LLC is Applicant for the State of Belize ONLY

Box No. V DESIGNATIONS

The filing of this request **constitutes under Rule 4.9(a) the designation** of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.

However,

☐ DE Germany **is not designated** for any kind of national protection

☐ JP Japan **is not designated** for any kind of national protection

☐ KR Republic of Korea **is not designated** for any kind of national protection

(The check-boxes above may only be used to exclude (irrevocably) the designations concerned if, at the time of filing or subsequently under Rule 26bis.1, the international application contains in Box No. VI a priority claim to an earlier national application filed in the particular State concerned, in order to avoid the ceasing of the effect, under the national law, of this earlier national application.)

Box No. VI PRIORITY CLAIM AND DOCUMENT

The priority of the following earlier application(s) is hereby claimed:

Filing date of earlier application *(day/month/year)*	Number of earlier application	Where earlier application is:		
		national application: country or Member of WTO	regional application: regional Office	international application: receiving Office
item (1) 22/04/2014 22 APRIL 2014	61/982,358	US		
item (2)				
item (3)				

☐ Further priority claims are indicated in the Supplemental Box.

Furnishing the priority document(s):

☒ The **receiving Office** is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application(s) was filed with the receiving Office which, for the purposes of this international application, is the receiving Office)* identified above as:

☒ all items ☐ item (1) ☐ item (2) ☐ item (3) ☐ other, see Supplemental Box

☐ The **International Bureau** is requested to obtain from a digital library a certified copy of the earlier application(s) identified above, using, where applicable, the access code(s) indicated below *(if the earlier application(s) is available to it from a digital library)*:

☐ item (1) access code ______________ ☐ item (2) access code ______________ ☐ item (3) access code ______________ ☐ other, see Supplemental Box

Restore the right of priority: the receiving Office is requested to restore the right of priority for the earlier application(s) identified above or in the Supplemental Box as item(s) (______________________________). *(See also the Notes to Box No. VI; further information **must** be provided to support a request to restore the right of priority.)*

Incorporation by reference: where an element of the international application referred to in Article 11(1)(iii)(d) or (e) or a part of the description, claims or drawings referred to in Rule 20.5(a) is not otherwise contained in this international application but is completely contained in an earlier application whose priority is claimed on the date on which one or more elements referred to in Article 11(1)(iii) were first received by the receiving Office, that element or part is, subject to confirmation under Rule 20.6, incorporated by reference in this international application for the purposes of Rule 20.6.

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if more than one International Searching Authority is competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used)*:

ISA/ RU

Sheet No. ...5....

Box No. IX **CHECK LIST for EFS-Web filings** - this sheet is only to be used when filing an international application with RO/US via **EFS-Web**

This international application **contains** the following:	Number of sheets	This international application is **accompanied by** the following item(s) *(mark the applicable check-boxes below and indicate in right column the number of each item)*:	Number of items
(a) request form PCT/RO/101 (including any declarations and supplemental sheets) .... :	5	1. ☒ fee calculation sheet .... :	1
(b) description (excluding any sequence listing part of the description, see (f), below) ..... :	15	2. ☐ original separate power of attorney .... :	
(c) claims .... :	4	3. ☒ original general power of attorney .... :	5
(d) abstract .... :	1	4. ☐ copy of general power of attorney; reference number: .... :	
(e) drawings (if any) .... :	6	5. ☐ priority document(s) identified in Box No. VI as item(s) .... :	
(f) sequence listing part of the description in the form of an **image file** (e.g. PDF).......... :		6. ☐ Translation of international application into *(language)*: .... :	
		7. ☐ separate indications concerning deposited microorganism or other biological material .... :	
Total number of sheets (including the sequence listing part of the description if **filed as an image file**) .... :	31	8. ☐ *(only where item (f) is marked in the left column)* copy of the sequence listing in electronic form (Annex C/ST.25 text file) not forming part of the international application but **furnished only for the purposes of international search** under Rule 13*ter*.............. :	
(g) sequence listing part of the description		9. ☐ *(only where item (f) is marked in the left column)* a statement confirming that "the information recorded in electronic form submitted under Rule 13*ter* is identical to the sequence listing as contained in the international application" as filed via EFS-Web: .... :	
☐ filed in the form of an **Annex C/ST.25 text file**		10. ☐ copy of results of earlier search(es) (Rule 12*bis*.1(a)) .. :	
☐ WILL BE filed separately on physical data carrier(s), on the same day and in the form of an **Annex C/ST.25 text file**		11. ☒ other *(specify)*: Transmittal Letter .... :	2
Indicate type and number of physical data carrier(s)			
Figure of the drawings which should accompany the abstract: FIG. 3		**Language of filing** of the international application: English	

Box No. X **SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE**

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

/Michael Ben-Shimon/

Michael Ben-Shimon
USPTO Reg. No. 69610

For receiving Office use only

1. Date of actual receipt of the purported international application: 21 APRIL 2015 (21.04.15)	2. Drawings:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:	☐ received:
4. Date of timely receipt of the required corrections under PCT Article 11(2):	☐ not received:
5. International Searching Authority (if two or more are competent): ISA / RU — 6. ☐ Transmittal of search copy delayed until search fee is paid	

For International Bureau use only

Date of receipt of the record copy by the International Bureau:

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92*bis*.1 and Administrative Instructions, Section 422)

To:

BEN-SHIMON, Michael
M&B IP Analysts, LLC
45 S. Park Place #262
Morristown, NJ 07960
ÉTATS-UNIS D'AMÉRIQUE

Date of mailing *(day/month/year)* 31 May 2016 (31.05.2016)	
Applicant's or agent's file reference ORCK P0406PCT	**IMPORTANT NOTIFICATION**
International application No. PCT/US2015/026869	International filing date *(day/month/year)* 21 April 2015 (21.04.2015)

1. The following indications appeared on record concerning:

☒ the applicant ☐ the inventor ☐ the agent ☐ the common representative

Name and Address	State of Nationality	State of Residence
ORCKIT IP, LLC 831 Beacon St. #307 Newton, MA 02459 United States of America	IL	IL
	Telephone No.	
	Facsimile No.	
	E-mail address pair@mb-ip.com	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☐ the name ☐ the address ☒ the nationality ☒ the residence

Name and Address	State of Nationality	State of Residence
ORCKIT IP, LLC 831 Beacon St. #307 Newton, MA 02459 United States of America	US	US
	Telephone No.	
	Facsimile No.	
	E-mail address pair@mb-ip.com ☐ Notifications by e-mail authorized	

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office
☐ the International Searching Authority
☐ the Authority(ies) specified for supplementary search
☐ the International Preliminary Examining Authority
☒ the designated Offices concerned
☐ the elected Offices concerned
☐ other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 71 30	Authorized officer Ben-Mansour Naceur e-mail pt09.pct@wipo.int Telephone No. +41 22 338 74 09

Form PCT/IB/306 (January 2009) 1/KYZHHYL7RXVSY0

PATENT COOPERATION TREATY

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PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92*bis*.1 and Administrative Instructions, Section 422)

To:

BEN-SHIMON, Michael
M&B IP Analysts, LLC
45 S. Park Place #262
Morristown, NJ 07960
ÉTATS-UNIS D'AMÉRIQUE

Date of mailing *(day/month/year)* 18 May 2016 (18.05.2016)	
Applicant's or agent's file reference ORCK P0406PCT	**IMPORTANT NOTIFICATION**
International application No. PCT/US2015/026869	International filing date *(day/month/year)* 21 April 2015 (21.04.2015)

1. The following indications appeared on record concerning:

☒ the applicant ☐ the inventor ☐ the agent ☐ the common representative

Name and Address	State of Nationality	State of Residence
ORCKIT-CORRIGENT LTD. 126 Yigal Allon Street 67443 Tel Aviv Israel	IL	IL
	Telephone No.	
	Facsimile No.	
	E-mail address pair@mb-ip.com	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☒ the name ☒ the address ☐ the nationality ☐ the residence

Name and Address	State of Nationality	State of Residence
ORCKIT IP, LLC 831 Beacon St. #307 Newton, MA 02459 United States of America	IL	IL
	Telephone No.	
	Facsimile No.	
	E-mail address pair@mb-ip.com ☐ Notifications by e-mail authorized	

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office
☐ the International Searching Authority
☐ the Authority(ies) specified for supplementary search
☐ the International Preliminary Examining Authority
☒ the designated Offices concerned
☐ the elected Offices concerned
☐ other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 71 30	Authorized officer Mazoillier Auguste e-mail pt09.pct@wipo.int Telephone No. +41 22 338 74 09

PATENT COOPERATION TREATY

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NOTIFICATION OF THE RECORDING OF A CHANGE

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45 S. Park Place #262
Morristown, NJ 07960
ÉTATS-UNIS D'AMÉRIQUE

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1. The following indications appeared on record concerning:

☒ the applicant ☐ the inventor ☐ the agent ☐ the common representative

Name and Address	State of Nationality	State of Residence
M&B IP ANALYSTS, LLC 45 S. Park Place # 262 Morristown, NJ 07960 United States of America	US	US
	Telephone No.	
	Facsimile No.	
	E-mail address	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☐ the name ☐ the address ☐ the nationality ☐ the residence

Name and Address	State of Nationality	State of Residence
	Telephone No.	
	Facsimile No.	
	E-mail address ☐ Notifications by e-mail authorized	

3. Further observations, if necessary:
The person identified in Box 1 has been deleted from the records.

4. A copy of this notification has been sent to:

☒ the receiving Office
☐ the International Searching Authority
☐ the Authority(ies) specified for supplementary search
☐ the International Preliminary Examining Authority
☒ the designated Offices concerned
☐ the elected Offices concerned
☐ other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 71 30	Authorized officer Mazoillier Auguste e-mail pt09.pct@wipo.int Telephone No. +41 22 338 74 09

PATENT COOPERATION TREATY

ADVANCE E-MAIL

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92*bis*.1 and Administrative Instructions, Section 422)

To:

BINDER (SHEM-TOV), Dorit
11 Shu'alei Shimshon St.
P.O.Box 7230
Ramat-Gan 5217102
ISRAËL

Date of mailing *(day/month/year)* 08 June 2016 (08.06.2016)	
Applicant's or agent's file reference ORCKIT-001-PCT	**IMPORTANT NOTIFICATION**
International application No. PCT/US2015/026869	International filing date *(day/month/year)* 21 April 2015 (21.04.2015)

1. The following indications appeared on record concerning:

☐ the applicant ☒ the inventor ☐ the agent ☐ the common representative

Name and Address	State of Nationality	State of Residence
SOLOMON, Ronen Orckit-corrigent Ltd. 126 Yigai Allon Street 67443 Tel-aviv Israel		
	Telephone No.	
	Facsimile No.	
	E-mail address	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☐ the name ☒ the address ☐ the nationality ☐ the residence

Name and Address	State of Nationality	State of Residence
SOLOMON, Ronen 23 Rozen St. Ranat-Gan (IL). Israel		
	Telephone No.	
	Facsimile No.	
	E-mail address ☐ Notifications by e-mail authorized	

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office
☐ the International Searching Authority
☐ the Authority(ies) specified for supplementary search
☐ the International Preliminary Examining Authority
☒ the designated Offices concerned
☐ the elected Offices concerned
☐ other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 71 30	Authorized officer Ben-Mansour Naceur e-mail pt09.pct@wipo.int Telephone No. +41 22 338 74 09

PATENT COOPERATION TREATY

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1. The following indications appeared on record concerning:

☐ the applicant ☐ the inventor ☒ the agent ☐ the common representative

Name and Address	State of Nationality	State of Residence
BEN-SHIMON, Michael M&B IP Analysts, LLC 45 S. Park Place #262 Morristown, NJ 07960 United States of America	Telephone No. 1-908-655-6864 Facsimile No. 1-908-325-0276 E-mail address pair@mb-ip.com	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☒ the person ☐ the name ☐ the address ☐ the nationality ☐ the residence

Name and Address	State of Nationality	State of Residence
BINDER (SHEM-TOV), Dorit 11 Shu'alei Shimshon St. P.O.Box 7230 Ramat-Gan 5217102 Israel	Telephone No. +972-52-5550840 Facsimile No. +972-77-40105 58 E-mail address dorits.patentattorney@gmail.com ☒ Notifications by e-mail authorized	

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office
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☐ the Authority(ies) specified for supplementary search
☐ the International Preliminary Examining Authority
☒ the designated Offices concerned
☐ the elected Offices concerned
☐ other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 71 30	Authorized officer Ben-Mansour Naceur e-mail pt09.pct@wipo.int Telephone No. +41 22 338 74 09

PATENT COOPERATION TREATY PCT/US2015/026869

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NOTIFICATION OF THE RECORDING OF A CHANGE

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To:

BINDER (SHEM-TOV), Dorit
11 Shu'alei Shimshon St.
P.O.Box 7230
Ramat-Gan 5217102
ISRAËL

Date of mailing *(day/month/year)* 08 June 2016 (08.06.2016)	
Applicant's or agent's file reference ORCKIT-001-PCT	**IMPORTANT NOTIFICATION**
International application No. PCT/US2015/026869	International filing date *(day/month/year)* 21 April 2015 (21.04.2015)

1. The following indications appeared on record concerning:

☐ the applicant ☒ the inventor ☐ the agent ☐ the common representative

Name and Address	State of Nationality	State of Residence
DOCTORI, Simhon Orckit-corrigent Ltd. 126 Yigal Allon Street 67443 Tel Alviv Israel		
	Telephone No.	
	Facsimile No.	
	E-mail address	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☐ the name ☒ the address ☐ the nationality ☐ the residence

Name and Address	State of Nationality	State of Residence
DOCTORI, Simhon 15 Revivim St., Gan-Yavne (IL); Israel		
	Telephone No.	
	Facsimile No.	
	E-mail address ☐ Notifications by e-mail authorized	

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office
☐ the International Searching Authority
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☐ the International Preliminary Examining Authority
☒ the designated Offices concerned
☐ the elected Offices concerned
☐ other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 71 30	Authorized officer Ben-Mansour Naceur e-mail pt09.pct@wipo.int Telephone No. +41 22 338 74 09

Form PCT/IB/306 (January 2009) 1/EVVTHVQPQJUZ0

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
29 October 2015 (29.10.2015)

WIPO | PCT

(10) International Publication Number
WO 2015/164370 A1

(51) **International Patent Classification**:
H04L 12/26 (2006.01) ***H04L 12/741*** (2013.01)

(21) **International Application Number**:
PCT/US2015/026869

(22) **International Filing Date**:
21 April 2015 (21.04.2015)

(25) **Filing Language**: English

(26) **Publication Language**: English

(30) **Priority Data**:
61/982,358 22 April 2014 (22.04.2014) US

(71) **Applicant**: **ORCKIT-CORRIGENT LTD.** [IL/IL]; 126 Yigal Allon Street, 67443 Tel Aviv (IL).

(71) **Applicant** *(for BZ only)*: **M&B IP ANALYSTS, LLC** [US/US]; 45 S. Park Place # 262, Morristown, NJ 07960 (US).

(72) **Inventors**: **BARSHESHET, Yossi**; Orckit-corrigent Ltd., 126 Yigal Allon Street, 67443 Tel-aviv (IL). **DOCTORI, Simhon**; Orckit-corrigent Ltd., 126 Yigal Allon Street, 67443 Tel Alviv (IL). **SOLOMON, Ronen**; Orckit-corrigent Ltd., 126 Yigai Allon Street, 67443 Tel-aviv (IL).

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(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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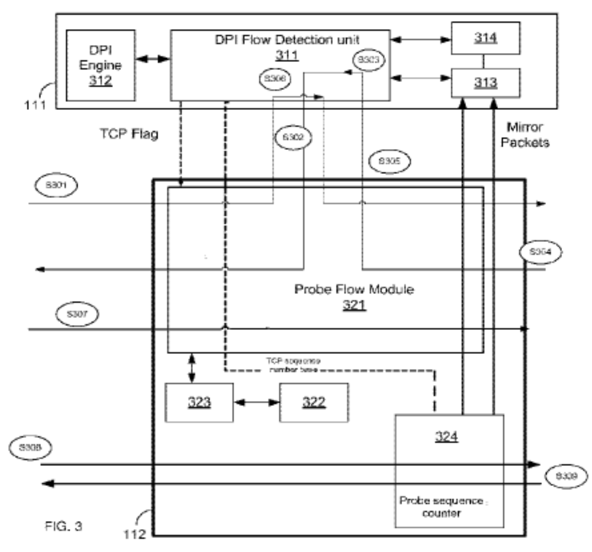


FIG. 3

(57) Abstract: A method for deep packet inspection (DPI) in a software defined network (SDN). The method includes configuring a plurality of network nodes operable in the SDN with at least one probe instruction; receiving from a network node a first packet of a flow, the first packet matches the at least one probe instruction and includes a first sequence number; receiving from a network node a second packet of the flow, the second packet matches the at least one probe instruction and includes a second sequence number, the second packet is a response of the first packet; computing a mask value respective of at least the first and second sequence numbers indicating which bytes to be mirrored from subsequent packets belonging to the same flow; generating at least one mirror instruction based on at least the mask value; and configuring the plurality of network nodes with at least one mirror instruction.

WO 2015/164370 A1

A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS

CROSS REFERENCE TO RELATED APPLICATIONS

[001] This application claims the benefit of US provisional application No. 61/982,358 filed on April 22, 2014, the contents of which are herein incorporated by reference.

TECHNICAL FIELD

[002] This disclosure generally relates to techniques for deep packet inspection (DPI), and particularly for DPI of traffic in cloud-based networks utilizing software defined networks.

BACKGROUND

[003] Deep packet inspection (DPI) technology is a form of network packet scanning technique that allows specific data patterns to be extracted from a data communication channel. Extracted data patterns can then be used by various applications, such as security and data analytics applications. DPI currently performs across various networks, such as internal networks, Internet service providers (ISPs), and public networks provided to customers. Typically, the DPI is performed by dedicated engines installed in such networks.

[004] A software defined networking is a relatively new type of networking architecture that provides centralized management of network nodes rather than a distributed architecture utilized by conventional networks. The SDN is prompted by an ONF (open network foundation). The leading communication standard that currently defines communication between the central controller (e.g., a SDN controller) and the network nodes (e.g., vSwitches) is the OpenFlow™ standard.

[005] Specifically, in SDN-based architectures the data forwarding (e.g. data plane) is typically decoupled from control decisions (e.g. control plane), such as routing, resources, and other management functionalities. The decoupling may also allow the data plane and the control plane to operate on different hardware, in different runtime environments, and/or operate using different models. As such, in an SDN network, the

network intelligence is logically centralized in the central controller which configures, using OpenFlow protocol, network nodes and to control application data traffic flows.

[006] Although, the OpenFlow protocol allows addition of programmability to network nodes for the purpose of packets-processing operations under the control of the central controller, the OpenFlow does not support any mechanism to allow DPI of packets through the various networking layers as defined by the OSI model. Specifically, the current OpenFlow specification defines a mechanism to parse and extract only packet headers, in layer-2 through layer-4, from packets flowing via the network nodes. The OpenFlow specification does not define or suggest any mechanism to extract non-generic, uncommon, and/or arbitrary data patterns contained in layer-4 to layer 7 fields. In addition, the OpenFlow specification does not define or suggest any mechanism to inspect or to extract content from packets belonging to a specific flow or session. This is a major limitation as it would not require inspection of the packet for the purpose of identification of, for example, security threats detection.

[007] The straightforward approach of routing all traffic from network nodes to the central controller introduces some significant drawbacks, such as increased end-to-end traffic delays between the client and the server; overflowing the controller capability to perform other networking functions; and a single point of failure for the re-routed traffic.

[008] Therefore, it would be advantageous to provide a solution that overcomes the deficiencies noted above and allow efficient DPI in SDNs.

SUMMARY

[009] A summary of several example embodiments of the disclosure follows. This summary is provided for the convenience of the reader to provide a basic understanding of such embodiments and does not wholly define the breadth of the disclosure. This summary is not an extensive overview of all contemplated embodiments, and is intended to neither identify key or critical nodes of all aspects nor delineate the scope of any or all embodiments. Its sole purpose is to present some concepts of one or more embodiments in a simplified form as a prelude to the more detailed description that is presented later. For convenience, the term some embodiments may be used herein to refer to a single embodiment or multiple embodiments of the disclosure.

[0010] Certain embodiments disclosed herein include a method for deep packet inspection (DPI) in a software defined network (SDN), wherein the method is performed by a central controller of the SDN. The method comprises: configuring a plurality of network nodes operable in the SDN with at least one probe instruction; receiving from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first sequence number; receiving from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second sequence number, wherein the second packet is a response of the first packet; computing a mask value respective of at least the first and second sequence numbers, wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected; generating at least one mirror instruction based on at least the mask value; and configuring the plurality of network nodes with at least one mirror instruction.

[0011] Certain embodiments disclosed herein include a system for deep packet inspection (DPI) in a software defined network (SDN), wherein the method is performed by a central controller of the SDN. The system comprises: a processor; a memory connected to the processor and configured to contain a plurality of instructions that when executed by the processor configure the system to: set a plurality of network nodes operable in the SDN with at least one probe instruction; receive from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first sequence number; receive from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second sequence number, wherein the second packet is a response of the first packet; compute a mask value respective of at least the first and second sequence numbers, wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected; generate at least one mirror instruction based on at least the mask value; and configure the plurality of network nodes with at least one mirror instruction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The subject matter disclosed herein is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other objects, features, and advantages of the invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings.

[0013] Figure 1 is a schematic diagram of a network system utilized to describe the various disclosed embodiments.

[0014] Figure 2 illustrates is a schematic diagram of a flow table stored in a central controller.

[0015] Figure 3 is a schematic diagram of a system utilized for describing the process of flow detection as performed by a central controller and a network node according to one embodiment.

[0016] Figure 4 is a schematic diagram of a system utilized for describing the process of flow termination as performed by a central controller and a network node according to one embodiment.

[0017] Figure 5 is a data structure depicting the organization of flows according to one embodiment.

[0018] Figure 6 is flowchart illustrating the operation of the central controller according to one embodiment.

DETAILED DESCRIPTION

[0019] It is important to note that the embodiments disclosed herein are only examples of the many advantageous uses of the innovative teachings herein. In general, statements made in the specification of the present application do not necessarily limit any of the various claimed embodiments. Moreover, some statements may apply to some inventive features but not to others. In general, unless otherwise indicated, singular nodes may be in plural and vice versa with no loss of generality. In the drawings, like numerals refer to like parts through several views.

[0020] Fig. 1 is an exemplary and non-limiting diagram of a network system 100 utilized to describe the various disclosed embodiments. The network system 100 includes a software defined network (SDN) 110 (not shown) containing a central controller 111 and a plurality of network nodes 112. The network nodes 112 communicate with the central

controller 111 using, for example, an OpenFlow protocol. The central controller 111 can configure the network nodes 112 to perform certain data path operations. The SDN 110 can be implemented in wide area networks (WANs), local area networks (LANs), the Internet, metropolitan area networks (MANs), ISP backbones, datacenters, inter-datacenter networks, and the like. Each network node 112 in the SDN may be a router, a switch, a bridge, and so on.

[0021] The central controller 111 provides inspected data (such as application metadata) to a plurality of application servers (collectively referred to as application servers 120, merely for simplicity purposes). An application server 120 executes, for example, security applications (e.g., Firewall, intrusion detection, etc.), data analytic applications, and so on.

[0022] In the exemplary network system 100, a plurality of client devices (collectively referred to as client devices 130, merely for simplicity purposes) communicate with a plurality of destination servers (collectively referred to as destination servers 140, merely for simplicity purposes) connected over the network 110. A client device 130 may be, for example, a smart phone, a tablet computer, a personal computer, a laptop computer, a wearable computing device, and the like. The destination servers 140 are accessed by the devices 130 and may be, for example, web servers.

[0023] According to some embodiments, the central controller 111 is configured to perform deep packet inspection on designated packets from designated flows or TCP sessions. To this end, the central controller 111 is further configured to instruct each of the network nodes 112 which of the packets and/or sessions should be directed to the controller 111 for packet inspections.

[0024] According to some embodiments, each network node 112 is configured to determine if an incoming packet requires inspection or not. The determination is performed based on a set of instructions provided by the controller 111. A packet that requires inspection is either redirected to the controller 111 or mirrored and a copy thereof is sent to the controller 111. It should be noted that traffic flows that are inspected are not affected by the operation of the network node 112. In an embodiment, each network node 112 is configured to extract and send only a portion of a packet data that contains meaningful information.

[0025] The set of instructions that the controller 111 configures each of the network nodes 112 with include “probe instructions”, “mirroring instructions”, and “termination instructions.” According to some exemplary and non-limiting embodiments, the probe instructions include:

If (TCP FLAG SYN=1) then (re-direct packet to central controller);
If (TCP FLAG SYN=1 and ACK=1) then (re-direct packet to central controller); and
If (TCP FLAG ACK=1) then (forward packet directly to a destination server).

The termination instructions include:

If (TCP FLAG FIN=1) then (re-direct packet to controller);
If (TCP FLAG FIN=1 and ACK=1) then (re-direct packet to controller); and
If (TCP FLAG RST=1) then (re-direct packet to controller).

[0026] The TCP FLAG SYN, TCP FLAG ACK, TCP FLAG FIN, TCP FLAG RST are fields in a TCP packet’s header that can be analyzed by the network nodes 112. That is, each node 112 is configured to receive an incoming packet (either a request from a client device 130 or response for a server 140), analyze the packet’s header, and perform the action (redirect the packet to controller 111 or send to destination server 140) respective of the value of the TCP flag.

[0027] The controller 111 also configures each of the network nodes 112 with mirroring instructions with a mirror action of X number of bytes within a packet. The mirrored bytes are sent to the controller 111 to perform the DPI analysis. According to some exemplary embodiments, the set of mirroring instructions have the following format:

If (source IP Address = V1 and destination IP Address = V2 and source TCP port = V3 and destination IP address = V4 and TCP sequence = V5 and TCP sequence mask = V6) then (mirror V7 bytes)

[0028] The values V1 through V7 are determined by the controller 111 per network node or for all nodes 112. The values of the TCP sequence, and TCP sequence mask are computed, by the controller 111, as discussed in detail below.

[0029] In another embodiment, in order to allow analysis of TCP packets' headers by a network node 112 and tracks flows, new type-length-value (TLV) structures are provided. The TLV structures may be applied to be utilized by an OpenFlow protocol standard as defined, for example, in the OpenFlow 1.3.3 specification published by the Open Flow Foundation on September 27, 2013 or OpenFlow 1.4.0 specification published on October 14, 2013, for parsing and identifying any arbitrary fields within a packet. According to non-limiting and exemplary embodiments, the TLV structures disclosed herein include:

1. TCP_FLG_OXM_HEADER (0x80FE, 2, 1). This TVL structure allows identification of the TCP header flags. The '0x80FE' value represents a unique vendor identification (ID), the value '2' represents a unique Type=2 value for the TLV, and the '1' value is 1-byte total length that stores the TCP flags header.
2. TCP_SEQ_OXM_HEADER (0x80FE, 1, 4) - This TLV structure allows identification of the TCP sequence number field. The '0x80FE' value represents a unique vendor ID, the value '1' represents a unique Type=1 value for this TLV, and the value '4' is a 4-byte total length that stores the TCP sequence number.

[0030] In order to track the flows, the central controller 111 also maintains a flow table having a structure 200 as illustrated in the exemplary and non-limiting Fig. 2. The flow table 200 contains two main fields KEY 210 and DATA 220. The KEY field 210 holds information with respect to the addresses/port numbers of a client device 130 and a destination server 140. The DATA field 220 contains information with respect to a TCP flow, such as a flow ID, a request (client to server) sequence number M, a response (server to client) sequence number N, a flow state (e.g., ACK, FIN), a creation timestamp, a client to server hit counter, server to client hit counter Y [bytes], client to server data buffer, server to client buffer, and an aging bit.

[0031] Fig. 3 shows an exemplary and non-limiting schematic diagram of a system 300 for describing the process of flow detection as performed by the central controller 111 and a network node 112 according to one embodiment. In an exemplary implementation, the central controller 111 includes a DPI flow detection module 311, a DPI engine 312, and a memory 313, and a processing unit 314. The DPI engine 312 in configured to inspect a packet or a number of bytes to provide application metadata as required by an application executed by an application server 120.

[0032] According to various embodiments discussed in detail above, the DPI flow detection module 311 is configured to detect all TCP flows and maintain them in the flow table (e.g., table 200). The module 311 is also configured to generate and provide the network logs with the required instructions to monitor, redirect, and mirror packets. The DPI flow detection module 311 executes certain functions including, but not limited to, flow management, computing sequence masks, and TCP flow analysis. These functions are discussed in detail below.

[0033] In exemplary implementation, the network node 112 includes a probe flow module 321, a memory 322, and a processing unit 323. The probe flow module 321 is configured to redirect any new TCP connection state initiation packets to the DPI flow detection module 311, as well as to extract several packets from each detected TCP flow and mirror them to the flow detection module 311. In an embodiment, probe flow module 321 executes functions and/or implements logic to intercept TCP flags, redirect packets, and count sequence numbers.

[0034] Both processing units 314 and 323 uses instructions stored in the memories 313 and 322 respectively to execute tasks generally performed by the central controllers of SDN as well as to control and enable the operation of behavioral network intelligence processes disclosed herewith. In an embodiment, the processing unit (314, 323) may include one or more processors. The one or more processors may be implemented with any combination of general-purpose microprocessors, multi-core processors, microcontrollers, digital signal processors (DSPs), field programmable gate array (FPGAs), programmable logic devices (PLDs), controllers, state machines, gated logic, discrete hardware components, dedicated hardware finite state machines, or any other suitable entities that can perform calculations or other manipulations of information. The

memories 313 and 322 may be implemented using any form of a non-transitory computer readable medium.

[0035] Prior to performing the flow detection process the network node 112 is set with the probe instructions, such as those discussed above. Referring to Fig. 3, at S301, a packet arrives from a client (e.g., client 130, Fig. 1) at a port (not shown) at the network node 112. The packet is a TCP packet with a header including the following value [TCP FLAG SYN=1, SEQUENCE = M].

[0036] As the header' value matches a redirect action, at S302, the probe flow module 321 redirects the packet to the controller 111, and in particular to the module 311.

[0037] In response, at S303, the module 311 traps the packet and creates a new flow-id in the flow table (e.g., table 200) and marks the flow-id's state as 'SYN'. The flow table is saved in the memory 313. The initial sequence from the client to a destination server number equals M and saved in the flow table as well. Then, the packet is sent to the node 112 for further processing.

[0038] At S304, a response packet arrives from a destination server (e.g., server 140, Fig. 1) with header value [TCP FLAG SYN=1, TCP FLAG ACK=1, SEQUENCE = N]. The response is received at the node's 112 port. At S305, as the header's value matches a probe instruction, the response packet is sent to the module 311 in the controller 111.

[0039] In response, the module 311 traps the packet and searches for a pre-allocated corresponding flow-id in the flow table and updates the respective state as 'SYN/ACK'. The module 311 also stores the initial sequence number of a packet from the server to client as equals to N. This will create a new bi-directional flow-id with M and N sequence numbers identified and the sequence mask logic can be calculated respective thereof.

[0040] According to various embodiments, the DPI flow detection module 311 implements or executes a sequence mask logic that computes a mask for the initial trapped sequence numbers (M and N) to be used for a new flow to be configured into the node 112. Specifically, the computed mask is used to define new mirroring instructions to allow mirroring of a number of bytes from the TCP session in both directions. The computed mask value specifies which bytes respective of the correct sequence number would be required to mirror from the TCP session. In an embodiment, the computed value is placed in a mask filed defined by the OpenFlow protocol.

[0041] The following steps are taken to extract the computed mask value: Compute a temporary mask value (temp_mask_val) as follows:

temp_mask_val = M XOR (M+ TCP_DATA_SIZE_DPI);

The value TCP_DATA_SIZE_DPI specifies the number of bytes the node 112 would be required to mirror from the TCP session. In an embodiment, a different value of the TCP_DATA_SIZE_DPI may be set for the upstream and downstream traffic. For example, for an upstream traffic fewer bytes may be mirrored than the downstream traffic, thus the TCP_DATA_SIZE_DPI value for upstream traffic would be smaller than a downstream traffic. The temp_mask_val returns a number where the most significant bit (MSB) set to one indicates the first bit of the mask. Then a sequence MSB is computed as follows:

seq_msb = (int32_t)msb32(temp_Mask_val);

The ‘msb32’ function returns the MSB place of temp_mask_val. Finally, the mask value is computed as follows:

mask = (int32_t)(0 - ((0x1 << seq_msb))).

[0042] As an example, if the sequence number M is M=0xf46d5c34, and TCP_DATA_SIZE_DPI = 16384, then:

temp_mask_val = 0xf46d5c34 XOR (0xf46d5c34 + 16384) = 0xc000
seq_msb = (int32_t)msb32(0xf46d9c34) = 16
mask = (int32_t)(0 - (0x1 << 16)) = 0xFFFF8000

[0043] The mask is defined such that a ‘0’ in a given bit position indicates a “don't care” match for the same bit in the corresponding field, whereas a ‘1’ means match the bit exactly. In above example, all data packets containing sequence number in the range of {0xf46d5c34 to 0xf46d9c34} be mirrored to the controller 111.

[0044] Using the computed mask value, the module 311 using a TCP flow analysis logic (not shown) creates the mirroring instructions related to the client and server traffic. One instruction identifies the client to server flow traffic, including the OXM_OF_ _TCP_SEQ to identify the initial sequence number of the flow with the mask_M computed. The action of the flow is to mirror all packets that the instruction applies, which will result in the TCP_DATA_SIZE_DPI number of bytes from the client to server direction to be mirrored to the controller 111. The second instruction identifies the server-to-client flow traffic, including the OXM_OF_TCP_SEQ to identify the initial sequence number of the flow with the mask_N. The action is to mirror all packets that the instruction applies to, which will result in the TCP_DATA_SIZE_DPI number of byte from the server to client direction to be mirrored to the controller 111 for further analysis. The mask_N and mask_M are computed using the sequence numbers N and M< respectively using the process discussed above. As a non-limiting example, the mirroring instructions includes:

Match							result	
Source IP address	destination IP address	source TCP port	destination TCP port	IP protocol number	TCP sequence	TCP sequence mask	action	Count byte
192.1.1.1	209.1.4.4	15431	21	6	0xf46d5c34	0xFFFF8000	Mirror	X
209.1.4.4	192.1.1.1	21	15431	6	0x3c98b9ab	0xFFFF8000	Mirror	Y

[0045] Referring back to Fig. 3, at S306, in the module 311 the processed packet is sent back to the node 112 for further processing. In an embodiment, a set of mirroring instructions generated respective of the computed mask value are sent to the node 112. At S307, a response TCP ACK packet with [TCP FLAG ACK=1] is received at a port of the node 112 and, based on the respective probe instruction, the packet is switched directly to the destination server 140.

[0046] In an embodiment, an audit mechanism scans the flow table every predefined time interval from the last timestamp and deletes all flows from the state is not SYN/ACK. Furthermore, an aging mechanism deletes all entries wherein their aging bit equal = 1. The aging bit is initialized to 0 upon flow creation of a flow-id entry and is set to 1 in the first audit pass if buffer length is 0. When a flow-id is deleted from the flow table, the flow-id also removed from the tables maintained by the probe sequence counter 324.

[0047] At S308 and S309, packets arrive from either the client device or a destination server with their sequence number that matches the mirroring instructions and are mirrored to the central controller 111 for buffering and for analysis by the DPI engine 312. It should be noted that each instruction hit increments a counter Client-to-Server hit counter X [bytes] and Server-to-Client hit counter Y [bytes]. The flow table audit mechanism scans the flow table, every predefined time interval, and updates the mask to 0x00000000 and the ACTION to “no Action” of all entries that their Client-to-Server buffer length = TCP_DATA_SIZE_DPI or Server-to-Client buffer length = TCP_DATA_SIZE_DPI. The various fields of the flow table are shown in Fig. 2.

[0048] Fig. 4 show an exemplary and non-limiting diagram of a system 400 for describing the process of flow termination as performed by the central controller 111 and a network node 112 according to one embodiment. The various module of the controller 111 and node 112 are discussed with reference to Fig. 3.

[0049] In the flow termination process, the module 311 follows a termination of a TCP flow and is responsible to remove the exiting flow from the flow table. In addition, the module 311 disables or removes the mirroring instructions from the node 112. According to one embodiment, the module 311 configures the node 112 with a set of termination instructions. Examples for such instructions are provided above.

[0050] At S401, a packet arrives, at the node 112, from a client 130 with a header including the value of [TCP FLAG FIN=1]. The value matches one of the termination instructions, thus, at S402, to the packet is sent to the center controller 111.

[0051] In response, at S403, the module 311 traps the packet and marks the corresponding flow-id in the flow table to update the state to FIN. Then, the packet is sent back it to the network log.

[0052] At S404, a response packet from the destination server (e.g., server 140) with a header’s value containing [TCP FLAG FIN=1, ACK=1] is received at the node 112. As the value matches one of the termination instructions, at S405, to the packet is sent to the center controller 111.

[0053] At S406, the module 311 traps the received packet and marks the corresponding FLOW-ID in its flow table DB as state=FIN/FIN/ACK. Then, the packet is sent back to the network node 112. At S407, a response TCP ACK packet arrives from a

client 130 with a header's value containing [TCP FLAG ACK=1] and is switched directly to the server 140. If the response packet includes the header's value of [TCP FLAG RST=1], the module 311 marks the state of respective flow id in the flow table.

[0054] In an embodiment, the audit mechanism implemented by the module 311 scans the flow table every predefined time interval to all flows that their respective state is any one of FIN, FIN/ACK, FIN/FIN/ACK, or RST. The flows are removed from the probe flow module 321 and the flow table.

[0055] According to one embodiment, each network node 112 is populated with one or more probe tables generated by the central controller 111. Fig. 5 shows a non-limiting and exemplary data structure 500 depicting the organization of the flows to allow functionality of both the probe flow detection module 321 and probe sequence counter 324.

[0056] The data structure 500 which may be in a form of a table is updated with a general instruction to match all traffic type with instruction 501 to go to a probe table 510. The instruction 501 is set to the highest priority, unless the controller 111 requires pre-processing of other instructions. All packets matching the instruction 500 are processed in the probe table 510.

[0057] In an embodiment, the probe table 510 is populated with a medium priority probe and termination instructions 511 to detect all SYN, SYN/ACK, FIN, FIN/ACK that are the TCP connection initiation packets. The instructions 511 allows the module 311 to update the flow table and as a consequence create new instructions for mirroring N bytes from each TCP connection setup.

[0058] The probe table 510 table is also populated with highest priority instructions 512, these are two bi-direction instructions per flow-id that match a number 'r' tupple flow headers including the TCP sequence number as calculated by the sequence mask logic. The instructions 512 are to send the packet to the central controller 111 and also to perform go to table ID <next table ID>. The instructions 512 will cause sending the packet to continue switching processing. Each of these bi-directional instructions 512 will cause the node to copy several bytes from the TCP stream to the TCP flow analysis logic to be stored for further DPI engine metadata analysis.

[0059] The final instruction 513 placed in the probe table 510 is in the lowest priority to catch all and proceed with the switch functionality. All traffic which does not correspond to the TCP initiation packets, nor a specific detected flow and the corresponding TCP sequence number shall continue regular processing.

[0060] Fig. 6 shows an exemplary and non-limiting flowchart 600 illustrating the operation of the central controller 111 according to one embodiment. At S610, all network nodes 112 are configured with a set of probe instructions utilized to instruct each node 112 to redirect a TCP packet having at least a flag value as designated in each probe instruction. Examples for probe instructions are provided above.

[0061] At S620, a first TCP packet with at least one TCP FLAG SYN value equal to 1 is received. This packet may have a sequence number M and may be sent from a client device 130. At S630, a second TCP packet with at least one TCP FLAG ACK value equal to 1 is received. This packet may have a sequence number N and may be sent from a destination server 140 in response to the first TCP packet. In an embodiment, the flow table is updated with the respective flow ID and the state of the first and second packets.

[0062] At S640, using at least the sequence numbers of the first and second packets a mask value is computed. The mask value is utilized to determine which bytes from the flow respective of the sequence numbers N and M should be mirrored by the nodes. An embodiment for computing the mask value is provided above.

[0063] At S650, a set of mirroring instructions are generated using the mirror value and sent to the network nodes. Each such instruction defines the packets (designed at least by a specific source/destination IP addresses, and TCP sequences), the number of bytes, and the bytes that should be mirrored. At S660, the received mirror bytes are inspected using a DPI engine in the controller 111. In addition, the flow table is updated with the number of the received mirror bytes.

[0064] In S670, it is checked if the inspection session should be terminated. The decision is based on the FIN and/or RST values of the TCP FLAG. As noted above, packets with TCP FLAG FIN=1 or TCP FLAG RST=1 are directed to the controller respective of the set of termination instructions. Some examples for the termination instructions are provided above. If S670, results with No answer execution returns to S660; otherwise, execution continues with S680. At S680, related exiting flows from the

flow table are removed. In addition, the nodes 112 are instructed not to perform the mirroring instructions provided at S650.

[0065] The various embodiments disclosed herein can be implemented as hardware, firmware, software, or any combination thereof. Moreover, the software is preferably implemented as an application program tangibly embodied on a program storage unit or computer readable medium consisting of parts, or of certain devices and/or a combination of devices. The application program may be uploaded to, and executed by, a machine comprising any suitable architecture. Preferably, the machine is implemented on a computer platform having hardware such as one or more central processing units ("CPUs"), a memory, and input/output interfaces. The computer platform may also include an operating system and microinstruction code. The various processes and functions described herein may be either part of the microinstruction code or part of the application program, or any combination thereof, which may be executed by a CPU, whether or not such a computer or processor is explicitly shown. In addition, various other peripheral units may be connected to the computer platform such as an additional data storage unit and a printing unit. Furthermore, a non-transitory computer readable medium is any computer readable medium except for a transitory propagating signal.

[0066] All examples and conditional language recited herein are intended for pedagogical purposes to aid the reader in understanding the principles of the disclosed embodiments and the concepts contributed by the inventor to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions. Moreover, all statements herein reciting principles, aspects, and embodiments of the invention, as well as specific examples thereof, are intended to encompass both structural and functional equivalents thereof. Additionally, it is intended that such equivalents include both currently known equivalents as well as equivalents developed in the future, i.e., any nodes developed that perform the same function, regardless of structure.

CLAIMS

What is claimed is:

1. A method for deep packet inspection (DPI) in a software defined network (SDN), wherein the method is performed by a central controller of the SDN, comprising:

configuring a plurality of network nodes operable in the SDN with at least one probe instruction;

receiving from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first sequence number;

receiving from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second sequence number, wherein the second packet is a response of the first packet;

computing a mask value respective of at least the first and second sequence numbers, wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected;

generating at least one mirror instruction based on at least the mask value; and

configuring the plurality of network nodes with at least one mirror instruction.

2. The method of claim 1, further comprising:

receiving mirrored bytes from a network node respective of the at least one mirror instruction; and

inspecting the mirrored bytes using a DPI engine.

3. The method of claim 1, further comprising:

maintaining a flow table listing each flow inspected by the central controller; and

updating a status field in the flow table upon reception of any one of: the first packet, the second packet, and the mirrored bytes.

4. The method of claim 3, further comprising:

configuring the plurality of network nodes with at least one termination instruction;

removing all entries from the flow table for each flow matching the at least one termination instruction; and

disabling the at least one mirror instruction for each flow matching the at least one termination instruction.

5. The method of claim 1, wherein the at least one probe instruction is any one of:

if (TCP FLAG SYN=1) then (re-direct packet to the central controller) and if (TCP FLAG SYN=1 and ACK=1) then (re-direct packet to central controller).

6. The method of claim 1, wherein the least one mirror action is at least: if (source IP Address = V1 and destination IP Address = V2 and source TCP port = V3 and destination IP address = V4 and TCP sequence = V5 and TCP sequence mask = V6) then (mirror V7 bytes).

7. The method of claim 4, wherein the at least one termination instruction is any one of: if (TCP FLAG FIN=1) then (re-direct packet to controller); if (TCP FLAG FIN=1 and ACK=1) then (re-direct packet to controller); and if (TCP FLAG RST=1) then (re-direct packet to controller).

8. The method of claim 1, wherein a number of bytes mirrored from each packet is a portion of the packet, wherein the bytes are mirrored from packets in sequence.

9. The method of claim 1, wherein the communication between central controller and the plurality of network nodes is performed using the OpenFlow standard.

10. A non-transitory computer readable medium having stored thereon instructions for causing one or more processing units to execute the computerized method according to claim 1.

11. A system for deep packet inspection (DPI) in a software defined network (SDN), wherein the method is performed by a central controller of the SDN, comprising:

a processor;

a memory connected to the processor and configured to contain a plurality of instructions that when executed by the processor configure the system to:

set a plurality of network nodes operable in the SDN with at least one probe instruction;

receive from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first sequence number;

receive from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second sequence number, wherein the second packet is a response of the first packet;

compute a mask value respective of at least the first and second sequence numbers, wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected;

generate at least one mirror instruction based on at least the mask value; and

configure the plurality of network nodes with at least one mirror instruction.

12. The system of claim 11, wherein the system is further configured to:

receive mirrored bytes from a network node respective of the at least one mirror instruction; and

inspect the mirrored bytes using a DPI engine.

13. The system of claim 11, wherein the system is further configured to:

maintain a flow table listing each flow inspected by the central controller; and

update a status field in the flow table upon reception of any one of: the first packet, the second packet, and the mirrored bytes.

14. The system of claim 13, wherein the system is further configured to:

configure the plurality of network nodes with at least one termination instruction;

remove all entries from the flow table for each flow matching the at least one termination instruction; and

disable the at least one mirror instruction for each flow matching the at least one termination instruction.

15. The system of claim 11, wherein the at least one probe instruction is any one of:
if (TCP FLAG SYN=1) then (re-direct packet to the central controller) and if (TCP FLAG SYN=1 and ACK=1) then (re-direct packet to central controller).

16. The system of claim 11, wherein the least one mirror action is at least: if (source IP Address = V1 and destination IP Address = V2 and source TCP port = V3 and destination IP address = V4 and TCP sequence = V5 and TCP sequence mask = V6) then (mirror V7 bytes).

17. The system of claim 14, wherein the at least one termination instruction is any one of: if (TCP FLAG FIN=1) then (re-direct packet to controller); if (TCP FLAG FIN=1 and ACK=1) then (re-direct packet to controller); and if (TCP FLAG RST=1) then (re-direct packet to controller).

18. The system of claim 11, wherein a number of bytes mirrored from each packet is a portion of the packet, wherein the bytes are mirrored from packets in sequence.

19. The system of claim 11, wherein the communication between central controller and the plurality of network node is performed using the OpenFlow standard

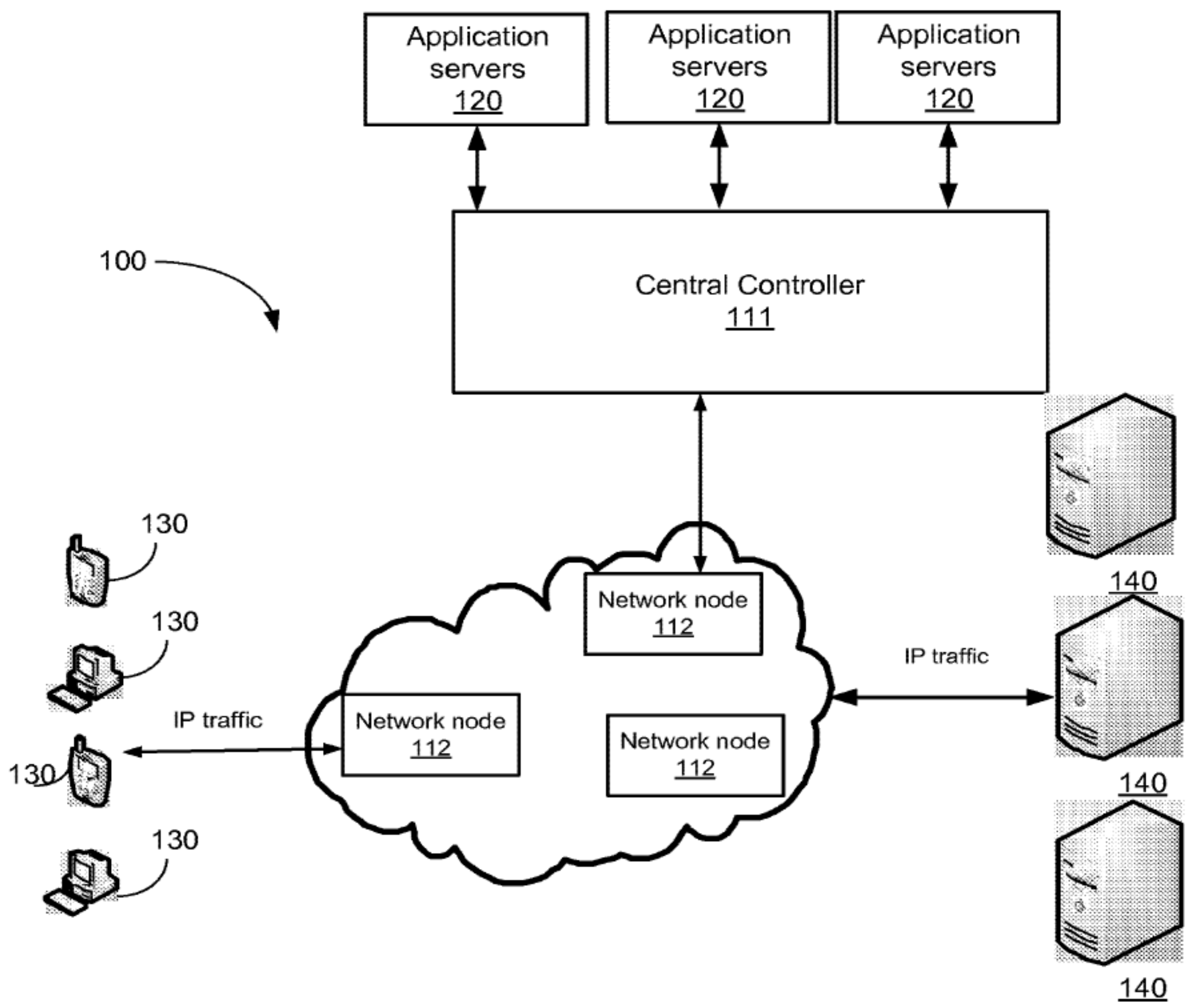

Application servers 120
Application servers 120
Application servers 120
100
Central Controller 111
130
130
130
130
Network node 112
Network node 112
Network node 112
IP traffic
IP traffic
140
140
140

FIG. 1

200

KEY 210					DATA 220										
Client IP address	Server IP address	Client source TCP port	Server destination TCP port	IP protocol number	Flow ID	Client→ Server sequence number M	Server→ Client sequence number N	state	Creation timestamp	Client→ Server Hit counter X [bytes]	Server → Client Hit counter Y [bytes]	Client→ Server data buffer	Server→ Client buffer	Age bit
192.1.1.1	209.1.4.4	15431	21	6	1	0xf46d5c34	0x3c98b9ab	ACK	15:32:13					

FIG. 2

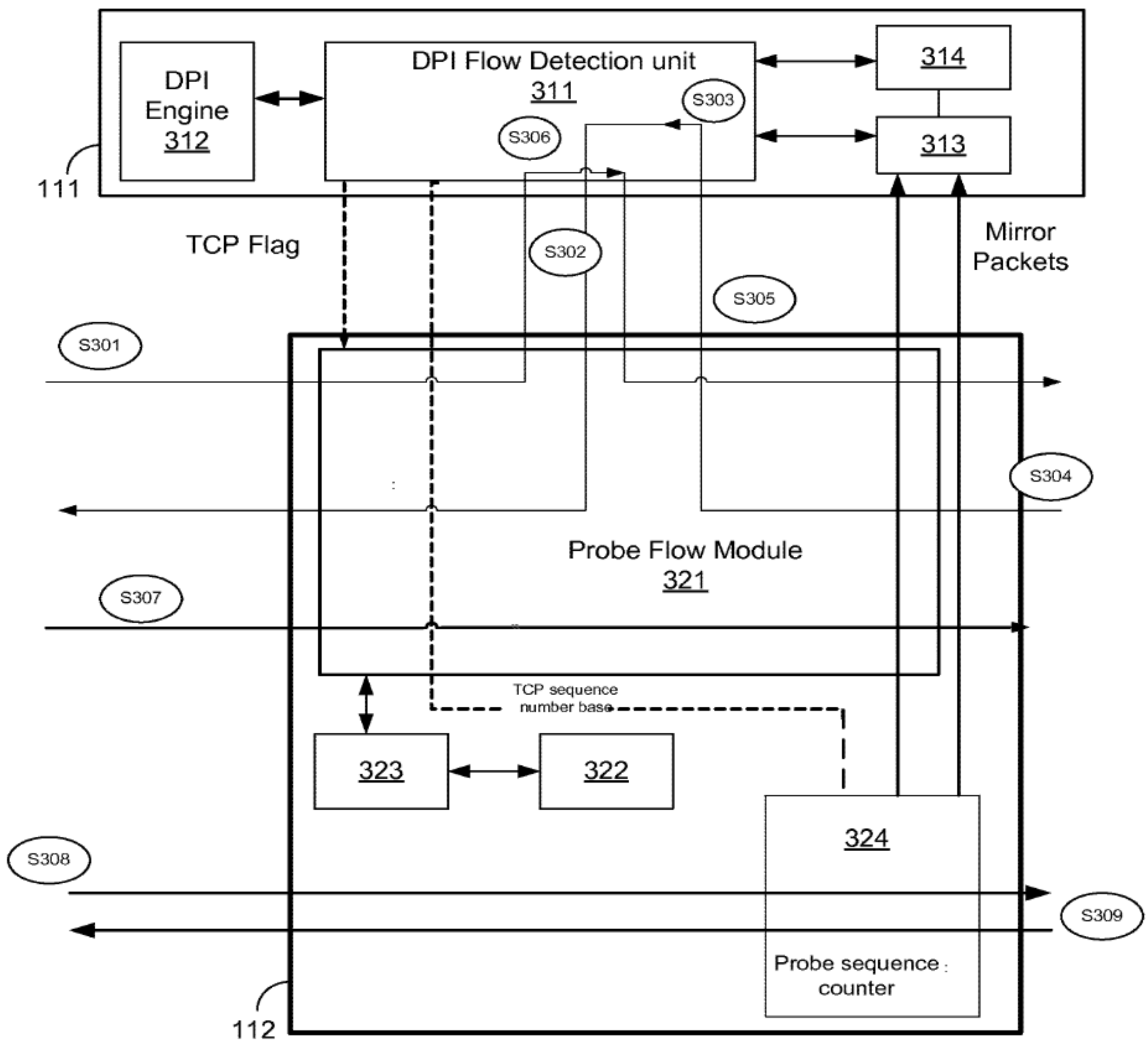
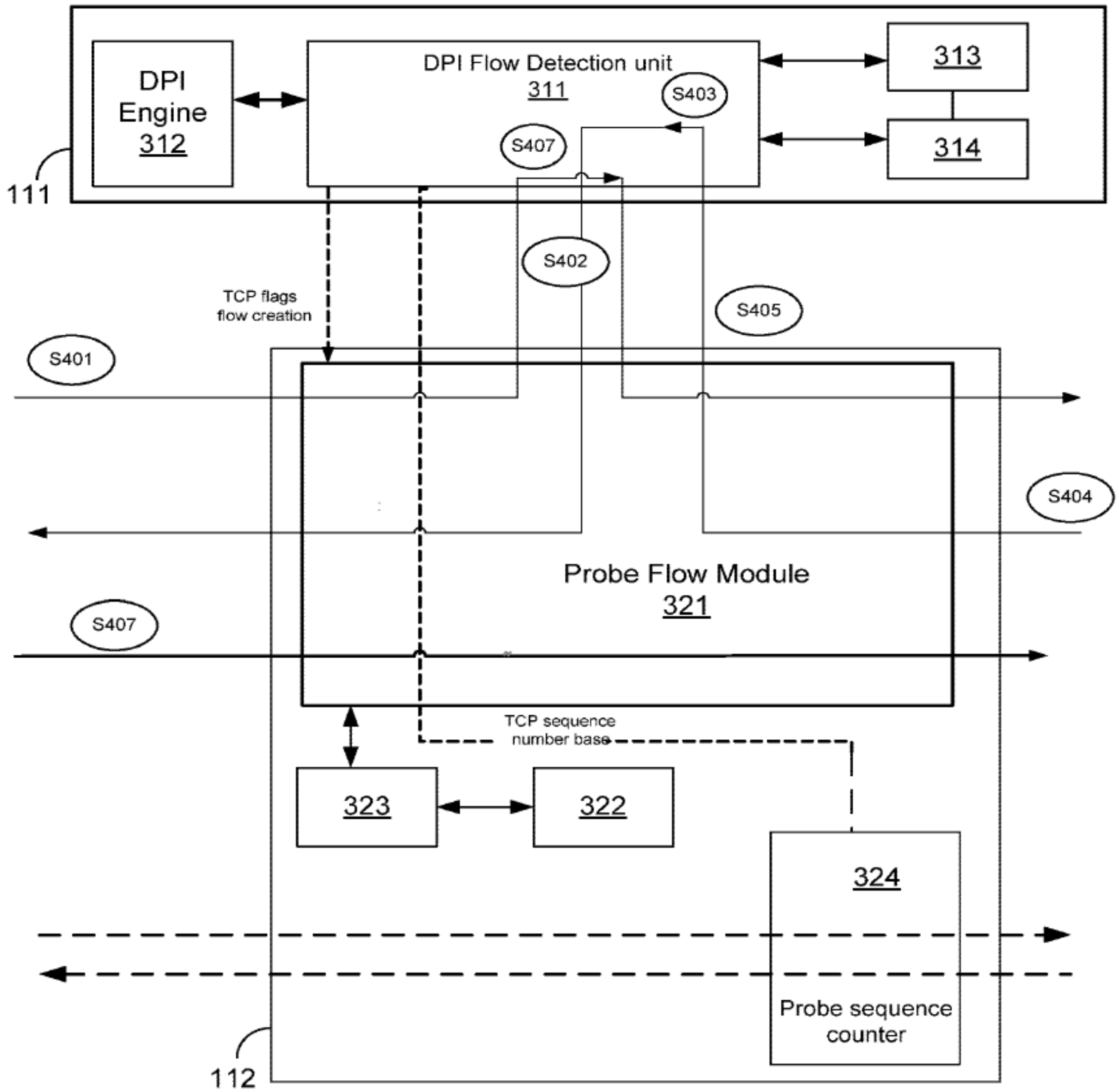

DPI Engine 312
DPI Flow Detection unit 311
314
313
111
S303
S306
TCP Flag
S302
Mirror Packets
S305
S301
S304
Probe Flow Module 321
S307
TCP sequence number base
323
322
324
S308
S309
Probe sequence counter
112

FIG. 3



DPI Engine 312
DPI Flow Detection unit 311
313
314
S403
S407
111
S402
S405
TCP flags flow creation
S401
S404
Probe Flow Module 321
S407
TCP sequence number base
323
322
324
Probe sequence counter
112

FIG. 4

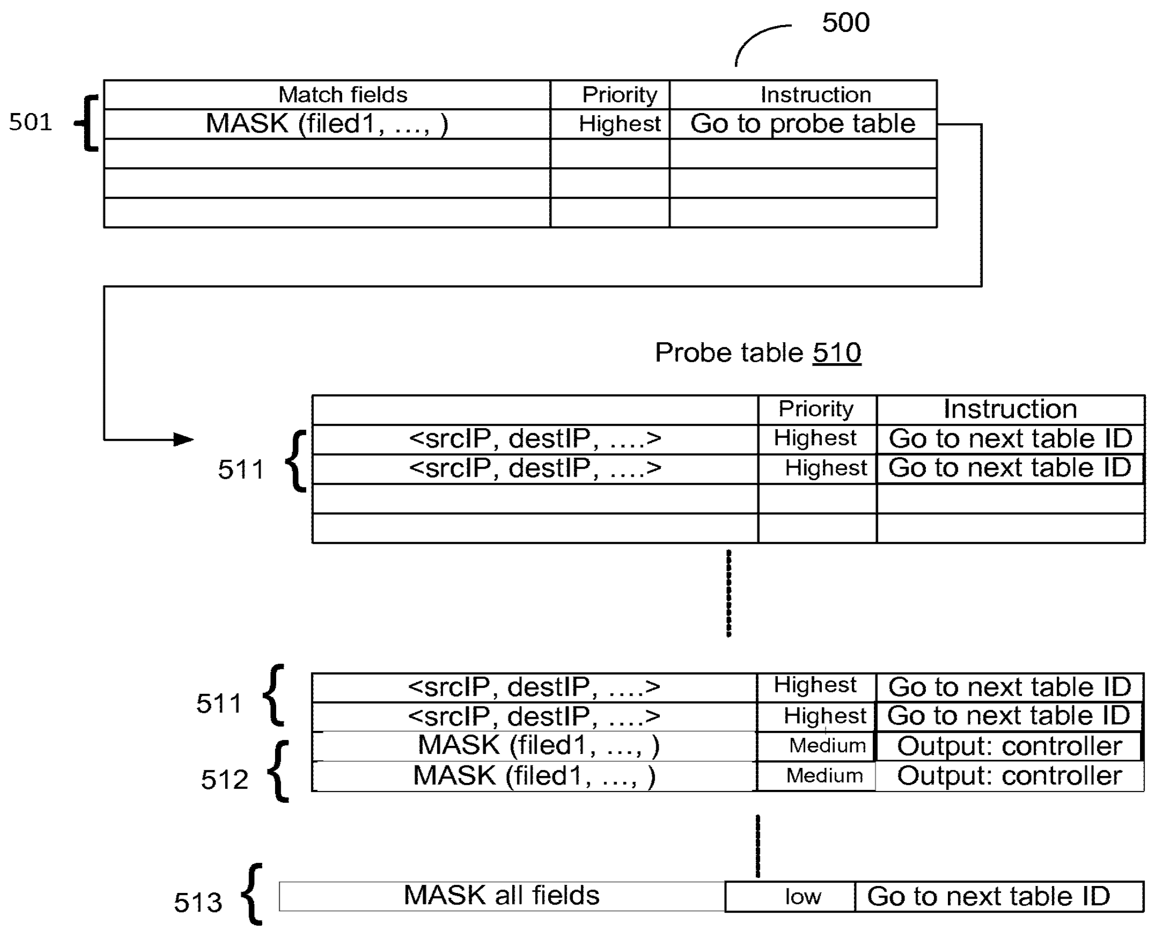

500
501
Match fields
Priority
Instruction
MASK (filed1, …,)
Highest
Go to probe table
Probe table 510
Priority
Instruction
511
<srcIP, destIP, ….>
Highest
Go to next table ID
<srcIP, destIP, ….>
Highest
Go to next table ID
511
<srcIP, destIP, ….>
Highest
Go to next table ID
<srcIP, destIP, ….>
Highest
Go to next table ID
512
MASK (filed1, …,)
Medium
Output: controller
MASK (filed1, …,)
Medium
Output: controller
513
MASK all fields
low
Go to next table ID

FIG. 5

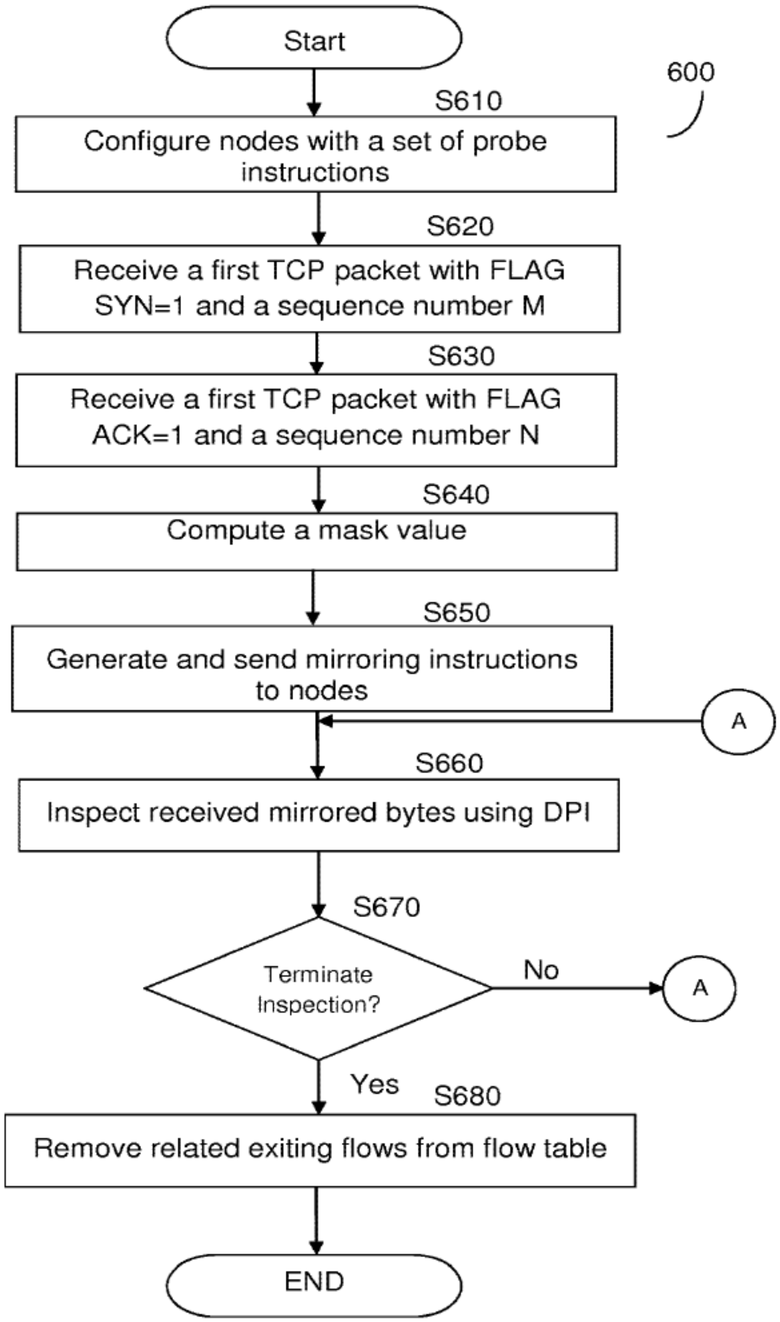

Start
600
S610
Configure nodes with a set of probe instructions
S620
Receive a first TCP packet with FLAG SYN=1 and a sequence number M
S630
Receive a first TCP packet with FLAG ACK=1 and a sequence number N
S640
Compute a mask value
S650
Generate and send mirroring instructions to nodes
A
S660
Inspect received mirrored bytes using DPI
S670
Terminate Inspection?
No
A
Yes
S680
Remove related exiting flows from flow table
END

FIG. 6

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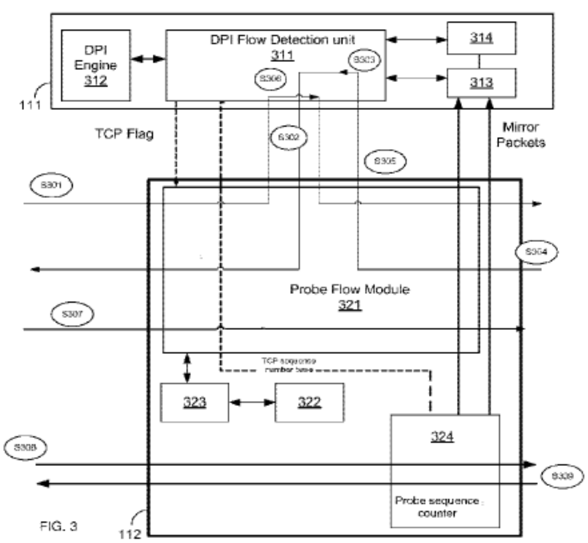

FIG. 3

(57) Abstract: A method for deep packet inspection (DPI) in a software defined network (SDN). The method includes configuring a plurality of network nodes operable in the SDN with at least one probe instruction; receiving from a network node a first packet of a flow, the first packet matches the at least one probe instruction and includes a first sequence number; receiving from a network node a second packet of the flow, the second packet matches the at least one probe instruction and includes a second sequence number, the second packet is a response of the first packet; computing a mask value respective of at least the first and second sequence numbers indicating which bytes to be mirrored from subsequent packets belonging to the same flow; generating at least one mirror instruction based on at least the mask value; and configuring the plurality of network nodes with at least one mirror instruction.

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A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS

CROSS REFERENCE TO RELATED APPLICATIONS

[001] This application claims the benefit of US provisional application No. 61/982,358 filed on April 22, 2014, the contents of which are herein incorporated by reference.

TECHNICAL FIELD

[002] This disclosure generally relates to techniques for deep packet inspection (DPI), and particularly for DPI of traffic in cloud-based networks utilizing software defined networks.

BACKGROUND

[003] Deep packet inspection (DPI) technology is a form of network packet scanning technique that allows specific data patterns to be extracted from a data communication channel. Extracted data patterns can then be used by various applications, such as security and data analytics applications. DPI currently performs across various networks, such as internal networks, Internet service providers (ISPs), and public networks provided to customers. Typically, the DPI is performed by dedicated engines installed in such networks.

[004] A software defined networking is a relatively new type of networking architecture that provides centralized management of network nodes rather than a distributed architecture utilized by conventional networks. The SDN is prompted by an ONF (open network foundation). The leading communication standard that currently defines communication between the central controller (e.g., a SDN controller) and the network nodes (e.g., vSwitches) is the OpenFlow™ standard.

[005] Specifically, in SDN-based architectures the data forwarding (e.g. data plane) is typically decoupled from control decisions (e.g. control plane), such as routing, resources, and other management functionalities. The decoupling may also allow the data plane and the control plane to operate on different hardware, in different runtime environments, and/or operate using different models. As such, in an SDN network, the

network intelligence is logically centralized in the central controller which configures, using OpenFlow protocol, network nodes and to control application data traffic flows.

[006] Although, the OpenFlow protocol allows addition of programmability to network nodes for the purpose of packets-processing operations under the control of the central controller, the OpenFlow does not support any mechanism to allow DPI of packets through the various networking layers as defined by the OSI model. Specifically, the current OpenFlow specification defines a mechanism to parse and extract only packet headers, in layer-2 through layer-4, from packets flowing via the network nodes. The OpenFlow specification does not define or suggest any mechanism to extract non-generic, uncommon, and/or arbitrary data patterns contained in layer-4 to layer 7 fields. In addition, the OpenFlow specification does not define or suggest any mechanism to inspect or to extract content from packets belonging to a specific flow or session. This is a major limitation as it would not require inspection of the packet for the purpose of identification of, for example, security threats detection.

[007] The straightforward approach of routing all traffic from network nodes to the central controller introduces some significant drawbacks, such as increased end-to-end traffic delays between the client and the server; overflowing the controller capability to perform other networking functions; and a single point of failure for the re-routed traffic.

[008] Therefore, it would be advantageous to provide a solution that overcomes the deficiencies noted above and allow efficient DPI in SDNs.

SUMMARY

[009] A summary of several example embodiments of the disclosure follows. This summary is provided for the convenience of the reader to provide a basic understanding of such embodiments and does not wholly define the breadth of the disclosure. This summary is not an extensive overview of all contemplated embodiments, and is intended to neither identify key or critical nodes of all aspects nor delineate the scope of any or all embodiments. Its sole purpose is to present some concepts of one or more embodiments in a simplified form as a prelude to the more detailed description that is presented later. For convenience, the term some embodiments may be used herein to refer to a single embodiment or multiple embodiments of the disclosure.

[0010] Certain embodiments disclosed herein include a method for deep packet inspection (DPI) in a software defined network (SDN), wherein the method is performed by a central controller of the SDN. The method comprises: configuring a plurality of network nodes operable in the SDN with at least one probe instruction; receiving from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first sequence number; receiving from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second sequence number, wherein the second packet is a response of the first packet; computing a mask value respective of at least the first and second sequence numbers, wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected; generating at least one mirror instruction based on at least the mask value; and configuring the plurality of network nodes with at least one mirror instruction.

[0011] Certain embodiments disclosed herein include a system for deep packet inspection (DPI) in a software defined network (SDN), wherein the method is performed by a central controller of the SDN. The system comprises: a processor; a memory connected to the processor and configured to contain a plurality of instructions that when executed by the processor configure the system to: set a plurality of network nodes operable in the SDN with at least one probe instruction; receive from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first sequence number; receive from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second sequence number, wherein the second packet is a response of the first packet; compute a mask value respective of at least the first and second sequence numbers, wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected; generate at least one mirror instruction based on at least the mask value; and configure the plurality of network nodes with at least one mirror instruction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The subject matter disclosed herein is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other objects, features, and advantages of the invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings.

[0013] Figure 1 is a schematic diagram of a network system utilized to describe the various disclosed embodiments.

[0014] Figure 2 illustrates is a schematic diagram of a flow table stored in a central controller.

[0015] Figure 3 is a schematic diagram of a system utilized for describing the process of flow detection as performed by a central controller and a network node according to one embodiment.

[0016] Figure 4 is a schematic diagram of a system utilized for describing the process of flow termination as performed by a central controller and a network node according to one embodiment.

[0017] Figure 5 is a data structure depicting the organization of flows according to one embodiment.

[0018] Figure 6 is flowchart illustrating the operation of the central controller according to one embodiment.

DETAILED DESCRIPTION

[0019] It is important to note that the embodiments disclosed herein are only examples of the many advantageous uses of the innovative teachings herein. In general, statements made in the specification of the present application do not necessarily limit any of the various claimed embodiments. Moreover, some statements may apply to some inventive features but not to others. In general, unless otherwise indicated, singular nodes may be in plural and vice versa with no loss of generality. In the drawings, like numerals refer to like parts through several views.

[0020] Fig. 1 is an exemplary and non-limiting diagram of a network system 100 utilized to describe the various disclosed embodiments. The network system 100 includes a software defined network (SDN) 110 (not shown) containing a central controller 111 and a plurality of network nodes 112. The network nodes 112 communicate with the central

controller 111 using, for example, an OpenFlow protocol. The central controller 111 can configure the network nodes 112 to perform certain data path operations. The SDN 110 can be implemented in wide area networks (WANs), local area networks (LANs), the Internet, metropolitan area networks (MANs), ISP backbones, datacenters, inter-datacenter networks, and the like. Each network node 112 in the SDN may be a router, a switch, a bridge, and so on.

[0021] The central controller 111 provides inspected data (such as application metadata) to a plurality of application servers (collectively referred to as application servers 120, merely for simplicity purposes). An application server 120 executes, for example, security applications (e.g., Firewall, intrusion detection, etc.), data analytic applications, and so on.

[0022] In the exemplary network system 100, a plurality of client devices (collectively referred to as client devices 130, merely for simplicity purposes) communicate with a plurality of destination servers (collectively referred to as destination servers 140, merely for simplicity purposes) connected over the network 110. A client device 130 may be, for example, a smart phone, a tablet computer, a personal computer, a laptop computer, a wearable computing device, and the like. The destination servers 140 are accessed by the devices 130 and may be, for example, web servers.

[0023] According to some embodiments, the central controller 111 is configured to perform deep packet inspection on designated packets from designated flows or TCP sessions. To this end, the central controller 111 is further configured to instruct each of the network nodes 112 which of the packets and/or sessions should be directed to the controller 111 for packet inspections.

[0024] According to some embodiments, each network node 112 is configured to determine if an incoming packet requires inspection or not. The determination is performed based on a set of instructions provided by the controller 111. A packet that requires inspection is either redirected to the controller 111 or mirrored and a copy thereof is sent to the controller 111. It should be noted that traffic flows that are inspected are not affected by the operation of the network node 112. In an embodiment, each network node 112 is configured to extract and send only a portion of a packet data that contains meaningful information.

[0025] The set of instructions that the controller 111 configures each of the network nodes 112 with include “probe instructions”, “mirroring instructions”, and “termination instructions.” According to some exemplary and non-limiting embodiments, the probe instructions include:

If (TCP FLAG SYN=1) then (re-direct packet to central controller);
If (TCP FLAG SYN=1 and ACK=1) then (re-direct packet to central controller); and
If (TCP FLAG ACK=1) then (forward packet directly to a destination server).

The termination instructions include:

If (TCP FLAG FIN=1) then (re-direct packet to controller);
If (TCP FLAG FIN=1 and ACK=1) then (re-direct packet to controller); and
If (TCP FLAG RST=1) then (re-direct packet to controller).

[0026] The TCP FLAG SYN, TCP FLAG ACK, TCP FLAG FIN, TCP FLAG RST are fields in a TCP packet’s header that can be analyzed by the network nodes 112. That is, each node 112 is configured to receive an incoming packet (either a request from a client device 130 or response for a server 140), analyze the packet’s header, and perform the action (redirect the packet to controller 111 or send to destination server 140) respective of the value of the TCP flag.

[0027] The controller 111 also configures each of the network nodes 112 with mirroring instructions with a mirror action of X number of bytes within a packet. The mirrored bytes are sent to the controller 111 to perform the DPI analysis. According to some exemplary embodiments, the set of mirroring instructions have the following format:

If (source IP Address = V1 and destination IP Address = V2 and source TCP port = V3 and destination IP address = V4 and TCP sequence = V5 and TCP sequence mask = V6) then (mirror V7 bytes)

[0028] The values V1 through V7 are determined by the controller 111 per network node or for all nodes 112. The values of the TCP sequence, and TCP sequence mask are computed, by the controller 111, as discussed in detail below.

[0029] In another embodiment, in order to allow analysis of TCP packets' headers by a network node 112 and tracks flows, new type-length-value (TLV) structures are provided. The TLV structures may be applied to be utilized by an OpenFlow protocol standard as defined, for example, in the OpenFlow 1.3.3 specification published by the Open Flow Foundation on September 27, 2013 or OpenFlow 1.4.0 specification published on October 14, 2013, for parsing and identifying any arbitrary fields within a packet. According to non-limiting and exemplary embodiments, the TLV structures disclosed herein include:

1. TCP_FLG_OXM_HEADER (0x80FE, 2, 1). This TVL structure allows identification of the TCP header flags. The '0x80FE' value represents a unique vendor identification (ID), the value '2' represents a unique Type=2 value for the TLV, and the '1' value is 1-byte total length that stores the TCP flags header.
2. TCP_SEQ_OXM_HEADER (0x80FE, 1, 4) - This TLV structure allows identification of the TCP sequence number field. The '0x80FE' value represents a unique vendor ID, the value '1' represents a unique Type=1 value for this TLV, and the value '4' is a 4-byte total length that stores the TCP sequence number.

[0030] In order to track the flows, the central controller 111 also maintains a flow table having a structure 200 as illustrated in the exemplary and non-limiting Fig. 2. The flow table 200 contains two main fields KEY 210 and DATA 220. The KEY field 210 holds information with respect to the addresses/port numbers of a client device 130 and a destination server 140. The DATA field 220 contains information with respect to a TCP flow, such as a flow ID, a request (client to server) sequence number M, a response (server to client) sequence number N, a flow state (e.g., ACK, FIN), a creation timestamp, a client to server hit counter, server to client hit counter Y [bytes], client to server data buffer, server to client buffer, and an aging bit.

[0031] Fig. 3 shows an exemplary and non-limiting schematic diagram of a system 300 for describing the process of flow detection as performed by the central controller 111 and a network node 112 according to one embodiment. In an exemplary implementation, the central controller 111 includes a DPI flow detection module 311, a DPI engine 312, and a memory 313, and a processing unit 314. The DPI engine 312 in configured to inspect a packet or a number of bytes to provide application metadata as required by an application executed by an application server 120.

[0032] According to various embodiments discussed in detail above, the DPI flow detection module 311 is configured to detect all TCP flows and maintain them in the flow table (e.g., table 200). The module 311 is also configured to generate and provide the network logs with the required instructions to monitor, redirect, and mirror packets. The DPI flow detection module 311 executes certain functions including, but not limited to, flow management, computing sequence masks, and TCP flow analysis. These functions are discussed in detail below.

[0033] In exemplary implementation, the network node 112 includes a probe flow module 321, a memory 322, and a processing unit 323. The probe flow module 321 is configured to redirect any new TCP connection state initiation packets to the DPI flow detection module 311, as well as to extract several packets from each detected TCP flow and mirror them to the flow detection module 311. In an embodiment, probe flow module 321 executes functions and/or implements logic to intercept TCP flags, redirect packets, and count sequence numbers.

[0034] Both processing units 314 and 323 uses instructions stored in the memories 313 and 322 respectively to execute tasks generally performed by the central controllers of SDN as well as to control and enable the operation of behavioral network intelligence processes disclosed herewith. In an embodiment, the processing unit (314, 323) may include one or more processors. The one or more processors may be implemented with any combination of general-purpose microprocessors, multi-core processors, microcontrollers, digital signal processors (DSPs), field programmable gate array (FPGAs), programmable logic devices (PLDs), controllers, state machines, gated logic, discrete hardware components, dedicated hardware finite state machines, or any other suitable entities that can perform calculations or other manipulations of information. The

memories 313 and 322 may be implemented using any form of a non-transitory computer readable medium.

[0035] Prior to performing the flow detection process the network node 112 is set with the probe instructions, such as those discussed above. Referring to Fig. 3, at S301, a packet arrives from a client (e.g., client 130, Fig. 1) at a port (not shown) at the network node 112. The packet is a TCP packet with a header including the following value [TCP FLAG SYN=1, SEQUENCE = M].

[0036] As the header' value matches a redirect action, at S302, the probe flow module 321 redirects the packet to the controller 111, and in particular to the module 311.

[0037] In response, at S303, the module 311 traps the packet and creates a new flow-id in the flow table (e.g., table 200) and marks the flow-id's state as 'SYN'. The flow table is saved in the memory 313. The initial sequence from the client to a destination server number equals M and saved in the flow table as well. Then, the packet is sent to the node 112 for further processing.

[0038] At S304, a response packet arrives from a destination server (e.g., server 140, Fig. 1) with header value [TCP FLAG SYN=1, TCP FLAG ACK=1, SEQUENCE = N]. The response is received at the node's 112 port. At S305, as the header's value matches a probe instruction, the response packet is sent to the module 311 in the controller 111.

[0039] In response, the module 311 traps the packet and searches for a pre-allocated corresponding flow-id in the flow table and updates the respective state as 'SYN/ACK'. The module 311 also stores the initial sequence number of a packet from the server to client as equals to N. This will create a new bi-directional flow-id with M and N sequence numbers identified and the sequence mask logic can be calculated respective thereof.

[0040] According to various embodiments, the DPI flow detection module 311 implements or executes a sequence mask logic that computes a mask for the initial trapped sequence numbers (M and N) to be used for a new flow to be configured into the node 112. Specifically, the computed mask is used to define new mirroring instructions to allow mirroring of a number of bytes from the TCP session in both directions. The computed mask value specifies which bytes respective of the correct sequence number would be required to mirror from the TCP session. In an embodiment, the computed value is placed in a mask filed defined by the OpenFlow protocol.

[0041] The following steps are taken to extract the computed mask value: Compute a temporary mask value (temp_mask_val) as follows:

temp_mask_val = M XOR (M+ TCP_DATA_SIZE_DPI);

The value TCP_DATA_SIZE_DPI specifies the number of bytes the node 112 would be required to mirror from the TCP session. In an embodiment, a different value of the TCP_DATA_SIZE_DPI may be set for the upstream and downstream traffic. For example, for an upstream traffic fewer bytes may be mirrored than the downstream traffic, thus the TCP_DATA_SIZE_DPI value for upstream traffic would be smaller than a downstream traffic. The temp_mask_val returns a number where the most significant bit (MSB) set to one indicates the first bit of the mask. Then a sequence MSB is computed as follows:

seq_msb = (int32_t)msb32(temp_Mask_val);

The 'msb32' function returns the MSB place of temp_mask_val. Finally, the mask value is computed as follows:

mask = (int32_t)(0 - ((0x1 << seq_msb))).

[0042] As an example, if the sequence number M is M=0xf46d5c34, and TCP_DATA_SIZE_DPI = 16384, then:

temp_mask_val = 0xf46d5c34 XOR (0xf46d5c34 + 16384) = 0xc000
seq_msb = (int32_t)msb32(0xf46d9c34) = 16
mask = (int32_t)(0 - (0x1 << 16)) = 0xFFFF8000

[0043] The mask is defined such that a '0' in a given bit position indicates a "don't care" match for the same bit in the corresponding field, whereas a '1' means match the bit exactly. In above example, all data packets containing sequence number in the range of {0xf46d5c34 to 0xf46d9c34} be mirrored to the controller 111.

[0044] Using the computed mask value, the module 311 using a TCP flow analysis logic (not shown) creates the mirroring instructions related to the client and server traffic. One instruction identifies the client to server flow traffic, including the OXM_OF_ _TCP_SEQ to identify the initial sequence number of the flow with the mask_M computed. The action of the flow is to mirror all packets that the instruction applies, which will result in the TCP_DATA_SIZE_DPI number of bytes from the client to server direction to be mirrored to the controller 111. The second instruction identifies the server-to-client flow traffic, including the OXM_OF_TCP_SEQ to identify the initial sequence number of the flow with the mask_N. The action is to mirror all packets that the instruction applies to, which will result in the TCP_DATA_SIZE_DPI number of byte from the server to client direction to be mirrored to the controller 111 for further analysis. The mask_N and mask_M are computed using the sequence numbers N and M< respectively using the process discussed above. As a non-limiting example, the mirroring instructions includes:

Match							result	
Source IP address	destination IP address	source TCP port	destination TCP port	IP protocol number	TCP sequence	TCP sequence mask	action	Count byte
192.1.1.1	209.1.4.4	15431	21	6	0xf46d5c34	0xFFFF8000	Mirror	X
209.1.4.4	192.1.1.1	21	15431	6	0x3c98b9ab	0xFFFF8000	Mirror	Y

[0045] Referring back to Fig. 3, at S306, in the module 311 the processed packet is sent back to the node 112 for further processing. In an embodiment, a set of mirroring instructions generated respective of the computed mask value are sent to the node 112. At S307, a response TCP ACK packet with [TCP FLAG ACK=1] is received at a port of the node 112 and, based on the respective probe instruction, the packet is switched directly to the destination server 140.

[0046] In an embodiment, an audit mechanism scans the flow table every predefined time interval from the last timestamp and deletes all flows from the state is not SYN/ACK. Furthermore, an aging mechanism deletes all entries wherein their aging bit equal = 1. The aging bit is initialized to 0 upon flow creation of a flow-id entry and is set to 1 in the first audit pass if buffer length is 0. When a flow-id is deleted from the flow table, the flow-id also removed from the tables maintained by the probe sequence counter 324.

[0047] At S308 and S309, packets arrive from either the client device or a destination server with their sequence number that matches the mirroring instructions and are mirrored to the central controller 111 for buffering and for analysis by the DPI engine 312. It should be noted that each instruction hit increments a counter Client-to-Server hit counter X [bytes] and Server-to-Client hit counter Y [bytes]. The flow table audit mechanism scans the flow table, every predefined time interval, and updates the mask to 0x00000000 and the ACTION to “no Action” of all entries that their Client-to-Server buffer length = TCP_DATA_SIZE_DPI or Server-to-Client buffer length = TCP_DATA_SIZE_DPI. The various fields of the flow table are shown in Fig. 2.

[0048] Fig. 4 show an exemplary and non-limiting diagram of a system 400 for describing the process of flow termination as performed by the central controller 111 and a network node 112 according to one embodiment. The various module of the controller 111 and node 112 are discussed with reference to Fig. 3.

[0049] In the flow termination process, the module 311 follows a termination of a TCP flow and is responsible to remove the exiting flow from the flow table. In addition, the module 311 disables or removes the mirroring instructions from the node 112. According to one embodiment, the module 311 configures the node 112 with a set of termination instructions. Examples for such instructions are provided above.

[0050] At S401, a packet arrives, at the node 112, from a client 130 with a header including the value of [TCP FLAG FIN=1]. The value matches one of the termination instructions, thus, at S402, to the packet is sent to the center controller 111.

[0051] In response, at S403, the module 311 traps the packet and marks the corresponding flow-id in the flow table to update the state to FIN. Then, the packet is sent back it to the network log.

[0052] At S404, a response packet from the destination server (e.g., server 140) with a header’s value containing [TCP FLAG FIN=1, ACK=1] is received at the node 112. As the value matches one of the termination instructions, at S405, to the packet is sent to the center controller 111.

[0053] At S406, the module 311 traps the received packet and marks the corresponding FLOW-ID in its flow table DB as state=FIN/FIN/ACK. Then, the packet is sent back to the network node 112. At S407, a response TCP ACK packet arrives from a

client 130 with a header's value containing [TCP FLAG ACK=1] and is switched directly to the server 140. If the response packet includes the header's value of [TCP FLAG RST=1], the module 311 marks the state of respective flow id in the flow table.

[0054] In an embodiment, the audit mechanism implemented by the module 311 scans the flow table every predefined time interval to all flows that their respective state is any one of FIN, FIN/ACK, FIN/FIN/ACK, or RST. The flows are removed from the probe flow module 321 and the flow table.

[0055] According to one embodiment, each network node 112 is populated with one or more probe tables generated by the central controller 111. Fig. 5 shows a non-limiting and exemplary data structure 500 depicting the organization of the flows to allow functionality of both the probe flow detection module 321 and probe sequence counter 324.

[0056] The data structure 500 which may be in a form of a table is updated with a general instruction to match all traffic type with instruction 501 to go to a probe table 510. The instruction 501 is set to the highest priority, unless the controller 111 requires pre-processing of other instructions. All packets matching the instruction 500 are processed in the probe table 510.

[0057] In an embodiment, the probe table 510 is populated with a medium priority probe and termination instructions 511 to detect all SYN, SYN/ACK, FIN, FIN/ACK that are the TCP connection initiation packets. The instructions 511 allows the module 311 to update the flow table and as a consequence create new instructions for mirroring N bytes from each TCP connection setup.

[0058] The probe table 510 table is also populated with highest priority instructions 512, these are two bi-direction instructions per flow-id that match a number 'r' tupple flow headers including the TCP sequence number as calculated by the sequence mask logic. The instructions 512 are to send the packet to the central controller 111 and also to perform go to table ID <next table ID>. The instructions 512 will cause sending the packet to continue switching processing. Each of these bi-directional instructions 512 will cause the node to copy several bytes from the TCP stream to the TCP flow analysis logic to be stored for further DPI engine metadata analysis.

[0059] The final instruction 513 placed in the probe table 510 is in the lowest priority to catch all and proceed with the switch functionality. All traffic which does not correspond to the TCP initiation packets, nor a specific detected flow and the corresponding TCP sequence number shall continue regular processing.

[0060] Fig. 6 shows an exemplary and non-limiting flowchart 600 illustrating the operation of the central controller 111 according to one embodiment. At S610, all network nodes 112 are configured with a set of probe instructions utilized to instruct each node 112 to redirect a TCP packet having at least a flag value as designated in each probe instruction. Examples for probe instructions are provided above.

[0061] At S620, a first TCP packet with at least one TCP FLAG SYN value equal to 1 is received. This packet may have a sequence number M and may be sent from a client device 130. At S630, a second TCP packet with at least one TCP FLAG ACK value equal to 1 is received. This packet may have a sequence number N and may be sent from a destination server 140 in response to the first TCP packet. In an embodiment, the flow table is updated with the respective flow ID and the state of the first and second packets.

[0062] At S640, using at least the sequence numbers of the first and second packets a mask value is computed. The mask value is utilized to determine which bytes from the flow respective of the sequence numbers N and M should be mirrored by the nodes. An embodiment for computing the mask value is provided above.

[0063] At S650, a set of mirroring instructions are generated using the mirror value and sent to the network nodes. Each such instruction defines the packets (designed at least by a specific source/destination IP addresses, and TCP sequences), the number of bytes, and the bytes that should be mirrored. At S660, the received mirror bytes are inspected using a DPI engine in the controller 111. In addition, the flow table is updated with the number of the received mirror bytes.

[0064] In S670, it is checked if the inspection session should be terminated. The decision is based on the FIN and/or RST values of the TCP FLAG. As noted above, packets with TCP FLAG FIN=1 or TCP FLAG RST=1 are directed to the controller respective of the set of termination instructions. Some examples for the termination instructions are provided above. If S670, results with No answer execution returns to S660; otherwise, execution continues with S680. At S680, related exiting flows from the

flow table are removed. In addition, the nodes 112 are instructed not to perform the mirroring instructions provided at S650.

[0065] The various embodiments disclosed herein can be implemented as hardware, firmware, software, or any combination thereof. Moreover, the software is preferably implemented as an application program tangibly embodied on a program storage unit or computer readable medium consisting of parts, or of certain devices and/or a combination of devices. The application program may be uploaded to, and executed by, a machine comprising any suitable architecture. Preferably, the machine is implemented on a computer platform having hardware such as one or more central processing units ("CPUs"), a memory, and input/output interfaces. The computer platform may also include an operating system and microinstruction code. The various processes and functions described herein may be either part of the microinstruction code or part of the application program, or any combination thereof, which may be executed by a CPU, whether or not such a computer or processor is explicitly shown. In addition, various other peripheral units may be connected to the computer platform such as an additional data storage unit and a printing unit. Furthermore, a non-transitory computer readable medium is any computer readable medium except for a transitory propagating signal.

[0066] All examples and conditional language recited herein are intended for pedagogical purposes to aid the reader in understanding the principles of the disclosed embodiments and the concepts contributed by the inventor to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions. Moreover, all statements herein reciting principles, aspects, and embodiments of the invention, as well as specific examples thereof, are intended to encompass both structural and functional equivalents thereof. Additionally, it is intended that such equivalents include both currently known equivalents as well as equivalents developed in the future, i.e., any nodes developed that perform the same function, regardless of structure.

CLAIMS

What is claimed is:

1. A method for deep packet inspection (DPI) in a software defined network (SDN), wherein the method is performed by a central controller of the SDN, comprising:

configuring a plurality of network nodes operable in the SDN with at least one probe instruction;

receiving from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first sequence number;

receiving from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second sequence number, wherein the second packet is a response of the first packet;

computing a mask value respective of at least the first and second sequence numbers, wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected;

generating at least one mirror instruction based on at least the mask value; and

configuring the plurality of network nodes with at least one mirror instruction.

2. The method of claim 1, further comprising:

receiving mirrored bytes from a network node respective of the at least one mirror instruction; and

inspecting the mirrored bytes using a DPI engine.

3. The method of claim 1, further comprising:

maintaining a flow table listing each flow inspected by the central controller; and

updating a status field in the flow table upon reception of any one of: the first packet, the second packet, and the mirrored bytes.

4. The method of claim 3, further comprising:

configuring the plurality of network nodes with at least one termination instruction;

removing all entries from the flow table for each flow matching the at least one termination instruction; and

disabling the at least one mirror instruction for each flow matching the at least one termination instruction.

5. The method of claim 1, wherein the at least one probe instruction is any one of:

if (TCP FLAG SYN=1) then (re-direct packet to the central controller) and if (TCP FLAG SYN=1 and ACK=1) then (re-direct packet to central controller).

6. The method of claim 1, wherein the least one mirror action is at least: if (source IP Address = V1 and destination IP Address = V2 and source TCP port = V3 and destination IP address = V4 and TCP sequence = V5 and TCP sequence mask = V6) then (mirror V7 bytes).

7. The method of claim 4, wherein the at least one termination instruction is any one of: if (TCP FLAG FIN=1) then (re-direct packet to controller); if (TCP FLAG FIN=1 and ACK=1) then (re-direct packet to controller); and if (TCP FLAG RST=1) then (re-direct packet to controller).

8. The method of claim 1, wherein a number of bytes mirrored from each packet is a portion of the packet, wherein the bytes are mirrored from packets in sequence.

9. The method of claim 1, wherein the communication between central controller and the plurality of network nodes is performed using the OpenFlow standard.

10. A non-transitory computer readable medium having stored thereon instructions for causing one or more processing units to execute the computerized method according to claim 1.

11. A system for deep packet inspection (DPI) in a software defined network (SDN), wherein the method is performed by a central controller of the SDN, comprising:

a processor;

a memory connected to the processor and configured to contain a plurality of instructions that when executed by the processor configure the system to:

set a plurality of network nodes operable in the SDN with at least one probe instruction;

receive from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first sequence number;

receive from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second sequence number, wherein the second packet is a response of the first packet;

compute a mask value respective of at least the first and second sequence numbers, wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected;

generate at least one mirror instruction based on at least the mask value; and

configure the plurality of network nodes with at least one mirror instruction.

12. The system of claim 11, wherein the system is further configured to:

receive mirrored bytes from a network node respective of the at least one mirror instruction; and

inspect the mirrored bytes using a DPI engine.

13. The system of claim 11, wherein the system is further configured to:

maintain a flow table listing each flow inspected by the central controller; and

update a status field in the flow table upon reception of any one of: the first packet, the second packet, and the mirrored bytes.

14. The system of claim 13, wherein the system is further configured to:

configure the plurality of network nodes with at least one termination instruction;

remove all entries from the flow table for each flow matching the at least one termination instruction; and

disable the at least one mirror instruction for each flow matching the at least one termination instruction.

15. The system of claim 11, wherein the at least one probe instruction is any one of:

if (TCP FLAG SYN=1) then (re-direct packet to the central controller) and if (TCP FLAG SYN=1 and ACK=1) then (re-direct packet to central controller).

16. The system of claim 11, wherein the least one mirror action is at least: if (source IP Address = V1 and destination IP Address = V2 and source TCP port = V3 and destination IP address = V4 and TCP sequence = V5 and TCP sequence mask = V6) then (mirror V7 bytes).

17. The system of claim 14, wherein the at least one termination instruction is any one of: if (TCP FLAG FIN=1) then (re-direct packet to controller); if (TCP FLAG FIN=1 and ACK=1) then (re-direct packet to controller); and if (TCP FLAG RST=1) then (re-direct packet to controller).

18. The system of claim 11, wherein a number of bytes mirrored from each packet is a portion of the packet, wherein the bytes are mirrored from packets in sequence.

19. The system of claim 11, wherein the communication between central controller and the plurality of network node is performed using the OpenFlow standard

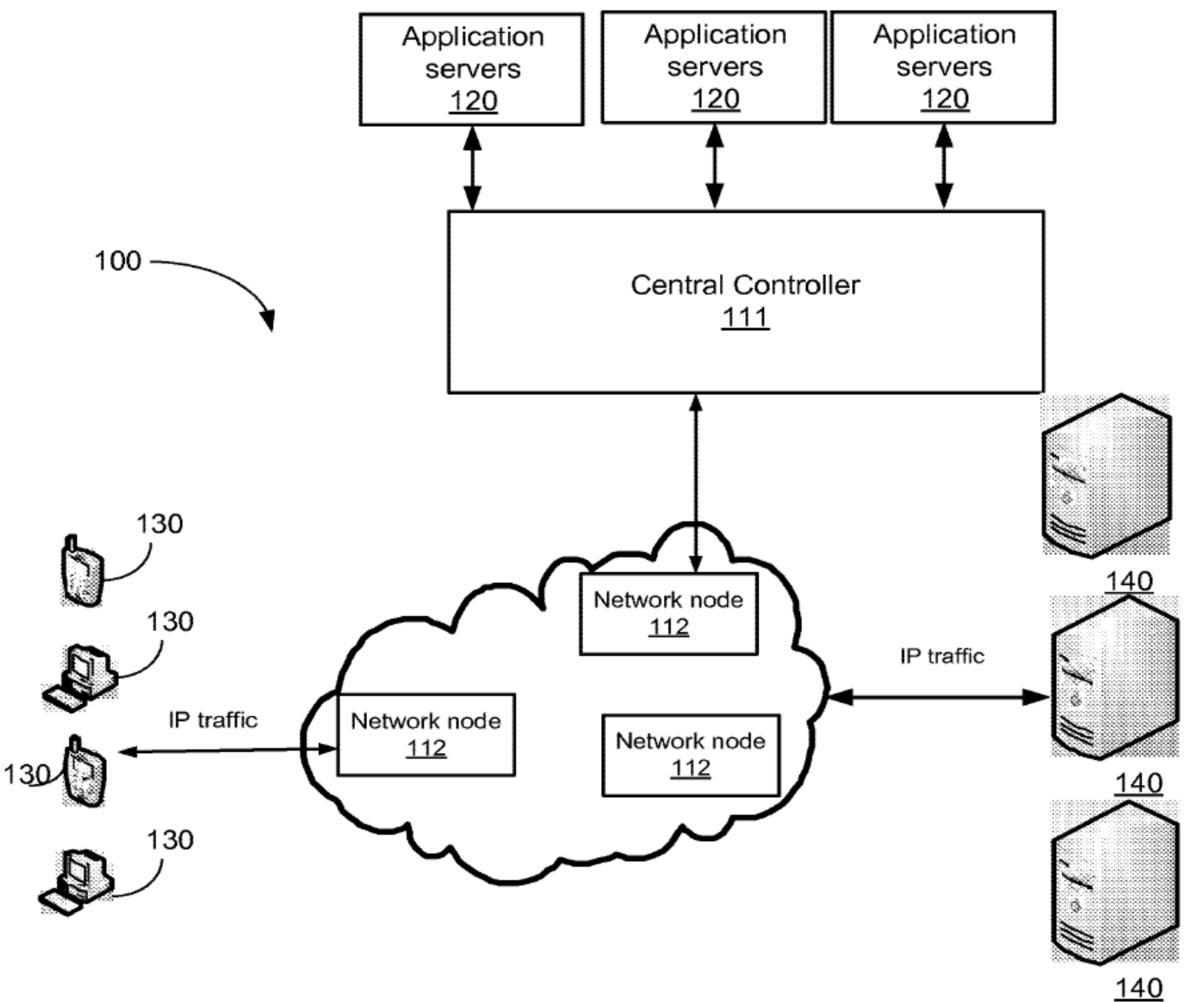
Application servers 120
Application servers 120
Application servers 120
100
Central Controller 111
130
130
130
130
Network node 112
Network node 112
Network node 112
IP traffic
IP traffic
140
140
140

FIG. 1

200

KEY **210**					DATA **220**										
Client IP address	Server IP address	Client source TCP port	Server destination TCP port	IP protocol number	Flow ID	Client→ Server sequence number M	Server→ Client sequence number N	state	Creation timestamp	Client→ Server Hit counter X [bytes]	Server → Client Hit counter Y [bytes]	Client→ Server data buffer	Server→ Client buffer	Age bit
192.1.1.1	209.1.4.4	15431	21	6	1	0xf46d5c34	0x3c98b9ab	ACK	15:32:13					

FIG. 2

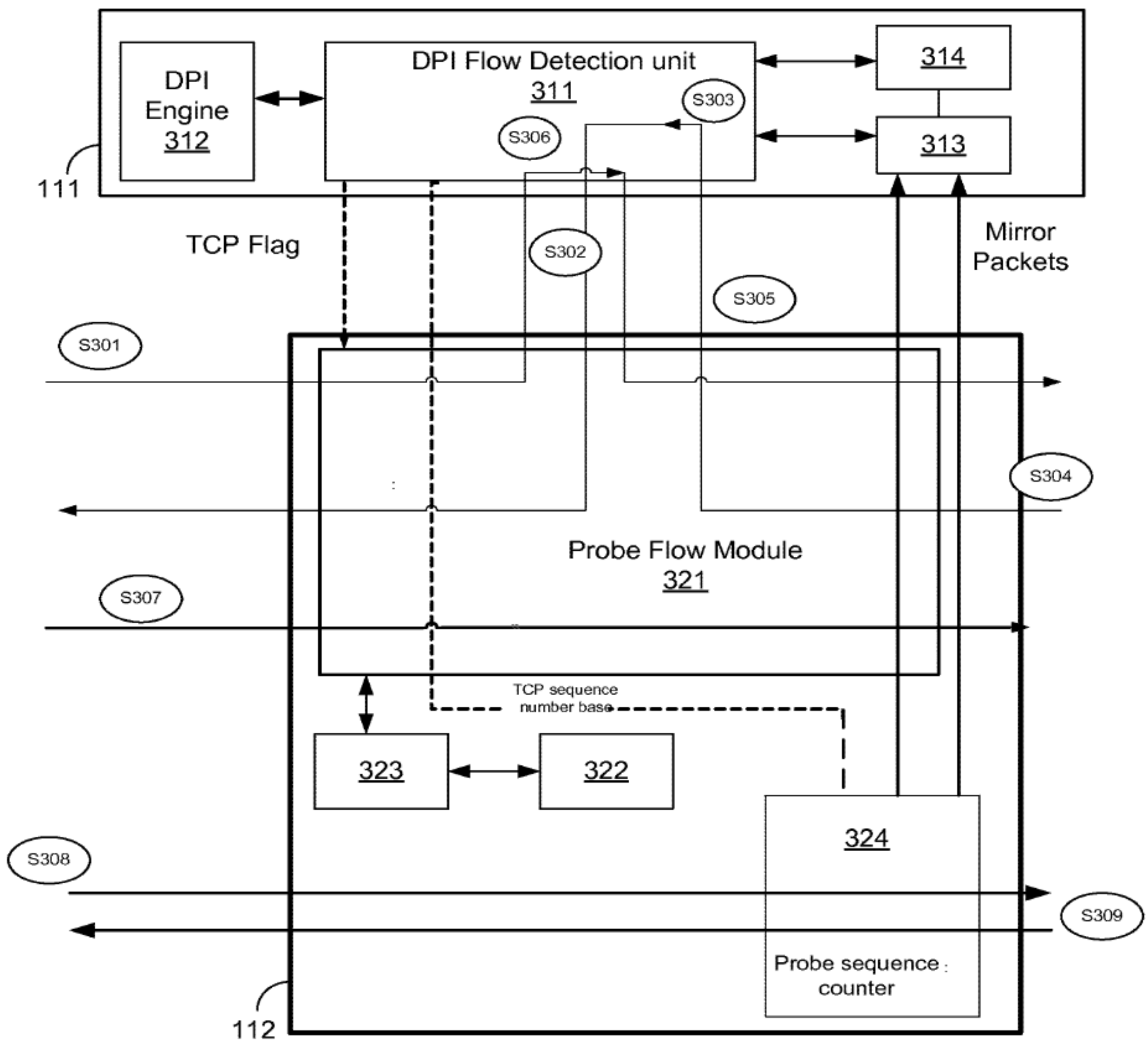
DPI Engine 312
DPI Flow Detection unit 311
314
313
S303
S306
111
TCP Flag
S302
Mirror Packets
S305
S301
S304
Probe Flow Module 321
S307
TCP sequence number base
323
322
324
S308
S309
Probe sequence counter
112

FIG. 3

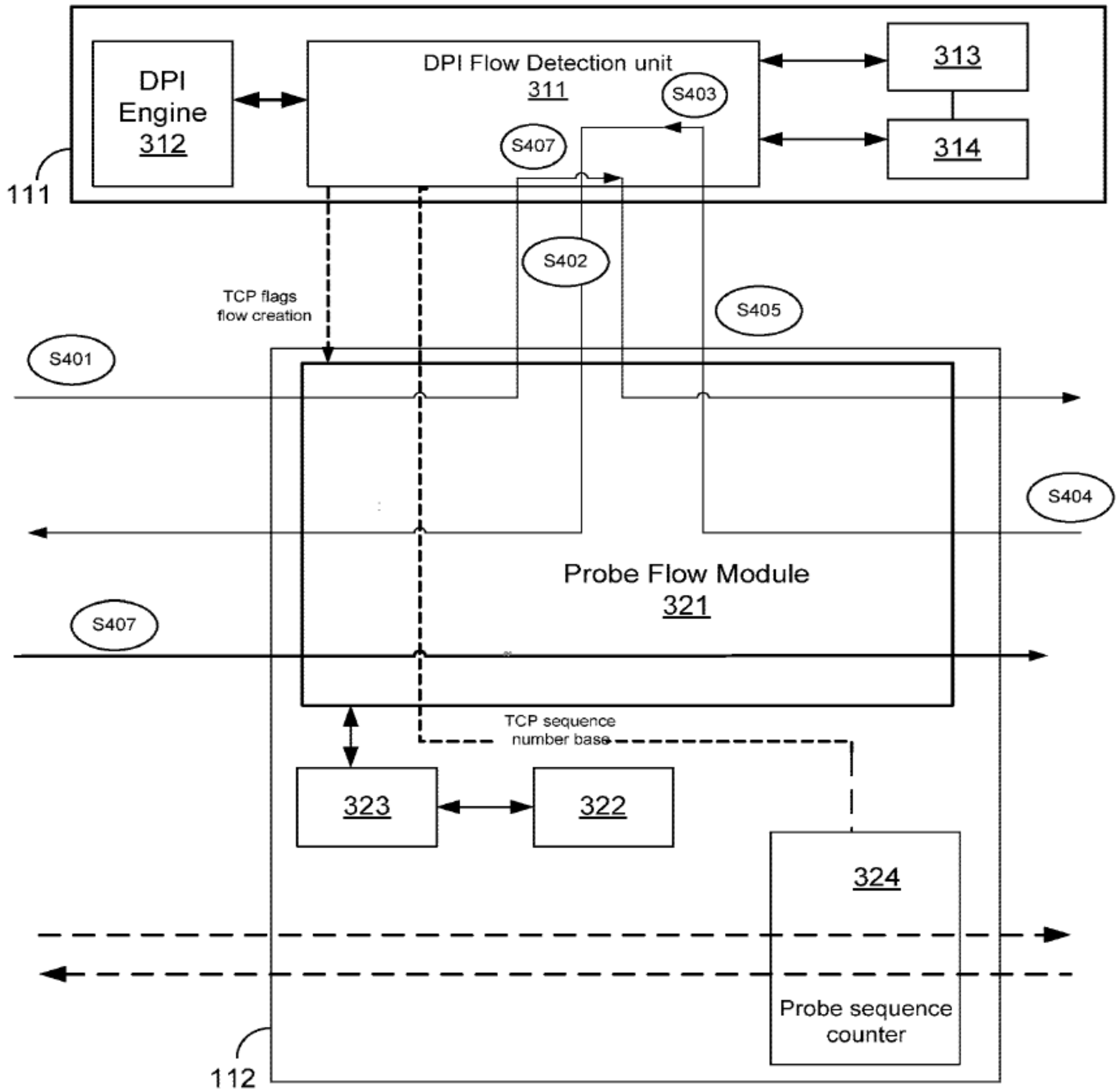
DPI Engine 312
DPI Flow Detection unit 311
313
314
S403
S407
111
S402
S405
TCP flags flow creation
S401
S404
Probe Flow Module 321
S407
TCP sequence number base
323
322
324
Probe sequence counter
112

FIG. 4

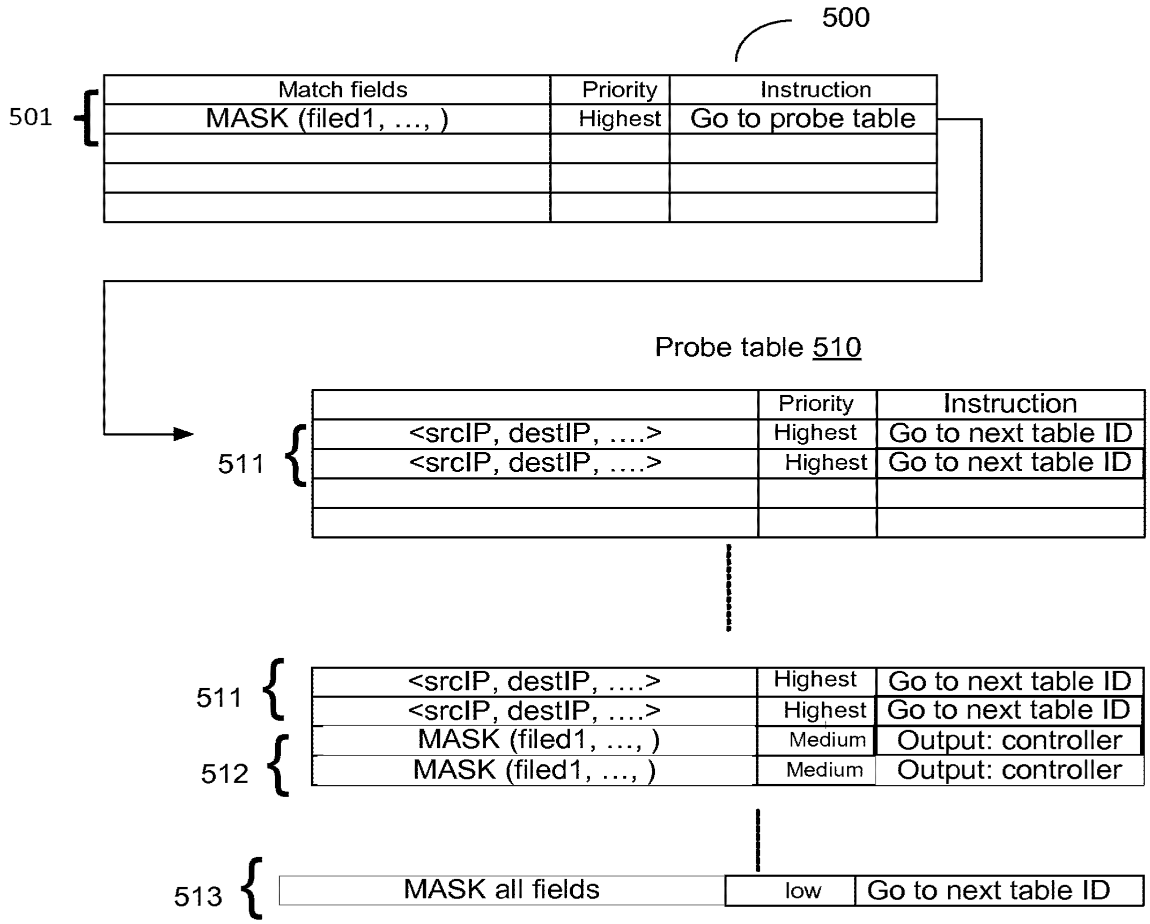
500
501
Match fields
Priority
Instruction
MASK (filed1, …,)
Highest
Go to probe table
Probe table 510
511
Priority
Instruction
<srcIP, destIP, ….>
Highest
Go to next table ID
<srcIP, destIP, ….>
Highest
Go to next table ID
511
<srcIP, destIP, ….>
Highest
Go to next table ID
<srcIP, destIP, ….>
Highest
Go to next table ID
512
MASK (filed1, …,)
Medium
Output: controller
MASK (filed1, …,)
Medium
Output: controller
513
MASK all fields
low
Go to next table ID

FIG. 5

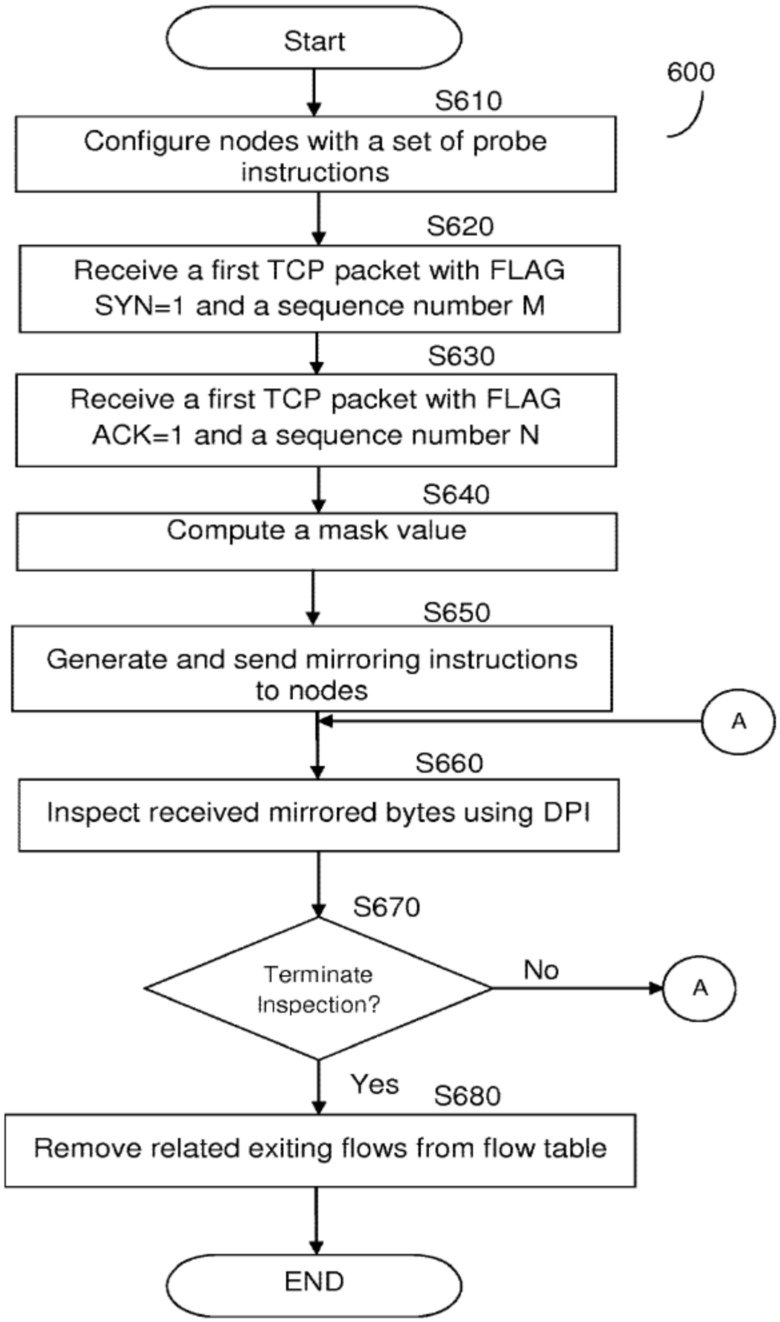
Start
600
S610
Configure nodes with a set of probe instructions
S620
Receive a first TCP packet with FLAG SYN=1 and a sequence number M
S630
Receive a first TCP packet with FLAG ACK=1 and a sequence number N
S640
Compute a mask value
S650
Generate and send mirroring instructions to nodes
A
S660
Inspect received mirrored bytes using DPI
S670
Terminate Inspection?
No
A
Yes
S680
Remove related exiting flows from flow table
END

FIG. 6

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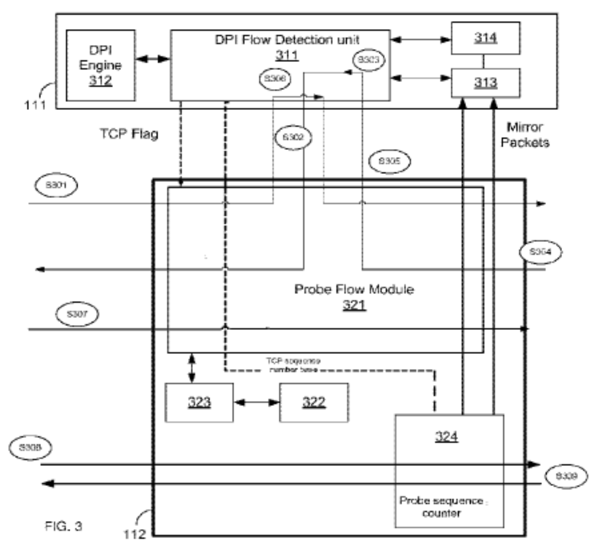

FIG. 3

(57) Abstract: A method for deep packet inspection (DPI) in a software defined network (SDN). The method includes configuring a plurality of network nodes operable in the SDN with at least one probe instruction; receiving from a network node a first packet of a flow, the first packet matches the at least one probe instruction and includes a first sequence number; receiving from a network node a second packet of the flow, the second packet matches the at least one probe instruction and includes a second sequence number, the second packet is a response of the first packet; computing a mask value respective of at least the first and second sequence numbers indicating which bytes to be mirrored from subsequent packets belonging to the same flow; generating at least one mirror instruction based on at least the mask value; and configuring the plurality of network nodes with at least one mirror instruction.

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A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS

CROSS REFERENCE TO RELATED APPLICATIONS

[001] This application claims the benefit of US provisional application No. 61/982,358 filed on April 22, 2014, the contents of which are herein incorporated by reference.

TECHNICAL FIELD

[002] This disclosure generally relates to techniques for deep packet inspection (DPI), and particularly for DPI of traffic in cloud-based networks utilizing software defined networks.

BACKGROUND

[003] Deep packet inspection (DPI) technology is a form of network packet scanning technique that allows specific data patterns to be extracted from a data communication channel. Extracted data patterns can then be used by various applications, such as security and data analytics applications. DPI currently performs across various networks, such as internal networks, Internet service providers (ISPs), and public networks provided to customers. Typically, the DPI is performed by dedicated engines installed in such networks.

[004] A software defined networking is a relatively new type of networking architecture that provides centralized management of network nodes rather than a distributed architecture utilized by conventional networks. The SDN is prompted by an ONF (open network foundation). The leading communication standard that currently defines communication between the central controller (e.g., a SDN controller) and the network nodes (e.g., vSwitches) is the OpenFlow™ standard.

[005] Specifically, in SDN-based architectures the data forwarding (e.g. data plane) is typically decoupled from control decisions (e.g. control plane), such as routing, resources, and other management functionalities. The decoupling may also allow the data plane and the control plane to operate on different hardware, in different runtime environments, and/or operate using different models. As such, in an SDN network, the

network intelligence is logically centralized in the central controller which configures, using OpenFlow protocol, network nodes and to control application data traffic flows.

[006] Although, the OpenFlow protocol allows addition of programmability to network nodes for the purpose of packets-processing operations under the control of the central controller, the OpenFlow does not support any mechanism to allow DPI of packets through the various networking layers as defined by the OSI model. Specifically, the current OpenFlow specification defines a mechanism to parse and extract only packet headers, in layer-2 through layer-4, from packets flowing via the network nodes. The OpenFlow specification does not define or suggest any mechanism to extract non-generic, uncommon, and/or arbitrary data patterns contained in layer-4 to layer 7 fields. In addition, the OpenFlow specification does not define or suggest any mechanism to inspect or to extract content from packets belonging to a specific flow or session. This is a major limitation as it would not require inspection of the packet for the purpose of identification of, for example, security threats detection.

[007] The straightforward approach of routing all traffic from network nodes to the central controller introduces some significant drawbacks, such as increased end-to-end traffic delays between the client and the server; overflowing the controller capability to perform other networking functions; and a single point of failure for the re-routed traffic.

[008] Therefore, it would be advantageous to provide a solution that overcomes the deficiencies noted above and allow efficient DPI in SDNs.

SUMMARY

[009] A summary of several example embodiments of the disclosure follows. This summary is provided for the convenience of the reader to provide a basic understanding of such embodiments and does not wholly define the breadth of the disclosure. This summary is not an extensive overview of all contemplated embodiments, and is intended to neither identify key or critical nodes of all aspects nor delineate the scope of any or all embodiments. Its sole purpose is to present some concepts of one or more embodiments in a simplified form as a prelude to the more detailed description that is presented later. For convenience, the term some embodiments may be used herein to refer to a single embodiment or multiple embodiments of the disclosure.

[0010] Certain embodiments disclosed herein include a method for deep packet inspection (DPI) in a software defined network (SDN), wherein the method is performed by a central controller of the SDN. The method comprises: configuring a plurality of network nodes operable in the SDN with at least one probe instruction; receiving from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first sequence number; receiving from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second sequence number, wherein the second packet is a response of the first packet; computing a mask value respective of at least the first and second sequence numbers, wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected; generating at least one mirror instruction based on at least the mask value; and configuring the plurality of network nodes with at least one mirror instruction.

[0011] Certain embodiments disclosed herein include a system for deep packet inspection (DPI) in a software defined network (SDN), wherein the method is performed by a central controller of the SDN. The system comprises: a processor; a memory connected to the processor and configured to contain a plurality of instructions that when executed by the processor configure the system to: set a plurality of network nodes operable in the SDN with at least one probe instruction; receive from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first sequence number; receive from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second sequence number, wherein the second packet is a response of the first packet; compute a mask value respective of at least the first and second sequence numbers, wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected; generate at least one mirror instruction based on at least the mask value; and configure the plurality of network nodes with at least one mirror instruction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The subject matter disclosed herein is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other objects, features, and advantages of the invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings.

[0013] Figure 1 is a schematic diagram of a network system utilized to describe the various disclosed embodiments.

[0014] Figure 2 illustrates is a schematic diagram of a flow table stored in a central controller.

[0015] Figure 3 is a schematic diagram of a system utilized for describing the process of flow detection as performed by a central controller and a network node according to one embodiment.

[0016] Figure 4 is a schematic diagram of a system utilized for describing the process of flow termination as performed by a central controller and a network node according to one embodiment.

[0017] Figure 5 is a data structure depicting the organization of flows according to one embodiment.

[0018] Figure 6 is flowchart illustrating the operation of the central controller according to one embodiment.

DETAILED DESCRIPTION

[0019] It is important to note that the embodiments disclosed herein are only examples of the many advantageous uses of the innovative teachings herein. In general, statements made in the specification of the present application do not necessarily limit any of the various claimed embodiments. Moreover, some statements may apply to some inventive features but not to others. In general, unless otherwise indicated, singular nodes may be in plural and vice versa with no loss of generality. In the drawings, like numerals refer to like parts through several views.

[0020] Fig. 1 is an exemplary and non-limiting diagram of a network system 100 utilized to describe the various disclosed embodiments. The network system 100 includes a software defined network (SDN) 110 (not shown) containing a central controller 111 and a plurality of network nodes 112. The network nodes 112 communicate with the central

controller 111 using, for example, an OpenFlow protocol. The central controller 111 can configure the network nodes 112 to perform certain data path operations. The SDN 110 can be implemented in wide area networks (WANs), local area networks (LANs), the Internet, metropolitan area networks (MANs), ISP backbones, datacenters, inter-datacenter networks, and the like. Each network node 112 in the SDN may be a router, a switch, a bridge, and so on.

[0021] The central controller 111 provides inspected data (such as application metadata) to a plurality of application servers (collectively referred to as application servers 120, merely for simplicity purposes). An application server 120 executes, for example, security applications (e.g., Firewall, intrusion detection, etc.), data analytic applications, and so on.

[0022] In the exemplary network system 100, a plurality of client devices (collectively referred to as client devices 130, merely for simplicity purposes) communicate with a plurality of destination servers (collectively referred to as destination servers 140, merely for simplicity purposes) connected over the network 110. A client device 130 may be, for example, a smart phone, a tablet computer, a personal computer, a laptop computer, a wearable computing device, and the like. The destination servers 140 are accessed by the devices 130 and may be, for example, web servers.

[0023] According to some embodiments, the central controller 111 is configured to perform deep packet inspection on designated packets from designated flows or TCP sessions. To this end, the central controller 111 is further configured to instruct each of the network nodes 112 which of the packets and/or sessions should be directed to the controller 111 for packet inspections.

[0024] According to some embodiments, each network node 112 is configured to determine if an incoming packet requires inspection or not. The determination is performed based on a set of instructions provided by the controller 111. A packet that requires inspection is either redirected to the controller 111 or mirrored and a copy thereof is sent to the controller 111. It should be noted that traffic flows that are inspected are not affected by the operation of the network node 112. In an embodiment, each network node 112 is configured to extract and send only a portion of a packet data that contains meaningful information.

[0025] The set of instructions that the controller 111 configures each of the network nodes 112 with include “probe instructions”, “mirroring instructions”, and “termination instructions.” According to some exemplary and non-limiting embodiments, the probe instructions include:

If (TCP FLAG SYN=1) then (re-direct packet to central controller);
If (TCP FLAG SYN=1 and ACK=1) then (re-direct packet to central controller); and
If (TCP FLAG ACK=1) then (forward packet directly to a destination server).

The termination instructions include:

If (TCP FLAG FIN=1) then (re-direct packet to controller);
If (TCP FLAG FIN=1 and ACK=1) then (re-direct packet to controller); and
If (TCP FLAG RST=1) then (re-direct packet to controller).

[0026] The TCP FLAG SYN, TCP FLAG ACK, TCP FLAG FIN, TCP FLAG RST are fields in a TCP packet’s header that can be analyzed by the network nodes 112. That is, each node 112 is configured to receive an incoming packet (either a request from a client device 130 or response for a server 140), analyze the packet’s header, and perform the action (redirect the packet to controller 111 or send to destination server 140) respective of the value of the TCP flag.

[0027] The controller 111 also configures each of the network nodes 112 with mirroring instructions with a mirror action of X number of bytes within a packet. The mirrored bytes are sent to the controller 111 to perform the DPI analysis. According to some exemplary embodiments, the set of mirroring instructions have the following format:

If (source IP Address = V1 and destination IP Address = V2 and source TCP port = V3 and destination IP address = V4 and TCP sequence = V5 and TCP sequence mask = V6) then (mirror V7 bytes)

[0028] The values V1 through V7 are determined by the controller 111 per network node or for all nodes 112. The values of the TCP sequence, and TCP sequence mask are computed, by the controller 111, as discussed in detail below.

[0029] In another embodiment, in order to allow analysis of TCP packets' headers by a network node 112 and tracks flows, new type-length-value (TLV) structures are provided. The TLV structures may be applied to be utilized by an OpenFlow protocol standard as defined, for example, in the OpenFlow 1.3.3 specification published by the Open Flow Foundation on September 27, 2013 or OpenFlow 1.4.0 specification published on October 14, 2013, for parsing and identifying any arbitrary fields within a packet. According to non-limiting and exemplary embodiments, the TLV structures disclosed herein include:

1. TCP_FLG_OXM_HEADER (0x80FE, 2, 1). This TVL structure allows identification of the TCP header flags. The '0x80FE' value represents a unique vendor identification (ID), the value '2' represents a unique Type=2 value for the TLV, and the '1' value is 1-byte total length that stores the TCP flags header.
2. TCP_SEQ_OXM_HEADER (0x80FE, 1, 4) - This TLV structure allows identification of the TCP sequence number field. The '0x80FE' value represents a unique vendor ID, the value '1' represents a unique Type=1 value for this TLV, and the value '4' is a 4-byte total length that stores the TCP sequence number.

[0030] In order to track the flows, the central controller 111 also maintains a flow table having a structure 200 as illustrated in the exemplary and non-limiting Fig. 2. The flow table 200 contains two main fields KEY 210 and DATA 220. The KEY field 210 holds information with respect to the addresses/port numbers of a client device 130 and a destination server 140. The DATA field 220 contains information with respect to a TCP flow, such as a flow ID, a request (client to server) sequence number M, a response (server to client) sequence number N, a flow state (e.g., ACK, FIN), a creation timestamp, a client to server hit counter, server to client hit counter Y [bytes], client to server data buffer, server to client buffer, and an aging bit.

[0031] Fig. 3 shows an exemplary and non-limiting schematic diagram of a system 300 for describing the process of flow detection as performed by the central controller 111 and a network node 112 according to one embodiment. In an exemplary implementation, the central controller 111 includes a DPI flow detection module 311, a DPI engine 312, and a memory 313, and a processing unit 314. The DPI engine 312 in configured to inspect a packet or a number of bytes to provide application metadata as required by an application executed by an application server 120.

[0032] According to various embodiments discussed in detail above, the DPI flow detection module 311 is configured to detect all TCP flows and maintain them in the flow table (e.g., table 200). The module 311 is also configured to generate and provide the network logs with the required instructions to monitor, redirect, and mirror packets. The DPI flow detection module 311 executes certain functions including, but not limited to, flow management, computing sequence masks, and TCP flow analysis. These functions are discussed in detail below.

[0033] In exemplary implementation, the network node 112 includes a probe flow module 321, a memory 322, and a processing unit 323. The probe flow module 321 is configured to redirect any new TCP connection state initiation packets to the DPI flow detection module 311, as well as to extract several packets from each detected TCP flow and mirror them to the flow detection module 311. In an embodiment, probe flow module 321 executes functions and/or implements logic to intercept TCP flags, redirect packets, and count sequence numbers.

[0034] Both processing units 314 and 323 uses instructions stored in the memories 313 and 322 respectively to execute tasks generally performed by the central controllers of SDN as well as to control and enable the operation of behavioral network intelligence processes disclosed herewith. In an embodiment, the processing unit (314, 323) may include one or more processors. The one or more processors may be implemented with any combination of general-purpose microprocessors, multi-core processors, microcontrollers, digital signal processors (DSPs), field programmable gate array (FPGAs), programmable logic devices (PLDs), controllers, state machines, gated logic, discrete hardware components, dedicated hardware finite state machines, or any other suitable entities that can perform calculations or other manipulations of information. The

memories 313 and 322 may be implemented using any form of a non-transitory computer readable medium.

[0035] Prior to performing the flow detection process the network node 112 is set with the probe instructions, such as those discussed above. Referring to Fig. 3, at S301, a packet arrives from a client (e.g., client 130, Fig. 1) at a port (not shown) at the network node 112. The packet is a TCP packet with a header including the following value [TCP FLAG SYN=1, SEQUENCE = M].

[0036] As the header' value matches a redirect action, at S302, the probe flow module 321 redirects the packet to the controller 111, and in particular to the module 311.

[0037] In response, at S303, the module 311 traps the packet and creates a new flow-id in the flow table (e.g., table 200) and marks the flow-id's state as 'SYN'. The flow table is saved in the memory 313. The initial sequence from the client to a destination server number equals M and saved in the flow table as well. Then, the packet is sent to the node 112 for further processing.

[0038] At S304, a response packet arrives from a destination server (e.g., server 140, Fig. 1) with header value [TCP FLAG SYN=1, TCP FLAG ACK=1, SEQUENCE = N]. The response is received at the node's 112 port. At S305, as the header's value matches a probe instruction, the response packet is sent to the module 311 in the controller 111.

[0039] In response, the module 311 traps the packet and searches for a pre-allocated corresponding flow-id in the flow table and updates the respective state as 'SYN/ACK'. The module 311 also stores the initial sequence number of a packet from the server to client as equals to N. This will create a new bi-directional flow-id with M and N sequence numbers identified and the sequence mask logic can be calculated respective thereof.

[0040] According to various embodiments, the DPI flow detection module 311 implements or executes a sequence mask logic that computes a mask for the initial trapped sequence numbers (M and N) to be used for a new flow to be configured into the node 112. Specifically, the computed mask is used to define new mirroring instructions to allow mirroring of a number of bytes from the TCP session in both directions. The computed mask value specifies which bytes respective of the correct sequence number would be required to mirror from the TCP session. In an embodiment, the computed value is placed in a mask filed defined by the OpenFlow protocol.

[0041] The following steps are taken to extract the computed mask value:
Compute a temporary mask value (temp_mask_val) as follows:

temp_mask_val = M XOR (M+ TCP_DATA_SIZE_DPI);

The value TCP_DATA_SIZE_DPI specifies the number of bytes the node 112 would be required to mirror from the TCP session. In an embodiment, a different value of the TCP_DATA_SIZE_DPI may be set for the upstream and downstream traffic. For example, for an upstream traffic fewer bytes may be mirrored than the downstream traffic, thus the TCP_DATA_SIZE_DPI value for upstream traffic would be smaller than a downstream traffic. The temp_mask_val returns a number where the most significant bit (MSB) set to one indicates the first bit of the mask. Then a sequence MSB is computed as follows:

seq_msb = (int32_t)msb32(temp_Mask_val);

The ‘msb32’ function returns the MSB place of temp_mask_val. Finally, the mask value is computed as follows:

mask = (int32_t)(0 - ((0x1 << seq_msb))).

[0042] As an example, if the sequence number M is M=0xf46d5c34, and TCP_DATA_SIZE_DPI = 16384, then:

temp_mask_val = 0xf46d5c34 XOR (0xf46d5c34 + 16384) = 0xc000
seq_msb = (int32_t)msb32(0xf46d9c34) = 16
mask = (int32_t)(0 - (0x1 << 16)) = 0xFFFF8000

[0043] The mask is defined such that a ‘0’ in a given bit position indicates a “don't care” match for the same bit in the corresponding field, whereas a ‘1’ means match the bit exactly. In above example, all data packets containing sequence number in the range of {0xf46d5c34 to 0xf46d9c34} be mirrored to the controller 111.

[0044] Using the computed mask value, the module 311 using a TCP flow analysis logic (not shown) creates the mirroring instructions related to the client and server traffic. One instruction identifies the client to server flow traffic, including the OXM_OF_ _TCP_SEQ to identify the initial sequence number of the flow with the mask_M computed. The action of the flow is to mirror all packets that the instruction applies, which will result in the TCP_DATA_SIZE_DPI number of bytes from the client to server direction to be mirrored to the controller 111. The second instruction identifies the server-to-client flow traffic, including the OXM_OF_TCP_SEQ to identify the initial sequence number of the flow with the mask_N. The action is to mirror all packets that the instruction applies to, which will result in the TCP_DATA_SIZE_DPI number of byte from the server to client direction to be mirrored to the controller 111 for further analysis. The mask_N and mask_M are computed using the sequence numbers N and M< respectively using the process discussed above. As a non-limiting example, the mirroring instructions includes:

Match							result	
Source IP address	destination IP address	source TCP port	destination TCP port	IP protocol number	TCP sequence	TCP sequence mask	action	Count byte
192.1.1.1	209.1.4.4	15431	21	6	0xf46d5c34	0xFFFF8000	Mirror	X
209.1.4.4	192.1.1.1	21	15431	6	0x3c98b9ab	0xFFFF8000	Mirror	Y

[0045] Referring back to Fig. 3, at S306, in the module 311 the processed packet is sent back to the node 112 for further processing. In an embodiment, a set of mirroring instructions generated respective of the computed mask value are sent to the node 112. At S307, a response TCP ACK packet with [TCP FLAG ACK=1] is received at a port of the node 112 and, based on the respective probe instruction, the packet is switched directly to the destination server 140.

[0046] In an embodiment, an audit mechanism scans the flow table every predefined time interval from the last timestamp and deletes all flows from the state is not SYN/ACK. Furthermore, an aging mechanism deletes all entries wherein their aging bit equal = 1. The aging bit is initialized to 0 upon flow creation of a flow-id entry and is set to 1 in the first audit pass if buffer length is 0. When a flow-id is deleted from the flow table, the flow-id also removed from the tables maintained by the probe sequence counter 324.

[0047] At S308 and S309, packets arrive from either the client device or a destination server with their sequence number that matches the mirroring instructions and are mirrored to the central controller 111 for buffering and for analysis by the DPI engine 312. It should be noted that each instruction hit increments a counter Client-to-Server hit counter X [bytes] and Server-to-Client hit counter Y [bytes]. The flow table audit mechanism scans the flow table, every predefined time interval, and updates the mask to 0x00000000 and the ACTION to “no Action” of all entries that their Client-to-Server buffer length = TCP_DATA_SIZE_DPI or Server-to-Client buffer length = TCP_DATA_SIZE_DPI. The various fields of the flow table are shown in Fig. 2.

[0048] Fig. 4 show an exemplary and non-limiting diagram of a system 400 for describing the process of flow termination as performed by the central controller 111 and a network node 112 according to one embodiment. The various module of the controller 111 and node 112 are discussed with reference to Fig. 3.

[0049] In the flow termination process, the module 311 follows a termination of a TCP flow and is responsible to remove the exiting flow from the flow table. In addition, the module 311 disables or removes the mirroring instructions from the node 112. According to one embodiment, the module 311 configures the node 112 with a set of termination instructions. Examples for such instructions are provided above.

[0050] At S401, a packet arrives, at the node 112, from a client 130 with a header including the value of [TCP FLAG FIN=1]. The value matches one of the termination instructions, thus, at S402, to the packet is sent to the center controller 111.

[0051] In response, at S403, the module 311 traps the packet and marks the corresponding flow-id in the flow table to update the state to FIN. Then, the packet is sent back it to the network log.

[0052] At S404, a response packet from the destination server (e.g., server 140) with a header’s value containing [TCP FLAG FIN=1, ACK=1] is received at the node 112. As the value matches one of the termination instructions, at S405, to the packet is sent to the center controller 111.

[0053] At S406, the module 311 traps the received packet and marks the corresponding FLOW-ID in its flow table DB as state=FIN/FIN/ACK. Then, the packet is sent back to the network node 112. At S407, a response TCP ACK packet arrives from a

client 130 with a header's value containing [TCP FLAG ACK=1] and is switched directly to the server 140. If the response packet includes the header's value of [TCP FLAG RST=1], the module 311 marks the state of respective flow id in the flow table.

[0054] In an embodiment, the audit mechanism implemented by the module 311 scans the flow table every predefined time interval to all flows that their respective state is any one of FIN, FIN/ACK, FIN/FIN/ACK, or RST. The flows are removed from the probe flow module 321 and the flow table.

[0055] According to one embodiment, each network node 112 is populated with one or more probe tables generated by the central controller 111. Fig. 5 shows a non-limiting and exemplary data structure 500 depicting the organization of the flows to allow functionality of both the probe flow detection module 321 and probe sequence counter 324.

[0056] The data structure 500 which may be in a form of a table is updated with a general instruction to match all traffic type with instruction 501 to go to a probe table 510. The instruction 501 is set to the highest priority, unless the controller 111 requires pre-processing of other instructions. All packets matching the instruction 500 are processed in the probe table 510.

[0057] In an embodiment, the probe table 510 is populated with a medium priority probe and termination instructions 511 to detect all SYN, SYN/ACK, FIN, FIN/ACK that are the TCP connection initiation packets. The instructions 511 allows the module 311 to update the flow table and as a consequence create new instructions for mirroring N bytes from each TCP connection setup.

[0058] The probe table 510 table is also populated with highest priority instructions 512, these are two bi-direction instructions per flow-id that match a number 'r' tupple flow headers including the TCP sequence number as calculated by the sequence mask logic. The instructions 512 are to send the packet to the central controller 111 and also to perform go to table ID <next table ID>. The instructions 512 will cause sending the packet to continue switching processing. Each of these bi-directional instructions 512 will cause the node to copy several bytes from the TCP stream to the TCP flow analysis logic to be stored for further DPI engine metadata analysis.

[0059] The final instruction 513 placed in the probe table 510 is in the lowest priority to catch all and proceed with the switch functionality. All traffic which does not correspond to the TCP initiation packets, nor a specific detected flow and the corresponding TCP sequence number shall continue regular processing.

[0060] Fig. 6 shows an exemplary and non-limiting flowchart 600 illustrating the operation of the central controller 111 according to one embodiment. At S610, all network nodes 112 are configured with a set of probe instructions utilized to instruct each node 112 to redirect a TCP packet having at least a flag value as designated in each probe instruction. Examples for probe instructions are provided above.

[0061] At S620, a first TCP packet with at least one TCP FLAG SYN value equal to 1 is received. This packet may have a sequence number M and may be sent from a client device 130. At S630, a second TCP packet with at least one TCP FLAG ACK value equal to 1 is received. This packet may have a sequence number N and may be sent from a destination server 140 in response to the first TCP packet. In an embodiment, the flow table is updated with the respective flow ID and the state of the first and second packets.

[0062] At S640, using at least the sequence numbers of the first and second packets a mask value is computed. The mask value is utilized to determine which bytes from the flow respective of the sequence numbers N and M should be mirrored by the nodes. An embodiment for computing the mask value is provided above.

[0063] At S650, a set of mirroring instructions are generated using the mirror value and sent to the network nodes. Each such instruction defines the packets (designed at least by a specific source/destination IP addresses, and TCP sequences), the number of bytes, and the bytes that should be mirrored. At S660, the received mirror bytes are inspected using a DPI engine in the controller 111. In addition, the flow table is updated with the number of the received mirror bytes.

[0064] In S670, it is checked if the inspection session should be terminated. The decision is based on the FIN and/or RST values of the TCP FLAG. As noted above, packets with TCP FLAG FIN=1 or TCP FLAG RST=1 are directed to the controller respective of the set of termination instructions. Some examples for the termination instructions are provided above. If S670, results with No answer execution returns to S660; otherwise, execution continues with S680. At S680, related exiting flows from the

flow table are removed. In addition, the nodes 112 are instructed not to perform the mirroring instructions provided at S650.

[0065] The various embodiments disclosed herein can be implemented as hardware, firmware, software, or any combination thereof. Moreover, the software is preferably implemented as an application program tangibly embodied on a program storage unit or computer readable medium consisting of parts, or of certain devices and/or a combination of devices. The application program may be uploaded to, and executed by, a machine comprising any suitable architecture. Preferably, the machine is implemented on a computer platform having hardware such as one or more central processing units ("CPUs"), a memory, and input/output interfaces. The computer platform may also include an operating system and microinstruction code. The various processes and functions described herein may be either part of the microinstruction code or part of the application program, or any combination thereof, which may be executed by a CPU, whether or not such a computer or processor is explicitly shown. In addition, various other peripheral units may be connected to the computer platform such as an additional data storage unit and a printing unit. Furthermore, a non-transitory computer readable medium is any computer readable medium except for a transitory propagating signal.

[0066] All examples and conditional language recited herein are intended for pedagogical purposes to aid the reader in understanding the principles of the disclosed embodiments and the concepts contributed by the inventor to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions. Moreover, all statements herein reciting principles, aspects, and embodiments of the invention, as well as specific examples thereof, are intended to encompass both structural and functional equivalents thereof. Additionally, it is intended that such equivalents include both currently known equivalents as well as equivalents developed in the future, i.e., any nodes developed that perform the same function, regardless of structure.

CLAIMS

What is claimed is:

1. A method for deep packet inspection (DPI) in a software defined network (SDN), wherein the method is performed by a central controller of the SDN, comprising:

configuring a plurality of network nodes operable in the SDN with at least one probe instruction;

receiving from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first sequence number;

receiving from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second sequence number, wherein the second packet is a response of the first packet;

computing a mask value respective of at least the first and second sequence numbers, wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected;

generating at least one mirror instruction based on at least the mask value; and

configuring the plurality of network nodes with at least one mirror instruction.

2. The method of claim 1, further comprising:

receiving mirrored bytes from a network node respective of the at least one mirror instruction; and

inspecting the mirrored bytes using a DPI engine.

3. The method of claim 1, further comprising:

maintaining a flow table listing each flow inspected by the central controller; and

updating a status field in the flow table upon reception of any one of: the first packet, the second packet, and the mirrored bytes.

4. The method of claim 3, further comprising:

configuring the plurality of network nodes with at least one termination instruction;

removing all entries from the flow table for each flow matching the at least one termination instruction; and

disabling the at least one mirror instruction for each flow matching the at least one termination instruction.

5. The method of claim 1, wherein the at least one probe instruction is any one of:

if (TCP FLAG SYN=1) then (re-direct packet to the central controller) and if (TCP FLAG SYN=1 and ACK=1) then (re-direct packet to central controller).

6. The method of claim 1, wherein the least one mirror action is at least: if (source IP Address = V1 and destination IP Address = V2 and source TCP port = V3 and destination IP address = V4 and TCP sequence = V5 and TCP sequence mask = V6) then (mirror V7 bytes).

7. The method of claim 4, wherein the at least one termination instruction is any one of: if (TCP FLAG FIN=1) then (re-direct packet to controller); if (TCP FLAG FIN=1 and ACK=1) then (re-direct packet to controller); and if (TCP FLAG RST=1) then (re-direct packet to controller).

8. The method of claim 1, wherein a number of bytes mirrored from each packet is a portion of the packet, wherein the bytes are mirrored from packets in sequence.

9. The method of claim 1, wherein the communication between central controller and the plurality of network nodes is performed using the OpenFlow standard.

10. A non-transitory computer readable medium having stored thereon instructions for causing one or more processing units to execute the computerized method according to claim 1.

11. A system for deep packet inspection (DPI) in a software defined network (SDN), wherein the method is performed by a central controller of the SDN, comprising:

a processor;

a memory connected to the processor and configured to contain a plurality of instructions that when executed by the processor configure the system to:

set a plurality of network nodes operable in the SDN with at least one probe instruction;

receive from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first sequence number;

receive from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second sequence number, wherein the second packet is a response of the first packet;

compute a mask value respective of at least the first and second sequence numbers, wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected;

generate at least one mirror instruction based on at least the mask value; and

configure the plurality of network nodes with at least one mirror instruction.

12. The system of claim 11, wherein the system is further configured to:

receive mirrored bytes from a network node respective of the at least one mirror instruction; and

inspect the mirrored bytes using a DPI engine.

13. The system of claim 11, wherein the system is further configured to:

maintain a flow table listing each flow inspected by the central controller; and

update a status field in the flow table upon reception of any one of: the first packet, the second packet, and the mirrored bytes.

14. The system of claim 13, wherein the system is further configured to:

configure the plurality of network nodes with at least one termination instruction;

remove all entries from the flow table for each flow matching the at least one termination instruction; and

disable the at least one mirror instruction for each flow matching the at least one termination instruction.

15. The system of claim 11, wherein the at least one probe instruction is any one of:

if (TCP FLAG SYN=1) then (re-direct packet to the central controller) and if (TCP FLAG SYN=1 and ACK=1) then (re-direct packet to central controller).

16. The system of claim 11, wherein the least one mirror action is at least: if (source IP Address = V1 and destination IP Address = V2 and source TCP port = V3 and destination IP address = V4 and TCP sequence = V5 and TCP sequence mask = V6) then (mirror V7 bytes).

17. The system of claim 14, wherein the at least one termination instruction is any one of: if (TCP FLAG FIN=1) then (re-direct packet to controller); if (TCP FLAG FIN=1 and ACK=1) then (re-direct packet to controller); and if (TCP FLAG RST=1) then (re-direct packet to controller).

18. The system of claim 11, wherein a number of bytes mirrored from each packet is a portion of the packet, wherein the bytes are mirrored from packets in sequence.

19. The system of claim 11, wherein the communication between central controller and the plurality of network node is performed using the OpenFlow standard

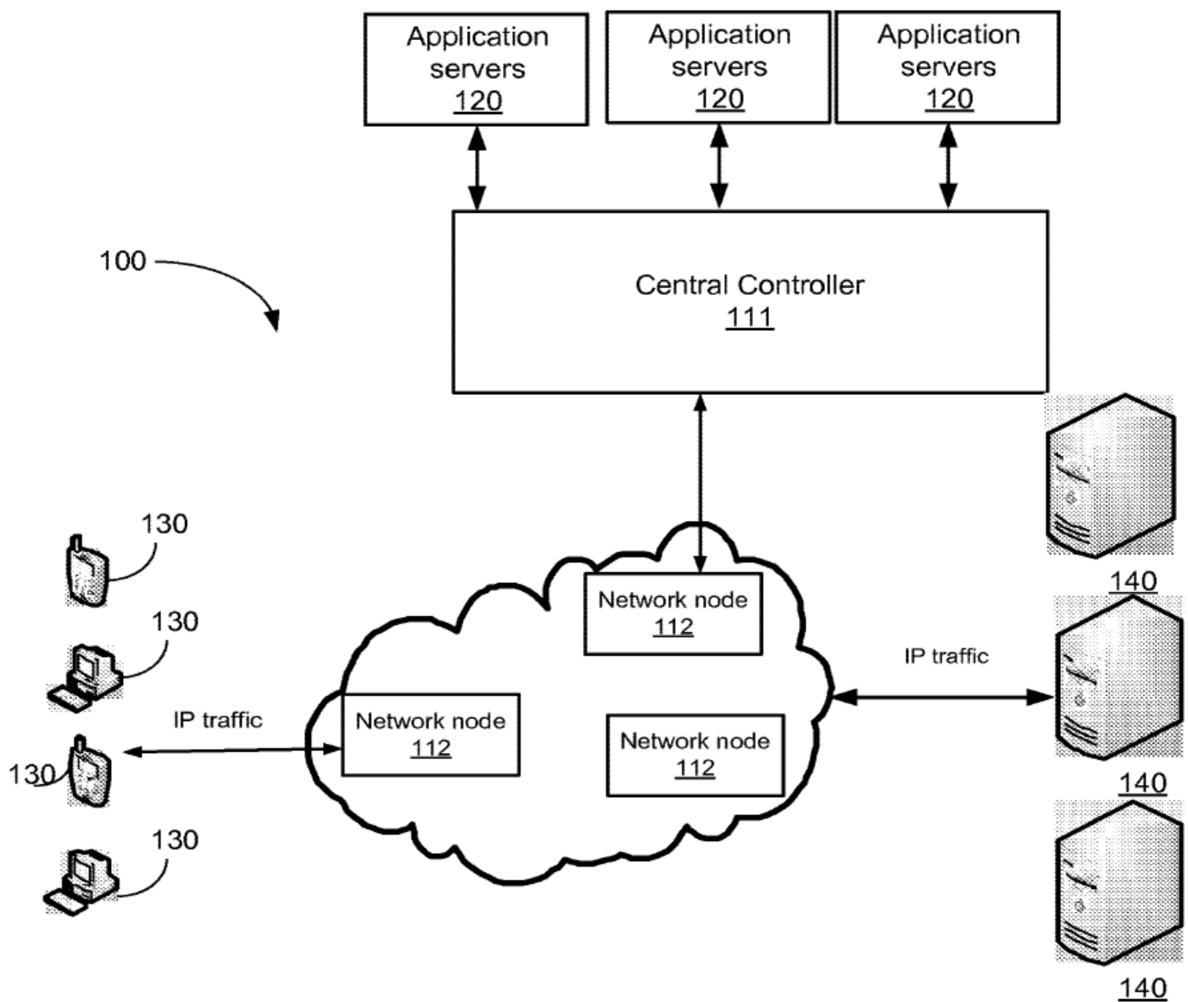

Application servers 120
Application servers 120
Application servers 120
100
Central Controller 111
130
130
130
130
Network node 112
Network node 112
Network node 112
IP traffic
IP traffic
140
140
140

FIG. 1

200

KEY **210**					DATA **220**									
Client IP address	Server IP address	Client source TCP port	Server destination TCP port	IP protocol number	Flow ID	Client→ Server sequence number M	Server→ Client sequence number N	state	Creation timestamp	Client→ Server Hit counter X [bytes]	Server → Client Hit counter Y [bytes]	Client→ Server data buffer	Server→ Client buffer	Age bit
192.1.1.1	209.1.4.4	15431	21	6	1	0xf46d5c34	0x3c98b9ab	ACK	15:32:13					

FIG. 2

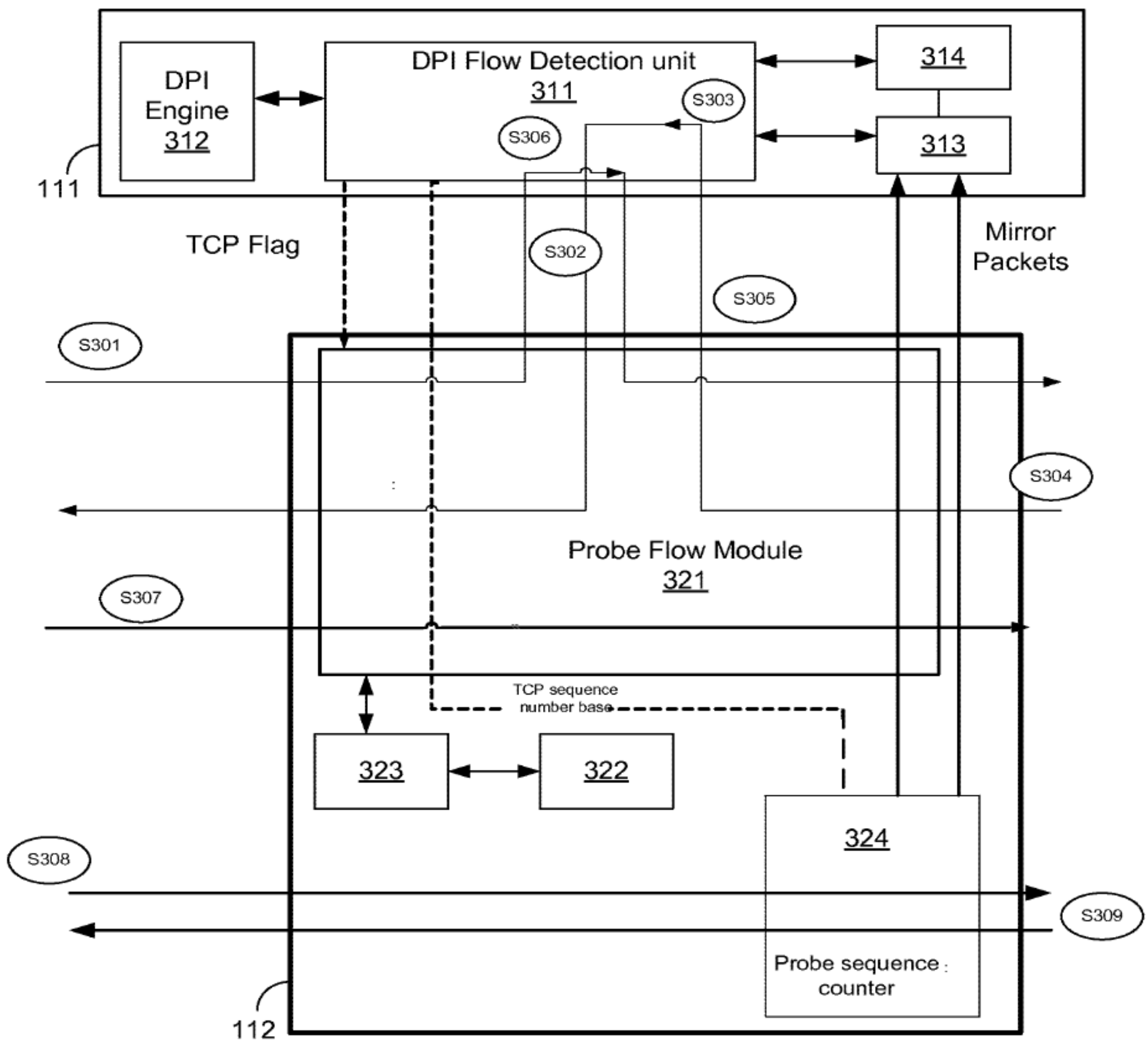
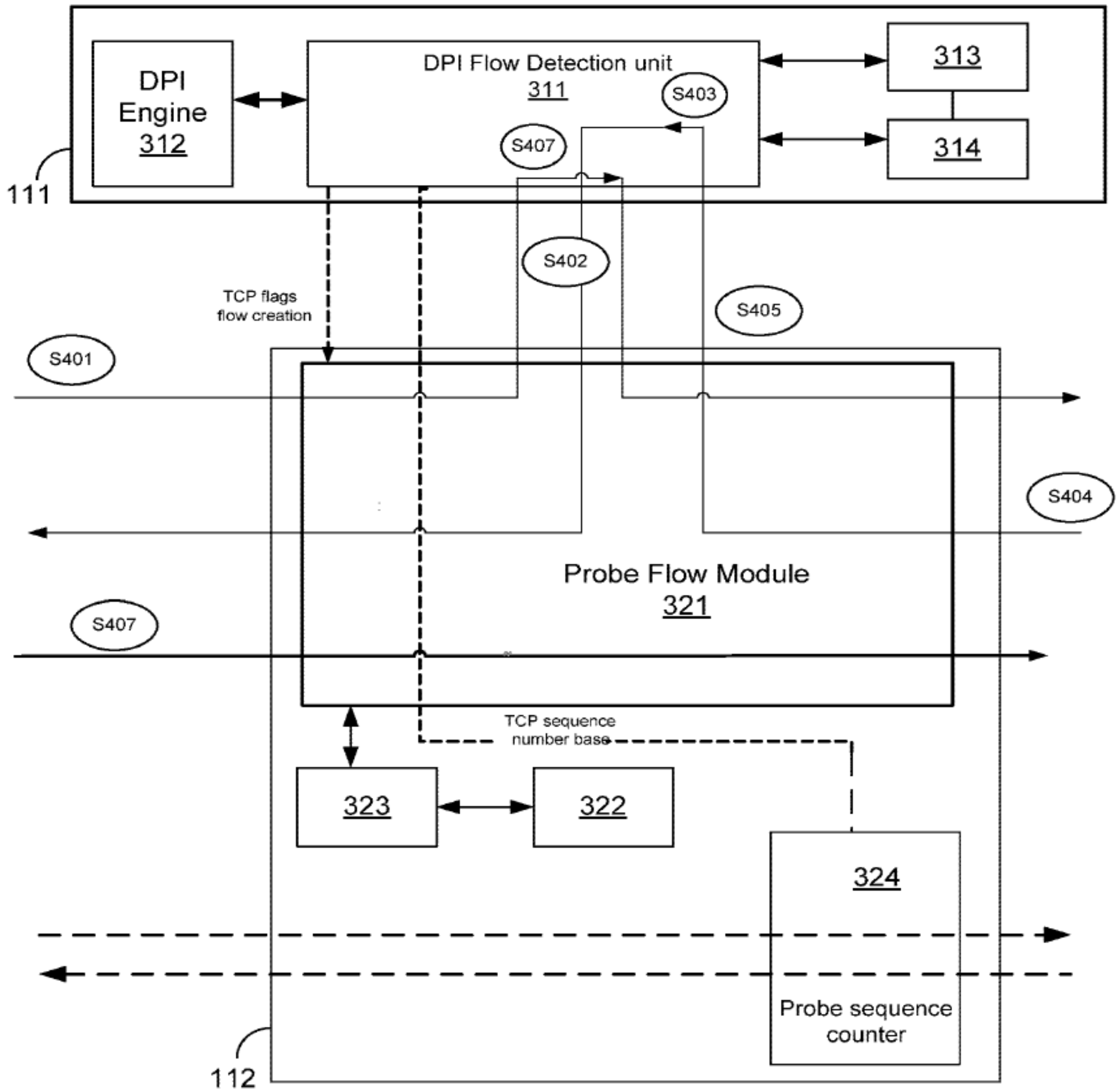

DPI Engine 312
DPI Flow Detection unit 311
314
313
S303
S306
111
TCP Flag
S302
Mirror Packets
S305
S301
S304
Probe Flow Module 321
S307
TCP sequence number base
323
322
324
S308
S309
Probe sequence counter
112

FIG. 3



DPI Engine 312
DPI Flow Detection unit 311
S403
S407
313
314
111
S402
S405
TCP flags flow creation
S401
S404
Probe Flow Module 321
S407
TCP sequence number base
323
322
324
Probe sequence counter
112

FIG. 4

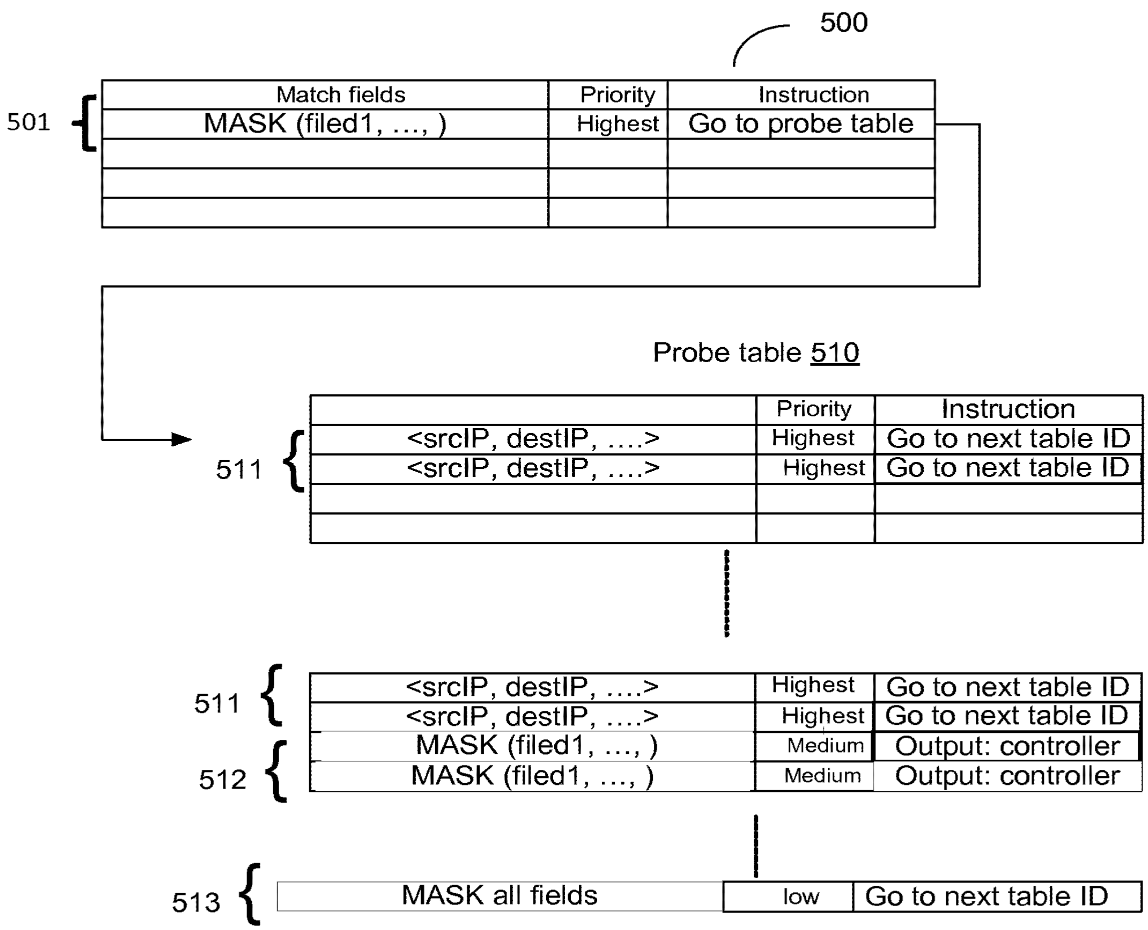

500
501
Match fields
Priority
Instruction
MASK (filed1, …,)
Highest
Go to probe table
Probe table 510
Priority
Instruction
511
<srcIP, destIP, ….>
Highest
Go to next table ID
<srcIP, destIP, ….>
Highest
Go to next table ID
511
<srcIP, destIP, ….>
Highest
Go to next table ID
<srcIP, destIP, ….>
Highest
Go to next table ID
512
MASK (filed1, …,)
Medium
Output: controller
MASK (filed1, …,)
Medium
Output: controller
513
MASK all fields
low
Go to next table ID

FIG. 5

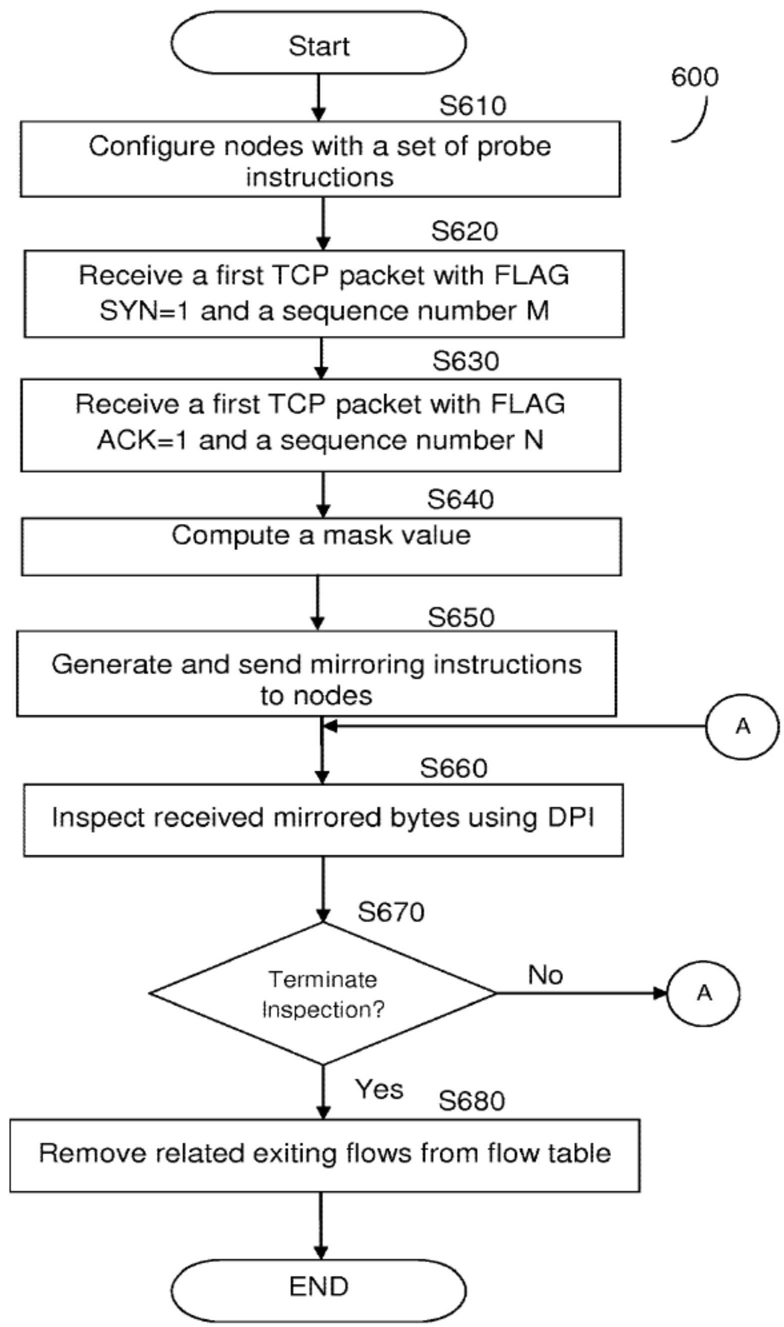

Start
600
S610
Configure nodes with a set of probe instructions
S620
Receive a first TCP packet with FLAG SYN=1 and a sequence number M
S630
Receive a first TCP packet with FLAG ACK=1 and a sequence number N
S640
Compute a mask value
S650
Generate and send mirroring instructions to nodes
A
S660
Inspect received mirrored bytes using DPI
S670
Terminate Inspection?
No
A
Yes
S680
Remove related exiting flows from flow table
END

FIG. 6

CLAIMS

What is claimed is:

1. A method for deep packet inspection (DPI) in a software defined network (SDN), wherein the method is performed by a central controller of the SDN, comprising:

configuring a plurality of network nodes operable in the SDN with at least one probe instruction;

receiving from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first sequence number;

receiving from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second sequence number, wherein the second packet is a response of the first packet;

computing a mask value respective of at least the first and second sequence numbers, wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected;

generating at least one mirror instruction based on at least the mask value; and

configuring the plurality of network nodes with at least one mirror instruction.

2. The method of claim 1, further comprising:

receiving mirrored bytes from a network node respective of the at least one mirror instruction; and

inspecting the mirrored bytes using a DPI engine.

3. The method of claim 1, further comprising:

maintaining a flow table listing each flow inspected by the central controller; and

updating a status field in the flow table upon reception of any one of: the first packet, the second packet, and the mirrored bytes.

4. The method of claim 3, further comprising:

configuring the plurality of network nodes with at least one termination instruction;

removing all entries from the flow table for each flow matching the at least one termination instruction; and

disabling the at least one mirror instruction for each flow matching the at least one termination instruction.

5. The method of claim 1, wherein the at least one probe instruction is any one of:

if (TCP FLAG SYN=1) then (re-direct packet to the central controller) and if (TCP FLAG SYN=1 and ACK=1) then (re-direct packet to central controller).

6. The method of claim 1, wherein the least one mirror action is at least: if (source IP Address = V1 and destination IP Address = V2 and source TCP port = V3 and destination IP address = V4 and TCP sequence = V5 and TCP sequence mask = V6) then (mirror V7 bytes).

7. The method of claim 4, wherein the at least one termination instruction is any one of: if (TCP FLAG FIN=1) then (re-direct packet to controller); if (TCP FLAG FIN=1 and ACK=1) then (re-direct packet to controller); and if (TCP FLAG RST=1) then (re-direct packet to controller).

8. The method of claim 1, wherein a number of bytes mirrored from each packet is a portion of the packet, wherein the bytes are mirrored from packets in sequence.

9. The method of claim 1, wherein the communication between central controller and the plurality of network nodes is performed using the OpenFlow standard.

10. A non-transitory computer readable medium having stored thereon instructions for causing one or more processing units to execute the computerized method according to claim 1.

11. A system for deep packet inspection (DPI) in a software defined network (SDN), wherein the method is performed by a central controller of the SDN, comprising:

a processor;

a memory connected to the processor and configured to contain a plurality of instructions that when executed by the processor configure the system to:

set a plurality of network nodes operable in the SDN with at least one probe instruction;

receive from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first sequence number;

receive from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second sequence number, wherein the second packet is a response of the first packet;

compute a mask value respective of at least the first and second sequence numbers, wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected;

generate at least one mirror instruction based on at least the mask value; and

configure the plurality of network nodes with at least one mirror instruction.

12. The system of claim 11, wherein the system is further configured to:

receive mirrored bytes from a network node respective of the at least one mirror instruction; and

inspect the mirrored bytes using a DPI engine.

13. The system of claim 11, wherein the system is further configured to:

maintain a flow table listing each flow inspected by the central controller; and

update a status field in the flow table upon reception of any one of: the first packet, the second packet, and the mirrored bytes.

14. The system of claim 13, wherein the system is further configured to:

configure the plurality of network nodes with at least one termination instruction;

remove all entries from the flow table for each flow matching the at least one termination instruction; and

disable the at least one mirror instruction for each flow matching the at least one termination instruction.

15. The system of claim 11, wherein the at least one probe instruction is any one of:
if (TCP FLAG SYN=1) then (re-direct packet to the central controller) and if (TCP FLAG SYN=1 and ACK=1) then (re-direct packet to central controller).

16. The system of claim 11, wherein the least one mirror action is at least: if (source IP Address = V1 and destination IP Address = V2 and source TCP port = V3 and destination IP address = V4 and TCP sequence = V5 and TCP sequence mask = V6) then (mirror V7 bytes).

17. The system of claim 14, wherein the at least one termination instruction is any one of: if (TCP FLAG FIN=1) then (re-direct packet to controller); if (TCP FLAG FIN=1 and ACK=1) then (re-direct packet to controller); and if (TCP FLAG RST=1) then (re-direct packet to controller).

18. The system of claim 11, wherein a number of bytes mirrored from each packet is a portion of the packet, wherein the bytes are mirrored from packets in sequence.

19. The system of claim 11, wherein the communication between central controller and the plurality of network node is performed using the OpenFlow standard

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JHARRIS	SALE	#00000004	Mailroom Dt:	09/15/2016	600117	15126288
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PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/126,288	Filing Date 09/15/2016	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	09/15/2016	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 31	Minus	** 31	= 0	x $40 =	0
	Independent (37 CFR 1.16(h))	* 1	Minus	***3	= 0	x $210 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	0

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
DORIS BURNS

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44*bis*)

Applicant's or agent's file reference ORCKIT-001-PCT	**FOR FURTHER ACTION**	See item 4 below
International application No. PCT/US2015/026869	International filing date *(day/month/year)* 21 April 2015 (21.04.2015)	Priority date *(day/month/year)* 22 April 2014 (22.04.2014)
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant ORCKIT IP, LLC		

1. This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 *bis*.1(a).

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.

3. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44*bis*.3(c) and 93*bis*.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44*bis* .2).

	Date of issuance of this report 25 October 2016 (25.10.2016)
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70	Authorized officer Simin Baharlou e-mail: pt09.pct@wipo.int

Form PCT/IB/373 (January 2004)

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (PCT Rule 43*bis*.1)	To: BEN-SHIMON Michael MYERS Brian S., M&B IP Analysts, LLC, 45 S. Park Place #262 Morristown NJ 07960 United States of America
Date of mailing *(day/month/year)* 06 August 2015 (06.08.2015)	
Applicant's or agent's file reference ORCKP0406PCT	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US 2015/026869	21 April 2015 (21.04.2015)	22 April 2014 (22.04.2014)

International Patent Classification (IPC) or both national classification and IPC
H04L 12/26 *(2006.01)*
H04L 12/741 *(2013.01)*

Applicant
ORCKIT-CORRIGENT LTD. et al.

1. This opinion contains indications relating to the following items:

- [X] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [X] Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/RU:	Date of completion of this opinion	Authorized officer
Federal Institute of Industrial Property, Berezhkovskaya nab., 30-1, Moscow, G-59, GSP-3, Russia, 125993 Facsimile No: (8-495) 531-63-18, (8-499) 243-33-37	27 July 2015 (27.07.2015)	A. Tokarev Telephone No. (499) 240-25-91

Form PCT/ISA/237 (cover sheet) (January 2015)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY	International application No. PCT/US 2015/026869

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:
   - [X] the international application in the language in which it was filed.
   - [ ] a translation of the international application into ______________ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. [ ] This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:
   - a. [ ] forming part of the international application as filed:
     - [ ] in the form of an Annex C/ST.25 text file.
     - [ ] on paper or in the form of an image file.
   - b. [ ] furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
   - c. [ ] furnished subsequent to the international filing date for the purposes of international search only:
     - [ ] in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).
     - [ ] on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. [ ] In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY	International application No. PCT/US 2015/026869

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-19	YES
	Claims		NO
Inventive step (IS)	Claims		YES
	Claims	1-19	NO
Industrial applicability (IA)	Claims	1-19	YES
	Claims		NO

2. Citations and explanations:

D1: US 2010/0208590 A1
D2: EP 2672668 A1
D3: US 2011/0264802 A1

Claims 1, 10, 11: D1 discloses a method for deep packet inspection (DPI) in a network and a non-transitory computer readable medium having stored thereon instructions for causing one or more processing units to execute the computerized method for deep packet inspection (DPI) in a network (D1, abstract, [0030]). The known solution comprises: a processor; a memory connected to the processor and configured to contain a plurality of instructions (D1, [0030]) that when executed by the processor configure the system to: set a plurality of network nodes operable in the network with at least one probe instruction (D1, [0048]); receive from a network node a first packet of a flow, wherein the first packet matches the at least one probe instruction, wherein the first packet includes a first field value (D1, [0012], [0075]); receive from a network node a second packet of the flow, wherein the second packet matches the at least one probe instruction, wherein the second packet includes a second field value, wherein the second packet is a response of the first packet (D1, [0012], [0075]); compute a mask value respective of at least the first and second field values (D1, [0012], [0014], [0044], [0075]), wherein the mask value indicates which bytes to be mirrored from subsequent packets belonging to the same flow, wherein the mirrored bytes are inspected (D1, [0013], [0045], [0046]); generate at least one action instruction based on at least the mask value (D1, [0034], [0045], [0046], [0056], [0057]); and configure the plurality of network nodes with at least one action instruction (D1, [0034], [0045], [0046], [0056], [0057]).

The solution of independent claims 1, 10, 11 differs from the solution from D1 in that the network is a software defined network (SDN), the field values of packets are sequence numbers of packets, and the action instruction is a mirror instruction.

The invention of independent claims 1, 10, 11 meets the criterion of novelty.

However, from the art it is known a method for automatically tracing back from a central location, disclosing employing software defined network (SDN) systems (D2, [0006]) and using fields of packets which are sequence numbers of packets (D2, [0222]).

From the art it is known a method for management of traffic in a telecommunications network (D3, [0002]) disclosing using mirror instructions (D3, abstract, [0043]).

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of V:

Therefore the invention of independent claims 1, 10, 11 is known from combination of solutions D1, D2 and D3.

Therefore the invention of independent claims 1, 10, 11 does not meet the criterion of inventive step.

Claims 2-9, 12-19 do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, the reasons being as follows:

claims 2, 12: inspecting the mirrored bytes using a DPI engine, is known from D3 ([0043]);

claims 3, 13: maintaining and updating a flow table, is known from D1 ([0051]-[0055]);

claims 4, 14: using termination instructions and removing all entries from the flow table for each flow matching the at least one termination instruction, is known from D1 ([0070]);

claims 5-7, 15-17: using particular fields for instructions, is known from D3 ([0044]-[0048]);

claims 8, 18: mirroring portions of packets, is known from D3 ([0043]);

claims 9, 19: performing communication between central controller and the plurality of network nodes using the OpenFlow standard, is known from D2 ([0186]).

The inventions of all the claims meet the criterion of industrial applicability.

Electronic Acknowledgement Receipt

EFS ID:	27428690
Application Number:	15126288
International Application Number:	
Confirmation Number:	9263
Title of Invention:	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS
First Named Inventor/Applicant Name:	Yossi BARSHESHET
Customer Number:	131926
Filer:	Yehuda Binder
Filer Authorized By:	
Attorney Docket Number:	ORCKIT-001-US
Receipt Date:	06-NOV-2016
Filing Date:	
Time Stamp:	05:15:17
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Documents submitted with 371 Applications	PCTUS2015026869-IPRP.pdf	239798 b96b8a61711705032873797777d6d2327ba5d3aea	no	5

Warnings:

Information:	
Total Files Size (in bytes):	239798

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

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www.uspto.gov

U.S. APPLICATION NUMBER NO.	FIRST NAMED INVENTOR	ATTY. DOCKET NO.
15/126,288	Yossi BARSHESHET	ORCKIT-001-US

131926
May Patents Ltd. c/o Dorit Shem-Tov
P.O.B 7230
Ramat-Gan, 5217102
ISRAEL

INTERNATIONAL APPLICATION NO.	
PCT/US2015/026869	
I.A. FILING DATE	PRIORITY DATE
04/21/2015	04/22/2014

CONFIRMATION NO. 9263
371 ACCEPTANCE LETTER

OC000000088122227

Date Mailed: 12/27/2016

NOTICE OF ACCEPTANCE OF APPLICATION UNDER 35 U.S.C 371 AND 37 CFR 1.495

The applicant is hereby advised that the United States Patent and Trademark Office, in its capacity as a Designated / Elected Office (37 CFR 1.495), has ACCEPTED the above identified international application for national patentability examination in the United States Patent and Trademark Office.

The United States Application Number assigned to the application is shown above. A Filing Receipt will be issued for the present application in due course. **THE DATE APPEARING ON THE FILING RECEIPT AS THE "FILING DATE or 371(c) DATE" IS THE DATE ON WHICH THE LAST OF THE 35 U.S.C. 371 (c)(1) and (c)(2) REQUIREMENTS HAS BEEN RECEIVED IN THE OFFICE. THIS DATE IS SHOWN BELOW.** The filing date of the above identified application is the international filing date of the international application (Article 11(3) and 35 U.S.C. 363)

09/15/2016
DATE OF RECEIPT OF 35 U.S.C.
371(c)(1) and (c)(2) REQUIREMENTS

The following items have been received:

- Indication of Small Entity Status
- Copy of the International Application filed on 09/15/2016
- Copy of the International Search Report filed on 09/15/2016
- Preliminary Amendments filed on 09/15/2016
- Information Disclosure Statements filed on 09/15/2016
- Inventor's Oath or Declaration filed on 09/15/2016
- Request for Immediate Examination filed on 09/15/2016
- U.S. Basic National Fees filed on 09/15/2016
- Authorize Access to Search Results filed on 09/15/2016
- Priority Documents filed on 09/15/2016
- Power of Attorney filed on 09/15/2016
- Application Data Sheet (37 CFR 1.76) filed on 09/15/2016

FORM PCT/DO/EO/903 (371 Acceptance Notice)

Applicant is reminded that any communications to the United States Patent and Trademark Office must be mailed to the address given in the heading and include the U.S. application no. shown above (37 CFR 1.5)

JAMILAH Z HARRIS

Telephone: (703) 756-1124

MULTIPLE DEPENDENT CLAIM FEE CALCULATION SHEET Substitute for Form PTO-1360 (For use with Form PTO/SB/06)	Application Number 15126288	Filing Date
	Applicant(s) Yossi BARSHESHET	
	* May be used for additional claims or amendments	

CLAIMS	AS FILED		AFTER FIRST AMENDMENT		AFTER SECOND AMENDMENT	
	Indep	Depend	Indep	Depend	Indep	Depend
1	1		---	---		
2		1	---	---		
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43				1		
44				1		
45				1		
46				1		
47				1		
48				1		
49				1		
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Total Indep	2		1		0	
Total Depend	17		30		0	
Total Claims	19		31		0	

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	Indep	Depend	Indep	Depend	Indep	Depend
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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
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www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/126,288	09/15/2016		1180	ORCKIT-001-US	31	1

CONFIRMATION NO. 9263

FILING RECEIPT

OC000000088122226

131926
May Patents Ltd. c/o Dorit Shem-Tov
P.O.B 7230
Ramat-Gan, 5217102
ISRAEL

Date Mailed: 12/27/2016

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Yossi BARSHESHET, Ashdod, ISRAEL;
Simhon DOCTORI, Gan-Yavne, ISRAEL;
Ronen SOLOMON, Ranat-Gan, ISRAEL;

Applicant(s)

ORCKIT IP, LLC., Newton, MA;

Power of Attorney: The patent practitioners associated with Customer Number 131926

Domestic Priority data as claimed by applicant

This application is a 371 of PCT/US2015/026869 04/21/2015
which claims benefit of 61/982,358 04/22/2014

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: No

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 12/27/2016

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/126,288**

Projected Publication Date: 04/06/2017

Non-Publication Request: No

Early Publication Request: No
**** SMALL ENTITY ****
Title

A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/126,288

APPLICATION AS FILED - PART I

FOR	NUMBER FILED (Column 1)	NUMBER EXTRA (Column 2)	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	140		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	240		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	360		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	31 minus 20 =	* 11	x 40 =	440	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*	x 210 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	1180		TOTAL	

APPLICATION AS AMENDED - PART II

AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/126,288	09/15/2016	Yossi BARSHESHET	ORCKIT-001-US

CONFIRMATION NO. 9263

PUBLICATION NOTICE

OC000000090438351

131926
May Patents Ltd. c/o Dorit Shem-Tov
P.O.B 7230
Ramat-Gan, 5217102
ISRAEL

Title:A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS

Publication No.US-2017-0099196-A1
Publication Date:04/06/2017

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	15126288
	Filing Date	2016-09-15
	First Named Inventor	BARSHESHET, Yossi
	Art Unit	2466
	Examiner Name	VOLTAIRE, JEAN F
	Attorney Docket Number	ORCKIT-001-US

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20130329734	A1	2013-12-12	CHESLA Avi et al	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	15126288
	Filing Date	2016-09-15
	First Named Inventor	BARSHESHET, Yossi
	Art Unit	2466
	Examiner Name	VOLTAIRE, JEAN F
	Attorney Docket Number	ORCKIT-001-US

	1	Supplementary Search Report of EP 15783292 dated 07 November 2017	
	2	Seugwon Shin et al, "Fresco: Modular Composable Security Services for Software-Defined Networks", NDSS Symposium 2013, 23 April 2013, pages 1-16 XP055422187	

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15126288
	Filing Date	2016-09-15
	First Named Inventor	BARSHESHET, Yossi
	Art Unit	2466
	Examiner Name	VOLTAIRE, JEAN F
	Attorney Docket Number	ORCKIT-001-US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Yehuda Binder/	Date (YYYY-MM-DD)	2017-11-19
Name/Print	Yehuda Binder	Registration Number	73612

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	30991941
Application Number:	15126288
International Application Number:	
Confirmation Number:	9263
Title of Invention:	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS
First Named Inventor/Applicant Name:	Yossi BARSHESHET
Customer Number:	131926
Filer:	Yehuda Binder
Filer Authorized By:	
Attorney Docket Number:	ORCKIT-001-US
Receipt Date:	19-NOV-2017
Filing Date:	15-SEP-2016
Time Stamp:	08:26:14
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	IDS1.pdf	1035169 34158c867eb1f0b5b0b04b791ea2787d1ed12707	no	4

Warnings:

Information:					
2	Other Reference-Patent/App/Search documents	Supplamental-Search-Report.pdf	189959 6514e5c5093dd3d1d27623fbe0700610244e32b2	no	8
Warnings:					
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
3	Non Patent Literature	D1.pdf	915704 28e1c7d98b82c60be138448a1c13520802853d58	no	16
Warnings:					
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
			Total Files Size (in bytes):	2140832	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/126,288	09/15/2016	Yossi BARSHESHET	ORCKIT-001-US	9263

131926 7590 09/12/2018
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EXAMINER
VOLTAIRE, JEAN F

ART UNIT	PAPER NUMBER
2466	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

PTOL-90A (Rev. 04/07)

Office Action Summary	**Application No.** 15/126,288	**Applicant(s)** BARSHESHET et al.	
	Examiner JEAN F VOLTAIRE	**Art Unit** 2466	**AIA Status** Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 09/15/2016.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 20-73 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 20-73 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 09/15/2016 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date ______.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date ______.

4) ☐ Other: ______.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

2. The following is a non-final Office action in response to the Applicant submission received on 09/15/2016.

3. Claims 20-73 are currently pending and have been examined.

Foreign Priority

4. No foreign priority claimed under 35 U.S.C. 119 (a)-(d).

Oath/Declaration

5. The applicant's oath/declaration filed on 09/15/2016 has been reviewed by the examiner and is found to conform to the requirements prescribed in 37 C.F.R. 1.63.

Drawings

6. The applicant’s drawings submitted on 09/15/2016 are acceptable for examination purposes.

Information Disclosure Statement

7. The information disclosure statements submitted by Applicant are in compliance with the provision of 37 CFR 1.97, 1.98 and MPEP § 609. It has been placed in the

application file and the information referred to therein has been considered as to the merits.

Claim Rejections - 35 USC § 103

8. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

9. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

10. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

11. This application currently names joint inventors. In considering patentability of the claims the examiner presumes that the subject matter of the various claims was commonly owned as of the effective filing date of the claimed invention(s) absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and effective filing dates of each claim that was not commonly owned as of the effective filing date of the later invention in order for the examiner to consider the applicability of 35 U.S.C. 102(b)(2)(C) for any potential 35 U.S.C. 102(a)(2) prior art against the later invention.

12. Claims 20-73 is/are rejected under 35 U.S.C. 103 as being unpatentable over Dolganow et al. (US 2010/0208590 A1) in view of Nguyen et al. (US 2014/0052836 A1).

Regarding claim 20, Dolganow discloses a method for use with a packet network including a network node for transporting packets between first and second entities under control of a controller, the method comprising: sending, by the controller to the network node over the packet network, an instruction and a packet-applicable criterion **(Dolganow, para. 30; DPI devices 134, 136 may include hardware, instructions encoded on a machine-readable medium, or a combination thereof, such that DPI devices 134, 136 may be configured to examine data packets sent to router/switch 132 to identify information associated with the packets)**; receiving, by the network node from the controller, the instruction and the criterion **(Dolganow, para. 12, 30, 81; receiving all relevant information associated with the packets)**; receiving, by the network node from the first entity over the packet network, a packet addressed to the second entity **(Dolganow, para. 59: network element 130a, 130b may receive a number of packets belonging to an IP flow between a P2P client 110 and a P2P central entity 150)**.

Dolganow does not appear to explicitly disclose checking, by the network node, if the packet satisfies the criterion; responsive to the packet not satisfying the criterion, sending, by the network node over the packet network, the packet to the second entity; and responsive to the packet satisfying the criterion, sending the packet, by the network node over the packet network, in response to the instruction.

Nguyen from similar field of endeavor discloses checking, by the network node, if the packet satisfies the criterion **(Nguyen, para. 32: determining if the packet satisfies the criterion)**; responsive to the packet not satisfying the criterion, sending, by the network node over the packet network, the packet to the second entity **(Nguyen, Fig. 3, para. 21: sending the packet to the next table for processing, and/or a variety of other flow processing actions if not satisfying the criterion)**; and responsive to the packet satisfying the criterion, sending the packet, by the network node over the packet network, in response to the instruction **(Nguyen, para. 21: Nguyen, Fig. 3, para. 21: sending the packet to the next table for processing if the packet that satisfies the criteria in the matching filter)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as checking, by the network node, if the packet satisfies the criterion; responsive to the packet not satisfying the criterion, sending, by the network node over the packet network, the packet to the second entity; and responsive to the packet satisfying the criterion, sending the packet, by the network node over the packet network, in response to the instruction as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claims 21 and 52, Dolganow as modified by Nguyen discloses the method according to claim 20, wherein the instruction is 'probe', 'mirror', or 'terminate' instruction, and upon receiving by the network node the 'terminate' instruction, the method further comprising blocking, by the network node, the packet from being sent to the second entity and to the controller **(Dolganow, para. 50: this transmission may be accomplished by mirroring (i.e., duplicating) the packets in the IP flow that contain the key from DPI A 134 to DPI B 136. Alternatively, this transmission may be accomplished by redirecting (i.e., rerouting) the packets in the IP flow that contain the key from DPI A 134 to DPI B 136. As another alternative, DPI A 134 may build and send a message including the required information to DPI B 136)**.

Dolganow does not appear to disclose the packet is being sent to the controller.

Nguyen discloses the packet is being sent to the controller **(Nguyen, Fig. 2, para. 19: controller API 210 to receive and manage the packet)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as sending the packet to the controller as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claims 22 and 53, Dolganow as modified by Nguyen discloses the method according to claim 20, wherein the instruction is a 'probe', a 'mirror', or a 'terminate' instruction, and upon receiving by the network node the 'mirror' instruction and responsive to the packet satisfying the criterion, the method further comprising sending the packet, by the network node, to the second entity and to the controller **(Dolganow, para. 50, 59: Alternatively, this transmission may be accomplished by redirecting (i.e., rerouting) the packets in the IP flow that contain the key from DPI A 134 to DPI B 136. As another alternative, DPI A 134 may build and send a message including the required information to DPI B 136)**.

Dolganow does not appear to disclose the packet is being sent to the controller.

Nguyen discloses the packet is being sent to the controller **(Nguyen, Fig. 2, para. 19: controller API 210 to receive and manage the packet)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as sending the packet to the controller as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claims 23 and 54, Dolganow as modified by Nguyen discloses the method according to claim 20, however, Nguyen further discloses wherein the instruction is 'probe' , 'mirror', or 'terminate' instruction, and upon receiving by the network node the 'probe' instruction and responsive to the packet satisfying the criterion, the method further comprising: sending the packet, by the network node, to the controller **(Nguyen, Fig. 2, para. 19: controller API 210 to receive and manage the packet)**; responsive to receiving the packet, analyzing the packet, by the controller **(Nguyen, Fig. 2, para. 19: controller API 210 to receive and manage the packet)**; sending the packet, by the controller, to the network node; and responsive to receiving the packet, sending the packet, by the network node, to the second entity **(Nguyen, para. 21: Nguyen, Fig. 3, para. 21: sending the packet to the next table for processing if the packet that satisfies the criteria in the matching filter)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as sending the packet to the controller as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claims 24, 25 and 55, Dolganow as modified by Nguyen discloses the method according to claim 20, further comprising responsive to the packet satisfying the criterion and to the instruction, sending the packet or a portion thereof, by the network node, to the controller **(Nguyen, Fig. 2, para. 19: controller API 210 to receive and manage the packet)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as sending the packet to the controller as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claims 26 and 56, Dolganow as modified by Nguyen discloses the method according to claim 24, however, Nguyen further comprising responsive to the packet satisfying the criterion and to the instruction, sending a portion of the packet, by the network node, to the controller **(Nguyen, Fig. 2, para. 19: controller API 210 to receive and manage the packet)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as sending the packet to the controller as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claims 27 and 57, Dolganow as modified by Nguyen discloses the method according to claim 26, wherein the portion of the packet consists of multiple consecutive bytes, and wherein the instruction comprises identification of the consecutive bytes in the packet **(Dolganow, para. 69: DPI B 136 performs deep packet inspection on the packets relating to the request to attempt to extract a key identifying the P2P content transmitted in the flow. For example, when the protocol is BitTorrent, DPI B 136 may perform deep packet inspection to determine whether an info_hash field is present in the packets of the flow)**.

Regarding claim 28, Dolganow as modified by Nguyen discloses the method according to claim 24, however, Nguyen further comprising responsive to receiving the packet, analyzing the packet, by the controller **(Nguyen, Fig. 2, para. 19: controller API 210 to receive and manage the packet)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as analyzing the packet, by the controller as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claim 29, Dolganow as modified by Nguyen discloses the method according to claim 28, However, Nguyen further for use with an application server that communicates with the controller, wherein the analyzing comprising sending the packet, by the controller, to the application server, and analyzing the packet by the application server **(Nguyen, Fig. 2, para. 19: controller API 210 to receive and manage the packet)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as sending the packet, by the controller, to the application server, and analyzing the packet by the application server as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claim 30, Dolganow as modified by Nguyen discloses the method according to claim 29, however, Nguyen wherein the analyzing further comprising sending the packet after analyzing by the application server to the controller, and sending the packet, after receiving from the controller by the network node, to the second entity **(Nguyen, Fig. 2, para. 19: controller API 210 to receive and manage the packet)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as sending the packet, by the controller, to the application server, and analyzing the packet by the application server as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claim 31, Dolganow as modified by Nguyen discloses the method according to claim 28, wherein the analyzing comprises applying security or data analytic application **(Dolganow, Fig. 4A, para. 60: DPI A 134 identifies an application protocol associated with the IP flow using one or more packets belonging to the IP flow or any other related information, such as packets belonging to other flows)**.

Regarding claim 32, Dolganow as modified by Nguyen discloses the method according to claim 28, wherein the analyzing comprises applying security application that comprises firewall or intrusion detection functionality **(Dolganow, Fig. 4A, para. 60: DPI A 134 identifies an application protocol associated with the IP flow using one or more packets belonging to the IP flow or any other related information, such as packets belonging to other flows)**.

Regarding claim 33, Dolganow as modified by Nguyen discloses the method according to claim 28, wherein the analyzing comprises performing Deep Packet Inspection (DPI) or using a DPI engine on the packet **(Dolganow, para. 12: performing DPI to extract a key from one or more of the first plurality of packets)**.

Regarding claim 34, Dolganow as modified by Nguyen discloses the method according to claim 28, wherein the packet comprises distinct header and payload fields, and wherein the analyzing comprises checking part of, or whole of, the payload field

(Dolganow, para. 52-54, 57: Key field 210 may indicate the value of a key used to uniquely identify a P2P content item. This field 210 may be populated when extracted from a request sent from P2P client 110 to P2P central entity 150, provided that the request includes the key).

Regarding claims 35 and 58, Dolganow as modified by Nguyen discloses the method according to claim 20, wherein the packet comprises distinct header and payload fields, the header comprises one or more flag bits, and wherein the packet-applicable criterion is that one or more of the flag bits is set **(Dolganow, para. 34, 43: P2P central entity 150 may be a BitTorrent tracker configured to receive a request including an info_hash from P2P client 110 and respond with a list containing location information of P2P client peers 160 that maintain the requested P2P content)**.

Regarding claims 36 and 59, Dolganow as modified by Nguyen discloses the method according to claim 35, wherein the packet is an Transmission Control Protocol (TCP) packet, and wherein the one or more flag bits comprises comprise a SYN flag bit, an ACK flag bit, a FIN flag bit, a RST flag bit, or any combination thereof **Nguyen, para. 17, 30: control packets typically carry device control information or communication protocol data that allows devices to communicate packet forwarding logic with each other, routing and discovery protocol, data packets that requirement additional attention, processing configurations, device**

configurations, and/or a variety of other control packet information known in the art).

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as the packet is an Transmission Control Protocol (TCP) packet, and wherein the one or more flag bits comprises comprise a SYN flag bit, an ACK flag bit, a FIN flag bit, a RST flag bit, or any combination thereof as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claims 37 and 60, Dolganow as modified by Nguyen discloses the method according to claim 20, wherein the packet comprises distinct header and payload fields, the header comprises at least the first and second entities addresses in the packet network, and wherein the packet-applicable criterion is that the first entity address, the second entity address, or both match a predetermined address or addresses **(Dolganow, para. 39, 55, 62: DPI A 134 may determine whether the source or destination address of the packets is the address of a system known to operate as a P2P central entity 150, such as a BitTorrent tracker. Suitable alternatives for determining whether the exchange is between a P2P client 110 and a P2P central entity 150 will be apparent to those of skill in the art)**.

Regarding claims 38 and 61, Dolganow as modified by Nguyen discloses the method according to claim 37, wherein the addresses are Internet Protocol (IP) addresses **(Dolganow, para. 39, 55, 62: addresses are IP addresses)**.

Regarding claims 39 and 62, Dolganow as modified by Nguyen discloses the method according to claim 20, wherein the packet is an Transmission Control Protocol (TCP) packet that comprises source and destination TCP ports, a TCP sequence number, and a TCP sequence mask fields, and wherein the packet-applicable criterion is that the source TCP port, the destination TCP port, the TCP sequence number, the TCP sequence mask, or any combination thereof, matches a predetermined value or values **(Dolganow, para. 39, 55, 62: It should be apparent that an IP flow may be any IP flow between P2P client 110 and P2P central entity 150 or P2P client 110 and a P2P client peer 160, as identifiable by IP 5-tuple information, which includes the source IP address, source port, destination IP address, destination port, and protocol of the IP flow. This IP flow may be further tunneled inside another networking layer, such as IP, Ethernet, ATM, and the like)**.

Regarding claims 40 and 63, Dolganow as modified by Nguyen discloses the method according to claim 20, wherein the packet network comprises a Wide Area Network (WAN), Local Area Network (LAN), the Internet, Metropolitan Area Network (MAN), Internet Service Provider (ISP) backbone, datacenter network, or inter-datacenter network **(Dolganow, Figs 1, 2, para. 28: Network element 130a may be an entity containing components configured to receive, process, and forward**

packets belonging to an IP flow received from packet-switched network 120. As an example, network element 130a may be owned and/or operated by an Internet Service Provider (ISP) providing services to P2P client 110. Network element 130a may include a router/switch 132, DPI A 134, DPI B 136, and key storage module 138).

Regarding claims 41 and 64, Dolganow as modified by Nguyen discloses the (New) The method according to claim 20, wherein the first entity is a server device and the second entity is a client device, or wherein the first entity is a client device and the second entity is a server device **(Dolganow, Fig. 1: entity 150 is a central entity (such as a server) and entity 160 is a client device)**.

Regarding claims 42 and 65, Dolganow as modified by Nguyen discloses the method according to claim 41, wherein the server device comprises a web server, and wherein the client device comprises a smartphone, a tablet computer, a personal computer, a laptop computer, or a wearable computing device **(Dolganow, para. 34: P2P central entity 150 may store a database of information maintained within a particular P2P network, such that a user may search P2P central entity 150 to determine the location of desired content based on the file key)**.

Regarding claims 43 and 66, Dolganow as modified by Nguyen discloses the method according to claim 41, wherein the communication between the network node and the controller is based on, or uses, a standard protocol **(Dolganow, Fig. 2, para.**

18: the OpenFlow communications protocol, separate the data plane and the control plane, with the data plane remaining on the networking device and the control plane (containing the routing protocol and forwarding logic) moved to a controller platform typically running on an IHS coupled to the networking device).

Regarding claims 44 and 67, Dolganow as modified by Nguyen discloses the method according to claim 43, Nguyen further discloses wherein the standard protocol is according to, based on, or compatible with, an OpenFlow protocol version 1.3.3 or 1.4.0 **(Nguyen, para. 19, 30: standard protocol is according to an OpenFlow protocol)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as the standard protocol is according to, based on, or compatible with, an OpenFlow protocol as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claims 45 and 68, Dolganow as modified by Nguyen discloses the method according to claim 44, wherein the instruction comprises a Type-Length-Value (TLV) structure **(Dolganow, para. 53: Key field 210 may indicate the value of a key used to uniquely identify a P2P content item. This field 210 may be populated**

when extracted from a request sent from P2P client 110 to P2P central entity 150, provided that the request includes the key).

Regarding claims 46 and 69, Dolganow as modified by Nguyen discloses the method according to claim 20, wherein the network node comprises a router, a switch, or a bridge **(Dolganow, Fig. 1, para. 25, 27: network element 130a may include a router, a switch, or a bridge)**.

Regarding claims 47 and 70, Dolganow as modified by Nguyen discloses the method according to claim 20, wherein the packet network is an Internet Protocol (IP) network, and the packet is an IP packet **(Dolganow, para. 60, 62: DPI A 134 identifies an application protocol associated with the IP flow using one or more packets belonging to the IP flow or any other related information, such as packets belonging to other flows)**.

Regarding claims 48 and 71, Dolganow as modified by Nguyen discloses the method according to claim 47, wherein the packet network is an Transmission Control Protocol (TCP) network, and the packet is an TCP packet **(Dolganow, para. 39, 55, 62: It should be apparent that an IP flow may be any IP flow between P2P client 110 and P2P central entity 150 or P2P client 110 and a P2P client peer 160, as identifiable by IP 5-tuple information, which includes the source IP address, source port, destination IP address, destination port, and protocol of the IP flow.**

This IP flow may be further tunneled inside another networking layer, such as IP, Ethernet, ATM, and the like).

Regarding claims 49 and 72, Dolganow as modified by Nguyen discloses the method according to claim 20, further comprising: receiving, by the network node from the first entity over the packet network, one or more additional packets **(Dolganow, para. 12: a network element may receive a first and second plurality of packets transmitted between a peer-to-peer (P2P) client and a P2P central entity)**.

Dolganow does not appear to explicitly disclose checking, by the network node, if any one of the one or more additional packets satisfies the criterion; responsive to an additional packet not satisfying the criterion, sending, by the network node over the packet network, the additional packet to the second entity; and responsive to the additional packet satisfying the criterion, sending the additional packet, by the network node over the packet network, in response to the instruction.

Nguyen from similar field of endeavor discloses checking, by the network node, if any one of the one or more additional packets satisfies the criterion **(Nguyen, para. 32: determining if more packets satisfy the criterion)**; responsive to an additional packet not satisfying the criterion, sending, by the network node over the packet network, the additional packet to the second entity **(Nguyen, Fig. 3, para. 21: sending the packet to the next table for processing, and/or a variety of other flow processing actions if not satisfying the criterion)**; and responsive to the additional packet satisfying the criterion, sending the additional packet, by the network node over the packet network, in response to the instruction **(Nguyen, para. 21: Nguyen, Fig. 3, para. 21: sending the**

additional packets to the next table for processing if the packet that satisfies the criteria in the matching filter).

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as checking, by the network node, if any one of the one or more additional packets satisfies the criterion; responsive to an additional packet not satisfying the criterion, sending, by the network node over the packet network, the additional packet to the second entity; and responsive to the additional packet satisfying the criterion, sending the additional packet, by the network node over the packet network, in response to the instruction as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claims 50 and 73, Dolganow as modified by Nguyen discloses the method according to claim 20, Nguyen further discloses wherein the packet network is a Software Defined Network (SDN), the packet is routed as part of a data plane and the network node communication with the controller serves as a control plane **(Nguyen, para. 17, 18: a data plane or fast processing path where data packets are received, queued, processed, and then forwarded to the appropriate destination, and a control plane or slow processing path where communication protocols, configuration, and administration takes place)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as the packet network is a Software Defined Network (SDN), the packet is routed as part of a data plane and the network node communication with the controller serves as a control plane as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claim 51, Dolganow discloses a method for use with a packet network including a network node for transporting packets between first and second entities under control of a controller, the method by the network node comprising: receiving, from the controller, the instruction and the criterion **(Dolganow, para. 30; DPI devices 134, 136 may include hardware, instructions encoded on a machine-readable medium, or a combination thereof, such that DPI devices 134, 136 may be configured to examine data packets sent to router/switch 132 to identify information associated with the packets)**; receiving, from the first entity over the packet network, a packet addressed to the second entity **(Dolganow, para. 59; network element 130a, 130b may receive a number of packets belonging to an IP flow between a P2P client 110 and a P2P central entity 150)**.

Dolganow does not appear to explicitly disclose checking if the packet satisfies the criterion; responsive to the packet not satisfying the criterion, sending over the packet network, the packet to the second entity; and responsive to the packet satisfying the criterion, sending the packet over the packet network, in response to the instruction.

Nguyen from similar field of endeavor discloses checking if the packet satisfies the criterion **(Nguyen, para. 32: determining if the packet satisfies the criterion)**; responsive to the packet not satisfying the criterion, sending over the packet network, the packet to the second entity **(Nguyen, Fig. 3, para. 21: sending the packet to the next table for processing, and/or a variety of other flow processing actions if not satisfying the criterion)**; and responsive to the packet satisfying the criterion, sending the packet over the packet network, in response to the instruction **(Nguyen, para. 21: Nguyen, Fig. 3, para. 21: sending the packet to the next table for processing if the packet that satisfies the criteria in the matching filter)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as checking if the packet satisfies the criterion; responsive to the packet not satisfying the criterion, sending over the packet network, the packet to the second entity; and responsive to the packet satisfying the criterion, sending the packet over the packet network, in response to the instruction as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Conclusion

13. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

14. Agarwal et al. (US 20150124812 A1), BIFULCO et al. (US 20160020998 A1), DE FOY et al. (US 20160197831 A1), all cited to show systems which are considered pertinent to the claimed invention.

15. Any inquiry concerning this communication or earlier communications from the examiner should be directed to JEAN F VOLTAIRE whose telephone number is (571)272-3953. The examiner can normally be reached on M-F 9:00-6:45 PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, FARUK HAMZA can be reached on (571)272-7969. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a

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/JEAN F VOLTAIRE/
Examiner, Art Unit 2466
/JAE Y LEE/
Primary Examiner, Art Unit 2466

Notice of References Cited	Application/Control No. 15/126,288	Applicant(s)/Patent Under Reexamination BARSHESHET et al.	
	Examiner JEAN F VOLTAIRE	Art Unit 2466	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20100208590-A1	08-2010	Dolganow; Andrew	H04L43/026	370/235
*	B	US-20140052836-A1	02-2014	Nguyen; Cuong	H04L45/306	709/223
*	C	US-20150124812-A1	05-2015	Agarwal; Kanak B.	H04L45/24	370/392
*	D	US-20160020998-A1	01-2016	BIFULCO; Roberto	H04L45/64	370/235
*	E	US-20160197831-A1	07-2016	DE FOY; Xavier	H04L45/7453	370/392
	F					
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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
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NON-PATENT DOCUMENTS

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Search Notes	Application/Control No. 15/126,288	Applicant(s)/Patent Under Reexamination BARSHESHET et al.
	Examiner JEAN F VOLTAIRE	Art Unit 2466

CPC - Searched*		
Symbol	**Date**	**Examiner**
H04L43/026 H04L12/6418 H04L43/028 H04L49/70 H04L69/161	08/29/2018	JV

CPC Combination Sets - Searched*		
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US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**
370	389	08/29/2018	JV

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
Inventorship search for double patenting issue	08/29/2018	JV
Text search in East	08/29/2018	JV
Text search in 3gpp.org, ieee.org, google.com for NPL publication	08/29/2018	JV
Consulted with primary examiner Candal Elpenord	08/24/2018	JV

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**

Index of Claims	Application/Control No. 15/126,288	Applicant(s)/Patent Under Reexamination BARSHESHET et al.
	Examiner JEAN F VOLTAIRE	Art Unit 2466

✓	Rejected		-	Cancelled		N	Non-Elected		A	Appeal
=	Allowed		÷	Restricted		I	Interference		O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/21/2018								
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Index of Claims	Application/Control No. 15/126,288	Applicant(s)/Patent Under Reexamination BARSHESHET et al.
	Examiner JEAN F VOLTAIRE	Art Unit 2466

CLAIM		DATE								
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	15126288
	Filing Date	2016-09-15
	First Named Inventor	BARSHESHET, Yossi
	Art Unit	2466
	Examiner Name	VOLTAIRE, JEAN F
	Attorney Docket Number	ORCKIT-001-US

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	1	20130329734	A1	2013-12-12	CHESLA Avi et al	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15126288
	Filing Date	2016-09-15
	First Named Inventor	BARSHESHET, Yossi
	Art Unit	2466
	Examiner Name	VOLTAIRE, JEAN F
	Attorney Docket Number	ORCKIT-001-US

	1	Supplementary Search Report of EP 15783292 dated 07 November 2017	
	2	Seugwon Shin et al, "Fresco: Modular Composable Security Services for Software-Defined Networks", NDSS Symposium 2013, 23 April 2013, pages 1-16 XP055422187	

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EXAMINER SIGNATURE

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	Application Number	15126288
	Filing Date	2016-09-15
	First Named Inventor	BARSHESHET, Yossi
	Art Unit	2466
	Examiner Name	VOLTAIRE, JEAN F
	Attorney Docket Number	ORCKIT-001-US

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Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

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See attached certification statement.

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SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Yehuda Binder/	Date (YYYY-MM-DD)	2017-11-19
Name/Print	Yehuda Binder	Registration Number	73612

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
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S2	9	((Barsheshet)NEAR3(Yossi)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/08/14 19:59
S3	4	((Doctori)NEAR3(Simhon)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/08/14 20:00
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S6	39906	(H04L43/026 H04L12/6418 H04L43/028 H04L49/70 H04L69/161).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:04
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S33	5	"20130152187"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:22
S34	6	"20130121298"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:22
S35	10	"15126288"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/08/24 11:07
S36	7	"20140052836"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/08/24 11:22
S37	1140	(OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/24 11:26
S38	340	S37 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/24 11:26
S39	382	(SDN) same (packet PDU near2 (flow$1	US-PGPUB;	OR	OFF	2018/08/24

		stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			11:26
S40	91	S37 and (SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/24 11:27
S41	6	"L12" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:45
S42	4	"L13" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:45
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S44	3	"L15" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S45	3	"L16" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S46	4	"L17" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S47	4	"L18" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2018/08/27 07:46

			IBM_TDB			
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S49	39979	(H04L43/026 H04L12/6418 H04L43/028 H04L49/70 H04L69/161).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S50	416	S49 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S51	4	S46 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:47
S53	7	"L6" and (OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:48
S54	1	"L12" and (OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:49

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SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
15/126,288	09/15/2016 **RULE**	370	2466	ORCKIT-001-US

APPLICANTS
ORCKIT IP, LLC., Newton, MA;

INVENTORS
Yossi BARSHESHET, Ashdod, ISRAEL;
Simhon DOCTORI, Gan-Yavne, ISRAEL;
Ronen SOLOMON, Ranat-Gan, ISRAEL;

** **CONTINUING DATA** *************************
This application is a 371 of PCT/US2015/026869 04/21/2015
which claims benefit of 61/982,358 04/22/2014

** **FOREIGN APPLICATIONS** *************************

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12/27/2016

Foreign Priority claimed / 35 USC 119(a-d) conditions met / Verified and Acknowledged	Met after Allowance	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /JEAN F VOLTAIRE/ Examiner's Signature	☐ Met after Allowance Initials	ISRAEL	6	31	1

ADDRESS

May Patents Ltd. c/o Dorit Shem-Tov
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Ramat-Gan, 5217102
ISRAEL

TITLE

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	
	Filing Date	
	First Named Inventor	BARSHESHET, Yossi
	Art Unit	
	Examiner Name	
	Attorney Docket Number	ORCKIT-001-US

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	1	20100208590	A1	2010-08-19	ALCATEL LUCENT	
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	1	2672668	EP	A1	2013-12-11	JUNIPER NETWORKS INC		

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	Application Number	
	Filing Date	
	First Named Inventor	BARSHESHET, Yossi
	Art Unit	
	Examiner Name	
	Attorney Docket Number	ORCKIT-001-US

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	1	International Search Report of PCT/US2015/026869 dated 06 August 2015	

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Examiner Signature	/JEAN F VOLTAIRE/	Date Considered	08/14/2018

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	Application Number	
	Filing Date	
	First Named Inventor	BARSHESHET, Yossi
	Art Unit	
	Examiner Name	
	Attorney Docket Number	ORCKIT-001-US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Yehuda Binder/	Date (YYYY-MM-DD)	2016-09-15
Name/Print	Yehuda Binder	Registration Number	73612

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1 - 50 7,514,679 results

1. **A method and system for deep packet inspection in software defined networks**

A method for deep packet inspection (DPI) in a software defined network (SDN). The method includes configuring a plurality of network nodes operable in the SDN with at least one probe instruction; receiving from a network node a first packet of a flow, the first packet matches the at least one probe...

CURRENT ASSIGNEES: ORCKIT CORRIGENT LTD (+1)
US20170099196 | US APPLICATIONS | 06-APR-2017

2. **Controlled data network error recovery**

A method, a system and network nodes using indication of possible duplicates (IPD) of units, so that these units can be handled differently than other units. The unit is indicated to be a possible duplicate to the entity to which it is resent because no response was received from the entity it was...

CURRENT ASSIGNEES: MICROSOFT TECH LICENSING LLC
US20020009053 | US APPLICATIONS | 24-JAN-2002

3. **Selective Bicasting**

A method including receiving a packet and determining whether a bicast indication associated with the packet indicates that the packet has been transmitted to two or more access points; and dropping the packet in dependence on at least one criterion.

CURRENT ASSIGNEES: NOKIA SOLUTIONS & NETWORKS OY
US20150117313 | US APPLICATIONS | 30-APR-2015

4. **Prioritized handling of incoming packets by a network interface controller**

A network interface controller includes a host interface, which is configured to be coupled to a host processor having a host memory. A network interface is configured to receive data packets from a network, each data packet including a header, which includes header fields, and a payload including...

CURRENT ASSIGNEES: MELLANOX TECH LTD
US20180102976 | US APPLICATIONS | 12-APR-2018

5. **Prioritized Handling of Incoming Packets by a Network Interface Controller**

A network interface controller includes a host interface, which is configured to be coupled to a host processor having a host memory. A network interface is configured to receive data packets from a network, each data packet including a header, which includes header fields, and a payload including...

CURRENT ASSIGNEES: MELLANOX TECH LTD
US20130315237 | US APPLICATIONS | 28-NOV-2013

6. **Controlled data network error recovery**

A method, a system and network nodes use an indication of possible duplicates of units, so that these units can be handled differently than other units. The unit is indicated to be a possible duplicate to the entity to which it is resent because no response was received from the entity it was sent...

CURRENT ASSIGNEES: MICROSOFT TECH LICENSING LLC
US20080263424 | US APPLICATIONS | 23-OCT-2008

7. **Selective bicasting**

Top 1500 results

Relevance VIEW

0 Results

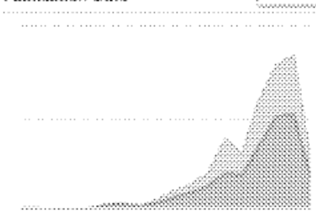
575 Results

925 Results

0 Results

0 Results

Publication Date VIEW



Cur Assignee by Relevance VIEW

- ORCKIT CORRIGENT LTD **(1)**
- MICROSOFT TECH LICENSI... **(18)**
- NOKIA SOLUTIONS & NET... **(21)**
- MELLANOX TECH LTD **(7)**
- NOKIA NETWORKS INC **(7)**
- NOKIA CORP **(44)**
- A10 NETWORKS INC **(7)**

View More Visualizations

Result #1 PREV NEXT

Electronic Acknowledgement Receipt

EFS ID:	34528122
Application Number:	15126288
International Application Number:	
Confirmation Number:	9263
Title of Invention:	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS
First Named Inventor/Applicant Name:	Yossi BARSHESHET
Customer Number:	131926
Filer:	Yehuda Binder/Dorit Binder
Filer Authorized By:	Yehuda Binder
Attorney Docket Number:	ORCKIT-001-US
Receipt Date:	10-DEC-2018
Filing Date:	15-SEP-2016
Time Stamp:	04:21:03
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	9-2018-NFOA-Response.pdf	54113 77b7f68cae35f4d195766e2bfb8839ccf6ca444f	no	9

Warnings:

Information:	
Total Files Size (in bytes):	54113

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

ATTY.'S DOCKET: ORCKIT-001-US

In re Application of:	)	Confirmation No. 9263
Ronen Solomon	)	Art Unit: 2466
Appln. No.: 15/126,288	)	Examiner: Voltaire, Jean F.
Filed: September 15, 2016	)	Washington, D.C.
For: A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION …	)	December 9, 2018

AMENDMENT

Customer Service Window, Mail Stop Amendment
Honorable Commissioner for Patents
U.S. Patent and Trademark Office
Randolph Building, 401 Dulany Street
Alexandria, Virginia 22314

Sir:

This is in response to the examiner's action of September 12, 2018 ("Action").

Remarks / Arguments begin on page 2 of this paper.

REMARKS / ARGUMENTS

The Examiner’s Action dated September 12, 2018, has been received, and its content carefully noted.

Office action, Section 12, pages 4-22

Claims 20-73 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dolganow *et al.* (US 2010/0208590 – “Dolganow”) in view of Nguyen *et al.* (US 2014/0052836 – “Nguyen”).

Combining Dolganow and Nguyen.

a. The Action contends that the Dolganow and Nguyen are combined being in a ‘similar field of endeavor’. The applicant respectfully request a clear definition of the ‘field of endeavor’ as required by the rules. (MPEP 2141.01(a)(I) – ‘*The examiner must determine what is “analogous prior art” for the purpose of analyzing the obviousness of the subject matter at issue*’).

b. Applicant submits that the Dolganow and Nguyen references are directed towards respectively different purposes and are based on respectively different structures, and thus are not analogous to one another and cannot logically be combined. The Dolganow reference involves DPI, where packets are handled based on their content, while the Nguyen reference involves SDN, where packets are handled based on externally received instructions. For example, the Dolganow reference involves **OSI Layer 3** or above analysis, while the Nguyen reference involves local routing (**OSI Layer 2**) without any analysis of the packet content.

Further, while the Dolagnow reference is directed to **network traffic handling or routing devices**, such as routers or switches (Figure 1 and paragraphs 25 and 27), the Nguyen reference is directed to HIS which is an **end devices**, intended to generate of received information, such as '*personal computer, a PDA, a consumer electronic device, a display device*' as described in Figure 1 and paragraph 0015.

Hence, the two references are directed to different devices having different functionalities and differently handling traffic, and thus cannot be combined. It is respectfully submitted that it is simply not appropriate to select a secondary reference that happens to disclose, in isolation, a single feature, and conclude, without a proper basis, that it would be obvious to add that feature to another device in a different field.

c. It is further noted that MPEP §808.02(A) explicitly recites that **different classes** "*… shows that each invention has attained recognition in the art as a* ***separate subject*** *for inventive effort, and also a* ***separate field*** *of search.*" (Emphasis added). Furthermore, there is no suggestion or motivation to combine:

> *[W]hen art is directed to* ***a different purpose then a claimed invention,*** *an inventor would have less motivation or occasion to consider it.*

In re Oetiker, 977 F.2d 1443 (Fed. Cir. 1992).

The Dolganow reference is classified under U.S. Class 370/235 associated with "MULTIPLEX COMMUNICATIONS - DATA FLOW CONGESTION PREVENTION OR CONTROL", mainly focusing on regulating the amount of information transmitted through the network, while the Nguyen reference is classified under U.S. Class 709/223 associated with "ELECTRICAL COMPUTERS AND DIGITAL PROCESSING SYSTEMS: MULTICOMPUTER DATA TRANSFERRING - COMPUTER NETWORK MANAGING" - relating mainly to the managing the resources of the computers connected by a computer network. Thus, the two reference are in different fields.

d. Further, it would not be appropriate to base this rejection on a combination of these references because the devices and networks described in the Dolganow and Nguyen references are each self-contained and independently operate effectively.

> *Because each device independently operates effectively, a person having ordinary skill in the art, who was merely seeking to create a better device to drain fluids from a wound, would have no reason to combine the features of both devices into a single device.*

[Kinetic Concepts v. Smith and Nephew, 688 F.3d 1342, at 1369 (CAFC, 2012).] - See MPEP §2143.01.

e. The Action fails to explain HOW the device described in the Dolganow reference is being modified to include the limitations taught by the Nguyen reference. The Action only states that the missing limitations are disclosed by the Nguyen reference and as such may be combined. A clear explanation is required according to the rules.

Rationale for Combining Dolganow and Nguyen.

a. The rationale for combining is stated on page 6 as "… *to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality*". Assuming *arguendo* that such combination is properly made in accordance with prevailing U.S. patent law, it is respectfully submitted that SDN functionality is a technical functionality *per se*, and the Action fails to explain WHY such feature is required or is beneficial, and as such the rationale fails to explain **why** one of ordinary skill in the art at the time the invention was made would see any reason to combine the references in an attempt to arrive at the claimed invention. It is noted that "*Absent some articulated rationale for doing so, the Examiner's conclusory assertion is inadequate to support a conclusion of obviousness.*" See KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398, 418 (2007); see also In re Warner, 379 F.2d 1011, 1017 (CCPA 1967) ("*The legal conclusion of obviousness must be supported by facts. Where the legal conclusion is not supported by facts it cannot stand.*"). Further, even if the SDN is kind of advantage, none of the cited prior art references suggested that the primary reference could benefit from that advantage or was in need of that advantage. [See, e.g., Ex parte Saiki, No. 2000-0373, 2002 WL 32102452, at *3 (B.P.A.I. Jan. 17, 2002); Ex parte Burak, No. 2004-0823, 2004 WL 4981768, at *4 (Dec. 8, 2004)].

b. It is trivial, inherent, and self-evident that **<u>always</u>** adding a feature A to any device results in a device having a capability of feature A. Similarly, it is trivial, inherent, and self-evident that <u>always</u> adding the functionality of SDN to ANY system results in "*a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality*". Hence, the rationale provides no link to the specific present application, as required in MPEP 2143 that clearly states that "*Any rationale employed must provide* ***a link between the factual findings and the legal conclusion of obviousness.***" (Emphasis added), and "… *there must be "some articulated reasoning with some rational underpinning" to support the Examiner's findings and conclusion of obviousness*". See KSR Inti Co. v. Teleflex Inc., 550 U.S. 401, 418 (2007).

c. The Dolganow reference focuses on DPI of received packets, and acting upon the DPI analysis. However, the Dolganow reference is silent regarding any receiving any instruction of how to deal with received packet as known in SDN, and is in particular silent regarding routing any packet based on any received instruction or criteria. Adding such SDN functionalities inherently changes the scheme from DPI scheme, thus such modifications would change the principle of operation of the system described in the Dolganow reference, see 2143.01:

> *If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious.*

In re Ratti, 270 F.2d 810, 123 USPQ 349 (CCPA 1959).

d. In particular, such modification of the router or switch described in the Dolganow reference requires massive change of the device, to include means for receiving instruction via an additional port, storing these instructions and criteria, applying dedicated SDN software (such as OpenFlow) requiring massive hardware, processing power and software, and forwarding packets based on this criteria. Such modifications fundamentally and inherently change the conventional routing / switching functionalities described in the Dolganow reference, and would require a substantial reconstruction and redesign of the elements shown in the Dolganow reference as well as a change in the basic principles under which the Dolganow reference construction was designed to operate. (In re Ratti, 270 F.2d 810, 813 (CCPA 1959)): *"a change in the basic principles" refers to change that is fundamental in scope so as to relate to scientific or technical principles under which* *the invention is designed to operate.*". Further, such changes would render the Dolganow reference inoperable for its intended purpose since it could only operate in an SDN supported network.

Regarding claim 1.

a. Claim 1 explicitly recites the limitation of: "… *sending, by the controller to the network node over the packet network, an instruction and a packet-applicable criterion*". This limitation is not addressed by the Action. A prima facie case for obviousness "*requires a suggestion of all limitations in a claim,*" CFMT, Inc. v. Yieldup Int'l Corp., 349 F.3d 1333, 1342 (Fed. Cir. 2003). It is noted that the Dolganow reference fails to disclose any controller in general or any "*an instruction and a packet-applicable criterion*", and in particular fails to disclose the recited "… *sending, by the controller to the network node over the packet network, an instruction and a packet-applicable criterion*".

b. Claim 1 explicitly recites the limitation of: "… *receiving, by the network node from the controller, the instruction and the criterion*". The Action relies upon paragraphs 12, 30, and 81 of the Dolganow reference. HOWEVER, the Dolganow reference in general, and the cited paragraphs in particular, ONLY described receiving packets as part of the regular traffic to be analyzed, and are silent regarding any receiving from a controller in general, and receiving of '*the instruction and the criterion*' in particular.

Regarding claims 21-26, 28-30, 36, 44, 49-56, 59, 67, 72-73.

While these claims clearly define different features and functionalities, the Action improperly use the SAME rationale for combining with the Nguyen reference. First, the stated rationale is defective as described above. Second, using the SAME rationale clearly violates the fact that the Office must "*make the necessary findings and have an adequate 'evidentiary basis for its findings.*" [Quoting In re Nuvasive (Fed. Cir. 2016), internally quoting In re Lee (Fed. Cir. 2002)], and that the Office "*must examine the relevant data and articulate a satisfactory explanation for its actions* ***including a rational connection between the facts found and the choice made.***" Id. (Emphasis added). Further, In Broadcom Corp. v. Emulex Corp., 732 F.3d 1325, 1335 (Fed. Cir. 2013), the Court held that "*[a]n invention is not obvious just 'because all of the elements that comprise the invention were known in the prior art;' rather, a finding of obviousness at the time of the invention requires a 'plausible rational [sic] as to why the prior art references would have worked together.*". It is noted that "*Absent some articulated rationale for doing so, the Examiner's conclusory assertion is inadequate to support a conclusion of obviousness.*" See KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398, 418 (2007); see also In re Warner, 379 F.2d 1011, 1017 (CCPA 1967) ("*The legal conclusion of obviousness must be supported by facts. Where the legal conclusion is not supported by facts it cannot stand.*").

The absence of a reply to a specific rejection, issue, or comment, does not signify agreement with that rejection, issue, or comment. In addition, because the arguments made above may not be exhaustive, there may be reasons for patentability of any or all pending claims that have not been expressed.

Nothing in this reply should be understood as conceding any issue with regard to any claim, except as specifically stated in this reply, and the amendment of any claims does not necessarily signify concession of unpatentability to the claim before its amendment. It should further be understood that any filing of a terminal disclaimer to obviate a rejection based on nonstatutory double patenting is not an admission of the propriety of the rejection.

If the above arguments should not now place the application in the condition for allowance, the examiner is invited to call undersigned counsel to resolve any remaining issues.

Respectfully submitted,

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/126,288	09/15/2016	Yossi BARSHESHET	ORCKIT-001-US	9263

131926 7590 04/15/2019
May Patents Ltd. c/o Dorit Shem-Tov
P.O.B 7230
Ramat-Gan, 5217102
ISRAEL

EXAMINER	
VOLTAIRE, JEAN F	

ART UNIT	PAPER NUMBER
2466	

MAIL DATE	DELIVERY MODE
04/15/2019	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	**Application No.** 15/126,288	**Applicant(s)** BARSHESHET et al.	
	Examiner JEAN F VOLTAIRE	**Art Unit** 2466	**AIA (FITF) Status** Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 12/10/2018.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☑ This action is **FINAL.** 2b) ☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 20-73 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 20-73 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date ______.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date ______.

4) ☐ Other: ______.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Response to amendment

2. This is a Final Office action in response to applicant's remarks/arguments filed on 12/10/2018.

3. Status of the claims:

- Claims 20-73 have not been amended.
- Claims 20-73 are currently pending and have been examined.

Response to remarks/arguments

4. Applicant's remarks/arguments filed on 12/10/2018 with respect to the rejection of claims 20-73 have been fully considered but they are not persuasive.

5. On pages 2-7 of Applicant's remarks dated 12/10/2018, Applicant submits that ***the Dolganow and Nguyen references are directed towards respectively <u>different purposes</u> and are based on respectively <u>different structures</u>, and thus <u>are not analogous to one another</u> and <u>cannot logically be combined</u>***.

6. In response to applicant's argument that *Dolganow and Nguyen references* are nonanalogous arts, it has been held that a prior art reference must either be in the field of applicant's endeavor or, if not, then be reasonably pertinent to the particular problem with which the applicant was concerned, in order to be relied upon as a basis for

rejection of the claimed invention. See *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992). In this case, the combination of Dolganow and Nguyen allows for efficient deep packet inspection of traffic in cloud-based networks utilizing software defined networks (SDN).

7. In response to applicant's argument that Dolganow and Nguyen references are directed towards respectively different structures, a recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim. Moreover, the test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference; nor is it that the claimed invention must be expressly suggested in any one or all of the references. Rather, the test is what the combined teachings of the references would have suggested to those of ordinary skill in the art. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981).

8. In response to applicant’s argument that there is no teaching, suggestion, or motivation to combine the references, the examiner recognizes that obviousness may be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. See *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988), *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992), and *KSR International Co. v. Teleflex, Inc.*, 550 U.S. 398, 82 USPQ2d 1385 (2007). In this case,

the motivation to do so is found in Nguyen's reference, such that to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality. Such an advantage would include a flow-based handler receiving a packet, and determining that the packet is associated with a flow session and associating the rules with the packet.

9. **Regarding claim 1**, it is noted that claim 1 has been canceled by an Applicant preliminary amendment. The limitations agued by Applicant are disclosed in claim 20. On pages 7-9 of Applicants' remarks dated 12/10/2018, Applicant states that the office action has not addressed the limitation of: "... sending, by the controller to the network node the packet network, an instruction and a packet-applicable criterion", and "... receiving, by the network node from the controller, the instruction and the criterion", in particular fails to disclose any controller in general or any "an instruction and a packet-applicable criterion", as explicitly recited in claim 20.

10. In response to applicants' remarks, the Examiner respectfully disagrees because by virtue of performing sending and/or receiving implicitly implies the use of a controller. Although the Dolganow's reference does not explicitly disclose the controller, however, a machine-readable medium does inherently comprise a controller in order for it to function (i.e., sending and/or receiving). Moreover, Dolganow further discloses a method of sending/or receiving instructions encoded on a machine-readable medium, or a combination thereof, such that DPI devices 134, 136 may be configured to examine data packets sent to router/switch 132 to identify information associated with the packets, see at least paragraphs 12, 13, 28-31.

11. For at least the reasons provided above, applicants' remarks regarding independent claim 20 is not persuasive. Then independent claim 20 is not allowable over the cited prior art of record. Therefore, its dependent claims directly or indirectly are also not allowable based at least for the reasons provided above. Please see the rejection below.

Claim Rejections - 35 USC § 103

12. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

13. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

14. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

15. This application currently names joint inventors. In considering patentability of the claims the examiner presumes that the subject matter of the various claims was commonly owned as of the effective filing date of the claimed invention(s) absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and effective filing dates of each claim that was not commonly owned as of the effective filing date of the later invention in order for the examiner to consider the applicability of 35 U.S.C. 102(b)(2)(C) for any potential 35 U.S.C. 102(a)(2) prior art against the later invention.

16. Claims 20-73 is/are rejected under 35 U.S.C. 103 as being unpatentable over Dolganow et al. (US 2010/0208590 A1) in view of Nguyen et al. (US 2014/0052836 A1).

Regarding claim 20, Dolganow discloses a method for use with a packet network including a network node for transporting packets between first and second entities under control of a controller, the method comprising: sending, by the controller to the network node over the packet network, an instruction and a packet-applicable criterion **(Dolganow, para. 30; DPI devices 134, 136 may include hardware, instructions encoded on a machine-readable medium, or a combination thereof, such that DPI devices 134, 136 may be configured to examine data packets sent to router/switch 132 to identify information associated with the**

packets); receiving, by the network node from the controller, the instruction and the criterion **(Dolganow, para. 12, 30, 81; receiving all relevant information associated with the packets)**; receiving, by the network node from the first entity over the packet network, a packet addressed to the second entity **(Dolganow, para. 59: network element 130a, 130b may receive a number of packets belonging to an IP flow between a P2P client 110 and a P2P central entity 150)**.

Dolganow does not appear to explicitly disclose checking, by the network node, if the packet satisfies the criterion; responsive to the packet not satisfying the criterion, sending, by the network node over the packet network, the packet to the second entity; and responsive to the packet satisfying the criterion, sending the packet, by the network node over the packet network, in response to the instruction.

Nguyen from similar field of endeavor discloses checking, by the network node, if the packet satisfies the criterion **(Nguyen, para. 32: determining if the packet satisfies the criterion)**; responsive to the packet not satisfying the criterion, sending, by the network node over the packet network, the packet to the second entity **(Nguyen, Fig. 3, para. 21: sending the packet to the next table for processing, and/or a variety of other flow processing actions if not satisfying the criterion)**; and responsive to the packet satisfying the criterion, sending the packet, by the network node over the packet network, in response to the instruction **(Nguyen, para. 21: Nguyen, Fig. 3, para. 21: sending the packet to the next table for processing if the packet that satisfies the criteria in the matching filter)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as checking, by the network node, if the packet satisfies the criterion; responsive to the packet not satisfying the criterion, sending, by the network node over the packet network, the packet to the second entity; and responsive to the packet satisfying the criterion, sending the packet, by the network node over the packet network, in response to the instruction as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claims 21 and 52, Dolganow as modified by Nguyen discloses the method according to claim 20, wherein the instruction is 'probe', 'mirror', or 'terminate' instruction, and upon receiving by the network node the 'terminate' instruction, the method further comprising blocking, by the network node, the packet from being sent to the second entity and to the controller **(Dolganow, para. 50: this transmission may be accomplished by mirroring (i.e., duplicating) the packets in the IP flow that contain the key from DPI A 134 to DPI B 136. Alternatively, this transmission may be accomplished by redirecting (i.e., rerouting) the packets in the IP flow that contain the key from DPI A 134 to DPI B 136. As another alternative, DPI A 134 may build and send a message including the required information to DPI B 136)**.

Dolganow does not appear to disclose the packet is being sent to the controller.

Nguyen discloses the packet is being sent to the controller **(Nguyen, Fig. 2, para. 19: controller API 210 to receive and manage the packet)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as sending the packet to the controller as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claims 22 and 53, Dolganow as modified by Nguyen discloses the method according to claim 20, wherein the instruction is a 'probe', a 'mirror', or a 'terminate' instruction, and upon receiving by the network node the 'mirror' instruction and responsive to the packet satisfying the criterion, the method further comprising sending the packet, by the network node, to the second entity and to the controller **(Dolganow, para. 50, 59: Alternatively, this transmission may be accomplished by redirecting (i.e., rerouting) the packets in the IP flow that contain the key from DPI A 134 to DPI B 136. As another alternative, DPI A 134 may build and send a message including the required information to DPI B 136)**.

Dolganow does not appear to disclose the packet is being sent to the controller.

Nguyen discloses the packet is being sent to the controller **(Nguyen, Fig. 2, para. 19: controller API 210 to receive and manage the packet)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as sending the packet to the controller as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claims 23 and 54, Dolganow as modified by Nguyen discloses the method according to claim 20, however, Nguyen further discloses wherein the instruction is 'probe' , 'mirror', or 'terminate' instruction, and upon receiving by the network node the 'probe' instruction and responsive to the packet satisfying the criterion, the method further comprising: sending the packet, by the network node, to the controller **(Nguyen, Fig. 2, para. 19: controller API 210 to receive and manage the packet)**; responsive to receiving the packet, analyzing the packet, by the controller **(Nguyen, Fig. 2, para. 19: controller API 210 to receive and manage the packet)**; sending the packet, by the controller, to the network node; and responsive to receiving the packet, sending the packet, by the network node, to the second entity **(Nguyen, para. 21: Nguyen, Fig. 3, para. 21: sending the packet to the next table for processing if the packet that satisfies the criteria in the matching filter)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as sending the packet to the controller as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claims 24, 25 and 55, Dolganow as modified by Nguyen discloses the method according to claim 20, further comprising responsive to the packet satisfying the criterion and to the instruction, sending the packet or a portion thereof, by the network node, to the controller **(Nguyen, Fig. 2, para. 19: controller API 210 to receive and manage the packet)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as sending the packet to the controller as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claims 26 and 56, Dolganow as modified by Nguyen discloses the method according to claim 24, however, Nguyen further comprising responsive to the packet satisfying the criterion and to the instruction, sending a portion of the packet, by the network node, to the controller **(Nguyen, Fig. 2, para. 19: controller API 210 to receive and manage the packet)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as sending the packet to the controller as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claims 27 and 57, Dolganow as modified by Nguyen discloses the method according to claim 26, wherein the portion of the packet consists of multiple consecutive bytes, and wherein the instruction comprises identification of the consecutive bytes in the packet **(Dolganow, para. 69: DPI B 136 performs deep packet inspection on the packets relating to the request to attempt to extract a key identifying the P2P content transmitted in the flow. For example, when the protocol is BitTorrent, DPI B 136 may perform deep packet inspection to determine whether an info_hash field is present in the packets of the flow)**.

Regarding claim 28, Dolganow as modified by Nguyen discloses the method according to claim 24, however, Nguyen further comprising responsive to receiving the packet, analyzing the packet, by the controller **(Nguyen, Fig. 2, para. 19: controller API 210 to receive and manage the packet)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as analyzing the packet, by the controller as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claim 29, Dolganow as modified by Nguyen discloses the method according to claim 28, However, Nguyen further for use with an application server that communicates with the controller, wherein the analyzing comprising sending the packet, by the controller, to the application server, and analyzing the packet by the application server **(Nguyen, Fig. 2, para. 19: controller API 210 to receive and manage the packet)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as sending the packet, by the controller, to the application server, and analyzing the packet by the application server as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claim 30, Dolganow as modified by Nguyen discloses the method according to claim 29, however, Nguyen wherein the analyzing further comprising sending the packet after analyzing by the application server to the controller, and sending the packet, after receiving from the controller by the network node, to the second entity **(Nguyen, Fig. 2, para. 19: controller API 210 to receive and manage the packet)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as sending the packet, by the controller, to the application server, and analyzing the packet by the application server as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claim 31, Dolganow as modified by Nguyen discloses the method according to claim 28, wherein the analyzing comprises applying security or data analytic application **(Dolganow, Fig. 4A, para. 60: DPI A 134 identifies an application protocol associated with the IP flow using one or more packets belonging to the IP flow or any other related information, such as packets belonging to other flows)**.

Regarding claim 32, Dolganow as modified by Nguyen discloses the method according to claim 28, wherein the analyzing comprises applying security application that comprises firewall or intrusion detection functionality **(Dolganow, Fig. 4A, para. 60: DPI A 134 identifies an application protocol associated with the IP flow using one or more packets belonging to the IP flow or any other related information, such as packets belonging to other flows)**.

Regarding claim 33, Dolganow as modified by Nguyen discloses the method according to claim 28, wherein the analyzing comprises performing Deep Packet Inspection (DPI) or using a DPI engine on the packet **(Dolganow, para. 12: performing DPI to extract a key from one or more of the first plurality of packets)**.

Regarding claim 34, Dolganow as modified by Nguyen discloses the method according to claim 28, wherein the packet comprises distinct header and payload fields, and wherein the analyzing comprises checking part of, or whole of, the payload field **(Dolganow, para. 52-54, 57: Key field 210 may indicate the value of a key used to uniquely identify a P2P content item. This field 210 may be populated when extracted from a request sent from P2P client 110 to P2P central entity 150, provided that the request includes the key)**.

Regarding claims 35 and 58, Dolganow as modified by Nguyen discloses the method according to claim 20, wherein the packet comprises distinct header and payload fields, the header comprises one or more flag bits, and wherein the packet-applicable criterion is that one or more of the flag bits is set **(Dolganow, para. 34, 43: P2P central entity 150 may be a BitTorrent tracker configured to receive a request including an info_hash from P2P client 110 and respond with a list containing location information of P2P client peers 160 that maintain the requested P2P content)**.

Regarding claims 36 and 59, Dolganow as modified by Nguyen discloses the method according to claim 35, wherein the packet is an Transmission Control Protocol (TCP) packet, and wherein the one or more flag bits comprises comprise a SYN flag bit, an ACK flag bit, a FIN flag bit, a RST flag bit, or any combination thereof **Nguyen, para. 17, 30: control packets typically carry device control information or communication protocol data that allows devices to communicate packet**

forwarding logic with each other, routing and discovery protocol, data packets that requirement additional attention, processing configurations, device configurations, and/or a variety of other control packet information known in the art).

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as the packet is an Transmission Control Protocol (TCP) packet, and wherein the one or more flag bits comprises comprise a SYN flag bit, an ACK flag bit, a FIN flag bit, a RST flag bit, or any combination thereof as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claims 37 and 60, Dolganow as modified by Nguyen discloses the method according to claim 20, wherein the packet comprises distinct header and payload fields, the header comprises at least the first and second entities addresses in the packet network, and wherein the packet-applicable criterion is that the first entity address, the second entity address, or both match a predetermined address or addresses **(Dolganow, para. 39, 55, 62: DPI A 134 may determine whether the source or destination address of the packets is the address of a system known to operate as a P2P central entity 150, such as a BitTorrent tracker. Suitable alternatives for determining whether the exchange is between a P2P client 110 and a P2P central entity 150 will be apparent to those of skill in the art)**.

Regarding claims 38 and 61, Dolganow as modified by Nguyen discloses the method according to claim 37, wherein the addresses are Internet Protocol (IP) addresses **(Dolganow, para. 39, 55, 62: addresses are IP addresses)**.

Regarding claims 39 and 62, Dolganow as modified by Nguyen discloses the method according to claim 20, wherein the packet is an Transmission Control Protocol (TCP) packet that comprises source and destination TCP ports, a TCP sequence number, and a TCP sequence mask fields, and wherein the packet-applicable criterion is that the source TCP port, the destination TCP port, the TCP sequence number, the TCP sequence mask, or any combination thereof, matches a predetermined value or values **(Dolganow, para. 39, 55, 62: It should be apparent that an IP flow may be any IP flow between P2P client 110 and P2P central entity 150 or P2P client 110 and a P2P client peer 160, as identifiable by IP 5-tuple information, which includes the source IP address, source port, destination IP address, destination port, and protocol of the IP flow. This IP flow may be further tunneled inside another networking layer, such as IP, Ethernet, ATM, and the like)**.

Regarding claims 40 and 63, Dolganow as modified by Nguyen discloses the method according to claim 20, wherein the packet network comprises a Wide Area Network (WAN), Local Area Network (LAN), the Internet, Metropolitan Area Network (MAN), Internet Service Provider (ISP) backbone, datacenter network, or inter-datacenter network **(Dolganow, Figs 1, 2, para. 28: Network element 130a may be**

an entity containing components configured to receive, process, and forward packets belonging to an IP flow received from packet-switched network 120. As an example, network element 130a may be owned and/or operated by an Internet Service Provider (ISP) providing services to P2P client 110. Network element 130a may include a router/switch 132, DPI A 134, DPI B 136, and key storage module 138).

Regarding claims 41 and 64, Dolganow as modified by Nguyen discloses the (New) The method according to claim 20, wherein the first entity is a server device and the second entity is a client device, or wherein the first entity is a client device and the second entity is a server device **(Dolganow, Fig. 1: entity 150 is a central entity (such as a server) and entity 160 is a client device)**.

Regarding claims 42 and 65, Dolganow as modified by Nguyen discloses the method according to claim 41, wherein the server device comprises a web server, and wherein the client device comprises a smartphone, a tablet computer, a personal computer, a laptop computer, or a wearable computing device **(Dolganow, para. 34: P2P central entity 150 may store a database of information maintained within a particular P2P network, such that a user may search P2P central entity 150 to determine the location of desired content based on the file key)**.

Regarding claims 43 and 66, Dolganow as modified by Nguyen discloses the method according to claim 41, wherein the communication between the network node and the controller is based on, or uses, a standard protocol **(Dolganow, Fig. 2, para. 18: the OpenFlow communications protocol, separate the data plane and the control plane, with the data plane remaining on the networking device and the control plane (containing the routing protocol and forwarding logic) moved to a controller platform typically running on an IHS coupled to the networking device)**.

Regarding claims 44 and 67, Dolganow as modified by Nguyen discloses the method according to claim 43, Nguyen further discloses wherein the standard protocol is according to, based on, or compatible with, an OpenFlow protocol version 1.3.3 or 1.4.0 **(Nguyen, para. 19, 30: standard protocol is according to an OpenFlow protocol)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as the standard protocol is according to, based on, or compatible with, an OpenFlow protocol as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claims 45 and 68, Dolganow as modified by Nguyen discloses the method according to claim 44, wherein the instruction comprises a Type-Length-Value (TLV) structure **(Dolganow, para. 53: Key field 210 may indicate the value of a key used to uniquely identify a P2P content item. This field 210 may be populated**

when extracted from a request sent from P2P client 110 to P2P central entity 150, provided that the request includes the key).

Regarding claims 46 and 69, Dolganow as modified by Nguyen discloses the method according to claim 20, wherein the network node comprises a router, a switch, or a bridge **(Dolganow, Fig. 1, para. 25, 27: network element 130a may include a router, a switch, or a bridge)**.

Regarding claims 47 and 70, Dolganow as modified by Nguyen discloses the method according to claim 20, wherein the packet network is an Internet Protocol (IP) network, and the packet is an IP packet **(Dolganow, para. 60, 62: DPI A 134 identifies an application protocol associated with the IP flow using one or more packets belonging to the IP flow or any other related information, such as packets belonging to other flows)**.

Regarding claims 48 and 71, Dolganow as modified by Nguyen discloses the method according to claim 47, wherein the packet network is an Transmission Control Protocol (TCP) network, and the packet is an TCP packet **(Dolganow, para. 39, 55, 62: It should be apparent that an IP flow may be any IP flow between P2P client 110 and P2P central entity 150 or P2P client 110 and a P2P client peer 160, as identifiable by IP 5-tuple information, which includes the source IP address, source port, destination IP address, destination port, and protocol of the IP flow.**

This IP flow may be further tunneled inside another networking layer, such as IP, Ethernet, ATM, and the like).

Regarding claims 49 and 72, Dolganow as modified by Nguyen discloses the method according to claim 20, further comprising: receiving, by the network node from the first entity over the packet network, one or more additional packets **(Dolganow, para. 12: a network element may receive a first and second plurality of packets transmitted between a peer-to-peer (P2P) client and a P2P central entity)**.

Dolganow does not appear to explicitly disclose checking, by the network node, if any one of the one or more additional packets satisfies the criterion; responsive to an additional packet not satisfying the criterion, sending, by the network node over the packet network, the additional packet to the second entity; and responsive to the additional packet satisfying the criterion, sending the additional packet, by the network node over the packet network, in response to the instruction.

Nguyen from similar field of endeavor discloses checking, by the network node, if any one of the one or more additional packets satisfies the criterion **(Nguyen, para. 32: determining if more packets satisfy the criterion)**; responsive to an additional packet not satisfying the criterion, sending, by the network node over the packet network, the additional packet to the second entity **(Nguyen, Fig. 3, para. 21: sending the packet to the next table for processing, and/or a variety of other flow processing actions if not satisfying the criterion)**; and responsive to the additional packet satisfying the criterion, sending the additional packet, by the network node over the packet network, in response to the instruction **(Nguyen, para. 21: Nguyen, Fig. 3, para. 21: sending the**

additional packets to the next table for processing if the packet that satisfies the criteria in the matching filter).

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as checking, by the network node, if any one of the one or more additional packets satisfies the criterion; responsive to an additional packet not satisfying the criterion, sending, by the network node over the packet network, the additional packet to the second entity; and responsive to the additional packet satisfying the criterion, sending the additional packet, by the network node over the packet network, in response to the instruction as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claims 50 and 73, Dolganow as modified by Nguyen discloses the method according to claim 20, Nguyen further discloses wherein the packet network is a Software Defined Network (SDN), the packet is routed as part of a data plane and the network node communication with the controller serves as a control plane **(Nguyen, para. 17, 18: a data plane or fast processing path where data packets are received, queued, processed, and then forwarded to the appropriate destination, and a control plane or slow processing path where communication protocols, configuration, and administration takes place)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as the packet network is a Software Defined Network (SDN), the packet is routed as part of a data plane and the network node communication with the controller serves as a control plane as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Regarding claim 51, Dolganow discloses a method for use with a packet network including a network node for transporting packets between first and second entities under control of a controller, the method by the network node comprising: receiving, from the controller, the instruction and the criterion **(Dolganow, para. 30; DPI devices 134, 136 may include hardware, instructions encoded on a machine-readable medium, or a combination thereof, such that DPI devices 134, 136 may be configured to examine data packets sent to router/switch 132 to identify information associated with the packets)**; receiving, from the first entity over the packet network, a packet addressed to the second entity **(Dolganow, para. 59; network element 130a, 130b may receive a number of packets belonging to an IP flow between a P2P client 110 and a P2P central entity 150)**.

Dolganow does not appear to explicitly disclose checking if the packet satisfies the criterion; responsive to the packet not satisfying the criterion, sending over the packet network, the packet to the second entity; and responsive to the packet satisfying the criterion, sending the packet over the packet network, in response to the instruction.

Nguyen from similar field of endeavor discloses checking if the packet satisfies the criterion **(Nguyen, para. 32: determining if the packet satisfies the criterion)**; responsive to the packet not satisfying the criterion, sending over the packet network, the packet to the second entity **(Nguyen, Fig. 3, para. 21: sending the packet to the next table for processing, and/or a variety of other flow processing actions if not satisfying the criterion)**; and responsive to the packet satisfying the criterion, sending the packet over the packet network, in response to the instruction **(Nguyen, para. 21: Nguyen, Fig. 3, para. 21: sending the packet to the next table for processing if the packet that satisfies the criteria in the matching filter)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Nguyen by using the above features into the system of Dolganow such as checking if the packet satisfies the criterion; responsive to the packet not satisfying the criterion, sending over the packet network, the packet to the second entity; and responsive to the packet satisfying the criterion, sending the packet over the packet network, in response to the instruction as taught by Nguyen. The motivation for doing so would have been to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality.

Conclusion

17. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

18. Any inquiry concerning this communication or earlier communications from the examiner should be directed to JEAN F VOLTAIRE whose telephone number is (571)272-3953. The examiner can normally be reached on M-F 9:00-6:45 PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, FARUK HAMZA can be reached on (571)272-7969. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/JEAN F VOLTAIRE/
Examiner, Art Unit 2466

/FARUK HAMZA/
Supervisory Patent Examiner, Art Unit 2466

Notice of References Cited	Application/Control No. 15/126,288	Applicant(s)/Patent Under Reexamination BARSHESHET et al.	
	Examiner JEAN F VOLTAIRE	Art Unit 2466	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20100208590-A1	08-2010	Dolganow; Andrew	H04L43/026	370/235
*	B	US-20140052836-A1	02-2014	Nguyen; Cuong	H04L45/306	709/223
*	C	US-20150124812-A1	05-2015	Agarwal; Kanak B.	H04L45/24	370/392
*	D	US-20160020998-A1	01-2016	BIFULCO; Roberto	H04L45/64	370/235
*	E	US-20160197831-A1	07-2016	DE FOY; Xavier	H04L45/7453	370/392
	F					
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FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
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	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No. 15/126,288	Applicant(s)/Patent Under Reexamination BARSHESHET et al.
	Examiner JEAN F VOLTAIRE	Art Unit 2466

CPC - Searched*		
Symbol	**Date**	**Examiner**
H04L43/026 H04L12/6418 H04L43/028 H04L49/70 H04L69/161	08/29/2018	JV

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**
370	389	08/29/2018	JV

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
Inventorship search for double patenting issue	08/29/2018	JV
Text search in East	08/29/2018	JV
Text search in 3gpp.org, ieee.org, google.com for NPL publication	08/29/2018	JV
Consulted with primary examiner Candal Elpenord	08/24/2018	JV
Update text search	03/27/2019	JV
Consulted with Jae Y LEE	03/28/2019	JV

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**

/JEAN F VOLTAIRE/ Examiner, Art Unit 2466	

Index of Claims

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JEAN F VOLTAIRE	2466

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/21/2018	03/26/2019							
	1	-	-							
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	29	✓	✓							
	30	✓	✓							
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	38	✓	✓							
	39	✓	✓							
	40	✓	✓							
	41	✓	✓							
	42	✓	✓							

Index of Claims	Application/Control No. 15/126,288	Applicant(s)/Patent Under Reexamination BARSHESHET et al.
	Examiner JEAN F VOLTAIRE	Art Unit 2466

CLAIM		DATE								
Final	Original	07/21/2018	03/26/2019							
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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
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L7	815	DPI and ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/04/12 21:25
L8	249	DPI same (SDN) and (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:27
L9	460	(SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:29
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S3	4	((Doctori)NEAR3(Simhon)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/08/14 20:00
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S39	382	(SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/24 11:26
S40	91	S37 and (SDN) same (packet PDU near2	US-PGPUB;	OR	OFF	2018/08/24

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S42	4	"L13" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:45
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S48	3	"L19" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2018/08/27 07:46

			IBM_TDB			
S49	39979	(H04L43/026 H04L12/6418 H04L43/028 H04L49/70 H04L69/161).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S50	416	S49 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S51	4	S46 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:47
S53	7	"L6" and (OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:48
S54	1	"L12" and (OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:49
S55	404	DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/09/03 20:14
S56	1	"20170099196"	DERWENT	OR	OFF	2019/03/27 16:32
S57	1	"20100208590"	DERWENT	OR	OFF	2019/03/27 16:33
S58	1	"20140052836"	DERWENT	OR	OFF	2019/03/27 16:33
S59	3	"20100208590"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 16:59
S60	7	"20140052836"	US-PGPUB; USPAT; USOCR; FPRS;	OR	OFF	2019/03/27 17:04

			EPO; JPO; DERWENT; IBM_TDB			
S61	7	"L6" and (OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S62	4	"L17" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S63	4	S62 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S64	1524	"20170099196" "20020009053" "20150117313" "20180102976" "20130315237" "20080263424" "9391912" "20120020301" "9871734" "7417948" "8031593" "9178661" "20150350048" "20140181282" "9112807" "20170171085" "9853903" "20060153204" "20150289159" "9503365" "20040090923" "7242668" "8036107" "20130152187" "20130121298" "9220110" "8677489" "8577363" "20080049619" "20020196789" "20130198805" "20120142341" "20180167337" "6965666" "9277538" "10027559" "20160127223" "20170331750" "7852767" "20170104692" "6400681" "20150089048" "20150207724" "20140304776" "7917471" "20150085655" "7116661" "9894694" "20140194068" "20150305006" "20180167987" "20080052387" "20130100797" "20120201140" "20150295808" "20150207677" "9667556" "20150365879" "20150304209" "20140297847" "9485185" "20110116405" "9100285" "20160278140" "20170317933" "20170063660" "20080049624" "5282270" "20080049769" "20180091388" "9088581" "8780721" "20100085887" "20140064086" "9479506" "9661514" "20100054140" "9872185" "8743703" "20130322265" "9112729" "20110238985" "20080052401" "8670313" "20140050106" "20140043999" "20080052394" "20110289578" "20080049776" "20170257319"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42

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S66	1264	(OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S67	104	S66 and (SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2019/03/27 22:42

			IBM_TDB			
S68	1264	(OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:43
S69	478	DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:43
S70	3	370/389.ccls. and DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:44
S71	17590	370/389.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:44
S72	1	"15497119"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/28 10:50
S73	2	"15769777"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/28 13:55

4/12/2019 9:36:45 PM
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Visuals Query Results 0 Selected Sort: Relevance Cut-off: None De-dup: None

1 - 50 14,438,730 results

Top 1500 results

1. **A method and system for deep packet inspection in software defined networks**

A method for deep packet inspection (DPI) in a software defined network (SDN). The method includes configuring a plurality of network nodes operable in the SDN with at least one probe instruction; receiving from a network node a first packet of a flow, the first packet matches the at least one probe...

CURRENT ASSIGNEES: ORCKIT CORRIGENT LTD (+1)
US20170099196 | US APPLICATIONS | 06-APR-2017

2. **Selective bicasting**

A method including receiving a packet and determining whether a bicast indication associated with the packet indicates that the packet has been transmitted to two or more access points; and dropping the packet in dependence on at least one criterion.

CURRENT ASSIGNEES: NOKIA TECH OY
US9391912 | US PATENTS | 12-JUL-2016

3. **Selective Bicasting**

A method including receiving a packet and determining whether a bicast indication associated with the packet indicates that the packet has been transmitted to two or more access points; and dropping the packet in dependence on at least one criterion.

CURRENT ASSIGNEES: NOKIA TECH OY
US20150117313 | US APPLICATIONS | 30-APR-2015

4. **Selective bicasting**

A method comprising: receiving a packet and determining whether a bicast indication associated with the packet indicates that the packet has been transmitted to two or more access points; and dropping the packet in dependence on at least one criterion.

CURRENT ASSIGNEES: NOKIA SOLUTIONS & NETWORKS OY
EP2847877A1 | EPO APPLICATIONS | 18-MAR-2015

5. **Selective bicasting**

A method comprising: receiving a packet and determining whether a bicast indication associated with the packet indicates that the packet has been transmitted to two or more access points; and dropping the packet in dependence on at least one criterion.

CURRENT ASSIGNEES: NOKIA SOLUTIONS & NETWORKS OY
WO2013167360A1 | WIPO APPLICATIONS | 14-NOV-2013

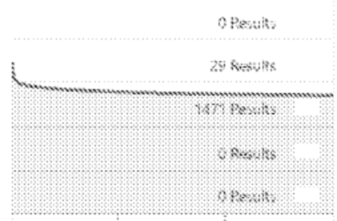
6. **User Defined Objects for Network Devices**

Provided are systems and methods for configuring a network servicing node with user-defined instruction scripts. A method for configuring a network servicing node with user-defined instruction scripts may commence with receiving, from a user of the network servicing node, a user loadable program...

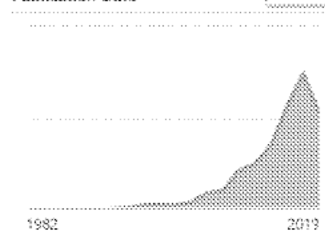
CURRENT ASSIGNEES: A10 NETWORKS INC
US20190089587 | US APPLICATIONS | 21-MAR-2019

7. **Lookahead computation of routing information**

Relevance VIEW



Publication Date VIEW



Cur Assignee by Relevance VIEW

- ORCKIT CORRIGENT LTD **(2)**
- NOKIA TECH OY **(12)**
- NOKIA SOLUTIONS & NET... **(30)**
- A10 NETWORKS INC **(15)**
- ALCATEL LUCENT **(27)**
- TELEFON AB LM ERICSSON... **(262)**
- NOKIA CORP **(36)**

View More Visualizations

Result #1 PREV NEXT

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	7	"L6" and (OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
L2	4	"L17" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
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			IBM_TDB			
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L9	478	DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:43
L10	3	370/389.ccls. and DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:44
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S1	10	"15126288"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 19:58
S2	9	((Barsheshet)NEAR3(Yossi)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/08/14 19:59
S3	4	((Doctori)NEAR3(Simhon)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/08/14 20:00
S4	91	((Solomon)NEAR3(Ronen)).INV.	US-PGPUB; USPAT; USOCR; FPRS;	ADJ	OFF	2018/08/14 20:00

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S6	39906	(H04L43/026 H04L12/6418 H04L43/028 H04L49/70 H04L69/161).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:04
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S8	3	"20100208590"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:07
S9	2	"20110264802"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:07
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S20	5	"20020009053"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:18
S21	6	"20150117313"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:18
S22	2	"20180102976"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:18
S23	3	"20130315237"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:19
S24	3	"20080263424"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:19
S26	5	"20120020301"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:20
S27	2	"20150350048"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2018/08/14 20:20

			IBM_TDB			
S28	4	"20140181282"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:20
S29	2	"20170171085"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:21
S30	3	"20060153204"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:21
S31	2	"20150289159"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:21
S32	6	"20040090923"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:22
S33	5	"20130152187"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:22
S34	6	"20130121298"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:22
S35	10	"15126288"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/08/24 11:07
S36	7	"20140052836"	US-PGPUB; USPAT; USOCR; FPRS;	ADJ	OFF	2018/08/24 11:22

			EPO; JPO; DERWENT; IBM_TDB			
S37	1140	(OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/24 11:26
S38	340	S37 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/24 11:26
S39	382	(SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/24 11:26
S40	91	S37 and (SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/24 11:27
S41	6	"L12" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:45
S42	4	"L13" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:45
S43	4	"L14" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:45
S44	3	"L15" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S45	3	"L16" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT;	OR	OFF	2018/08/27 07:46

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S46	4	"L17" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S47	4	"L18" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S48	3	"L19" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S49	39979	(H04L43/026 H04L12/6418 H04L43/028 H04L49/70 H04L69/161).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S50	416	S49 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S51	4	S46 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:47
S53	7	"L6" and (OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:48
S54	1	"L12" and (OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:49

S55	404	DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/09/03 20:14
S56	1	"20170099196"	DERWENT	OR	OFF	2019/03/27 16:32
S57	1	"20100208590"	DERWENT	OR	OFF	2019/03/27 16:33
S58	1	"20140052836"	DERWENT	OR	OFF	2019/03/27 16:33
S59	3	"20100208590"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 16:59
S60	7	"20140052836"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 17:04

3/ 27/ 2019 10:49:26 PM
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REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	15/126,288	Filing Date	2016-09-15	Docket Number (if applicable)	ORCKIT-001-US	Art Unit	2466
First Named Inventor	Yossi BARSHESHET			Examiner Name	VOLTAIRE, JEAN F		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☒ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

- ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on ____________
- ☐ Other ____________

☒ Enclosed

- ☒ Amendment/Reply
- ☐ Information Disclosure Statement (IDS)
- ☐ Affidavit(s)/ Declaration(s)
- ☐ Other ____________

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months ________
(Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other ____________

FEES

☒ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 600117

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature
Applicant Signature

PTO/SB/30EFS (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Signature of Registered U.S. Patent Practitioner			
Signature	/Yehuda Binder/	Date (YYYY-MM-DD)	2019-05-07
Name	BINDER Yehuda	Registration Number	73612

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	15126288
Filing Date:	15-Sep-2016
Title of Invention:	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS
First Named Inventor/Applicant Name:	Yossi BARSHESHET
Filer:	Yehuda Binder/Dorit Binder
Attorney Docket Number:	ORCKIT-001-US

Filed as Small Entity

Filing Fees for **U.S. National Stage under 35 USC 371**

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
RCE- 1ST REQUEST	2801	1	650	650
		Total in USD ($)		**650**

Electronic Acknowledgement Receipt

EFS ID:	35933135
Application Number:	15126288
International Application Number:	
Confirmation Number:	9263
Title of Invention:	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS
First Named Inventor/Applicant Name:	Yossi BARSHESHET
Customer Number:	131926
Filer:	Yehuda Binder/Dorit Binder
Filer Authorized By:	Yehuda Binder
Attorney Docket Number:	ORCKIT-001-US
Receipt Date:	07-MAY-2019
Filing Date:	15-SEP-2016
Time Stamp:	04:40:56
Application Type:	U.S. National Stage under 35 USC 371

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Submitted with Payment	yes
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RAM confirmation Number	050719INTEFSW00007838600117
Deposit Account	
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Continued Examination (RCE)	sb0030-RCE.pdf	1349928 aaaf83b971c9d9f0d4ba4c519f2a87b3df668930	no	3
Warnings:					
Information:					
2	Amendment Submitted/Entered with Filing of CPA/RCE	RCE-5-2019-FOA-Response.pdf	85356 a9a609262007adc7131f537bd7cc4887ad29fcde	no	21
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30275 6120917bf967c774515c2313f323281eea6495ca	no	2
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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
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New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

ATTY.'S DOCKET: ORCKIT-001-US

In re Application of:	Confirmation No. 9263
Ronen Solomon	Art Unit: 2466
Appln. No.: 15/126,288	Examiner: Voltaire, Jean F.
Filed: September 15, 2016	Washington, D.C.
For: A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION …	May 7, 2019

AMENDMENT

Customer Service Window, Mail Stop Amendment
Honorable Commissioner for Patents
U.S. Patent and Trademark Office
Randolph Building, 401 Dulany Street
Alexandria, Virginia 22314

Sir:

This is in response to the examiner's action of April 15, 2019 ("Action").

Amendments to the **Claims** appear in the Listing of Claims that begins on page **2** of this paper.

Remarks / Arguments begin on page **12** of this paper.

Amendments to the claims

This listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of claims:

1-19. (canceled)

20. (Currently amended) A method for use with a packet network including a network node for transporting packets between first and second entities under control of a controller that is external to the network node, the method comprising:

sending, by the controller to the network node over the packet network, an instruction and a packet-applicable criterion;

receiving, by the network node from the controller, the instruction and the criterion; receiving, by the network node from the first entity over the packet network, a packet addressed to the second entity;

checking, by the network node, if the packet satisfies the criterion;

responsive to the packet not satisfying the criterion, sending, by the network node over the packet network, the packet to the second entity; and

responsive to the packet satisfying the criterion, sending the packet, by the network node over the packet network, ~~in response to the instruction.~~ to an entity that is included in the instruction and is other than the second entity.

21. (Previously presented) The method according to claim 20, wherein the instruction is \`probe\`, \`mirror\`, or \`terminate\` instruction, and upon receiving by the network node the \`terminate\` instruction, the method further comprising

blocking, by the network node, the packet from being sent to the second entity and to the controller.

22. (Previously presented) The method according to claim 20, wherein the instruction is a `probe`, a `mirror`, or a `terminate` instruction, and upon receiving by the network node the `mirror` instruction and responsive to the packet satisfying the criterion, the method further comprising sending the packet, by the network node, to the second entity and to the controller.

23. (Previously presented) The method according to claim 20, wherein the instruction is `probe`, `mirror`, or `terminate` instruction, and upon receiving by the network node the `probe` instruction and responsive to the packet satisfying the criterion, the method further comprising: sending the packet, by the network node, to the controller; responsive to receiving the packet, analyzing the packet, by the controller; sending the packet, by the controller, to the network node; and responsive to receiving the packet, sending the packet, by the network node, to the second entity.

24. (Previously presented) The method according to claim 20, further comprising responsive to the packet satisfying the criterion and to the instruction, sending the packet or a portion thereof, by the network node, to the controller.

25. (Previously presented) The method according to claim 24, further comprising storing the received packet or a portion thereof, by the controller, in a memory.

26. (Previously presented) The method according to claim 24, further comprising responsive to the packet satisfying the criterion and to the instruction, sending a portion of the packet, by the network node, to the controller.

27. (Previously presented) The method according to claim 26, wherein the portion of the packet consists of multiple

consecutive bytes, and wherein the instruction comprises identification of the consecutive bytes in the packet.

28. (Previously presented) The method according to claim 24, further comprising responsive to receiving the packet, analyzing the packet, by the controller.

29. (Previously presented) The method according to claim 28, further for use with an application server that communicates with the controller, wherein the analyzing comprising sending the packet, by the controller, to the application server, and analyzing the packet by the application server.

30. (Previously presented) The method according to claim 29, wherein the analyzing further comprising sending the packet after analyzing by the application server to the controller, and sending the packet, after receiving from the controller by the network node, to the second entity.

31. (Previously presented) The method according to claim 28, wherein the analyzing comprises applying security or data analytic application.

32. (Previously presented) The method according to claim 28, wherein the analyzing comprises applying security application that comprises firewall or intrusion detection functionality.

33. (Previously presented) The method according to claim 28, wherein the analyzing comprises performing Deep Packet Inspection (DPI) or using a DPI engine on the packet.

34. (Previously presented) The method according to claim 28, wherein the packet comprises distinct header and payload fields, and wherein the analyzing comprises checking part of, or whole of, the payload field.

35. (Previously presented) The method according to claim 20, wherein the packet comprises distinct header and payload fields, the header comprises one or more flag bits, and wherein the packet-applicable criterion is that one or more of

the flag bits is set.

36. (Previously presented) The method according to claim 35, wherein the packet is an Transmission Control Protocol (TCP) packet, and wherein the one or more flag bits comprises comprise a SYN flag bit, an ACK flag bit, a FIN flag bit, a RST flag bit, or any combination thereof.

37. (Previously presented) The method according to claim 20, wherein the packet comprises distinct header and payload fields, the header comprises at least the first and second entities addresses in the packet network, and wherein the packet-applicable criterion is that the first entity address, the second entity address, or both match a predetermined address or addresses.

38. (Previously presented) The method according to claim 37, wherein the addresses are Internet Protocol (IP) addresses.

39. (Previously presented) The method according to claim 20, wherein the packet is an Transmission Control Protocol (TCP) packet that comprises source and destination TCP ports, a TCP sequence number, and a TCP sequence mask fields, and wherein the packet-applicable criterion is that the source TCP port, the destination TCP port, the TCP sequence number, the TCP sequence mask, or any combination thereof, matches a predetermined value or values.

40. (Previously presented) The method according to claim 20, wherein the packet network comprises a Wide Area Network (WAN), Local Area Network (LAN), the Internet, Metropolitan Area Network (MAN), Internet Service Provider (ISP) backbone, datacenter network, or inter-datacenter network.

41. (Previously presented) The method according to claim 20, wherein the first entity is a server device and the second entity is a client device, or wherein the first entity is a client device and the second entity is a server device.

42. (Previously presented) The method according to claim 41, wherein the server device comprises a web server, and wherein the client device comprises a smartphone, a tablet computer, a personal computer, a laptop computer, or a wearable computing device.

43. (Previously presented) The method according to claim 41, wherein the communication between the network node and the controller is based on, or uses, a standard protocol.

44. (Previously presented) The method according to claim 43, wherein the standard protocol is according to, based on, or compatible with, an OpenFlow protocol version 1.3.3 or 1.4.0.

45. (Previously presented) The method according to claim 44, wherein the instruction comprises a Type-Length-Value (TLV) structure.

46. (Previously presented) The method according to claim 20, wherein the network node comprises a router, a switch, or a bridge.

47. (Previously presented) The method according to claim 20, wherein the packet network is an Internet Protocol (IP) network, and the packet is an IP packet.

48. (Previously presented) The method according to claim 47, wherein the packet network is an Transmission Control Protocol (TCP) network, and the packet is an TCP packet.

49. (Previously presented) The method according to claim 20, further comprising:

receiving, by the network node from the first entity over the packet network, one or more additional packets; checking, by the network node, if any one of the one or more additional packets satisfies the criterion;

responsive to an additional packet not satisfying the criterion, sending, by the network node over the packet network, the additional packet to the second entity; and responsive to the additional packet satisfying the criterion, sending the additional packet, by the network node over the packet network, in response to the instruction.

50. (Previously presented) The method according to claim 20, wherein the packet network is a Software Defined Network (SDN), the packet is routed as part of a data plane and the network node communication with the controller serves as a control plane.

51. (Currently amended) A method for use with a packet network including a network node for transporting packets between first and second entities under control of a controller that is external to the network node, the method by the network node comprising:

receiving, from the controller, the instruction and the criterion;

receiving, from the first entity over the packet network, a packet addressed to the second entity;

checking if the packet satisfies the criterion;
responsive to the packet not satisfying the criterion, sending over the packet network, the packet to the second entity; and

responsive to the packet satisfying the criterion, sending the packet over the packet network, ~~in response to the instruction.~~ to an entity that is included in the instruction and is other than the second entity.

52. (Previously presented) The method according to claim 51, wherein the instruction is \`probe\`, \`mirror\`, or \`terminate\` instruction, and upon receiving the \`terminate\` instruction, the method further comprising blocking, the packet from being sent to the second entity and to the controller.

53. (Previously presented) The method according to claim 51, wherein the instruction is a \`probe\`, a \`mirror\`, or a \`terminate\` instruction, and upon receiving the \`mirror\` instruction and responsive to the packet satisfying the criterion, the method further comprising sending the packet to the second entity and to the controller.

54. (Previously presented) The method according to claim 51, wherein the instruction is \`probe\`, \`mirror\`, or \`terminate\` instruction, and upon receiving the \`probe\` instruction and responsive to the packet satisfying the criterion, the method further comprising: sending the packet to the controller;

receiving the packet, from the controller; and responsive to receiving the packet, sending the packet, to the second entity.

55. (Previously presented) The method according to claim 51, further comprising responsive to the packet satisfying the criterion and to the instruction, sending the packet or a portion thereof to the controller.

56. (Previously presented) The method according to claim 55, further comprising responsive to the packet satisfying the criterion and to the instruction, sending a portion of the packet to the controller.

57. (Previously presented) The method according to claim 56, wherein the portion of the packet consists of multiple consecutive bytes, and wherein the instruction comprises identification of the consecutive bytes in the packet.

58. (Previously presented) The method according to claim 51, wherein the packet comprises distinct header and payload fields, the header comprises one or more flag bits, and wherein the packet-applicable criterion is that one or more of the flag bits is set.

59. (Previously presented) The method according to claim 58, wherein the packet is an Transmission Control Protocol (TCP) packet, and wherein the one or more flag bits comprises comprise a SYN flag bit, an ACK flag bit, a FIN flag bit, a RST flag bit, or any combination thereof.

60. (Previously presented) The method according to claim 51, wherein the packet comprises distinct header and payload fields, the header comprises at least the first and second entities addresses in the packet network, and wherein the packet-applicable criterion is that the first entity address, the second entity address, or both match a predetermined address or addresses.

61. (Previously presented) The method according to claim 60, wherein the addresses are Internet Protocol (IP) addresses.
62. (Previously presented) The method according to claim 51, wherein the packet is an Transmission Control Protocol (TCP) packet that comprises source and destination TCP ports, a TCP sequence number, and a TCP sequence mask fields, and wherein the packet-applicable criterion is that the source TCP port, the destination TCP port, the TCP sequence number, the TCP sequence mask, or any combination thereof, matches a predetermined value or values.
63. (Previously presented) The method according to claim 51, wherein the packet network comprises a Wide Area Network (WAN), Local Area Network (LAN), the Internet, Metropolitan Area Network (MAN), Internet Service Provider (ISP) backbone, datacenter network, or inter-datacenter network.
64. (Previously presented) The method according to claim 51, wherein the first entity is a server device and the second entity is a client device, or wherein the first entity is a client device and the second entity is a server device.
65. (Previously presented) The method according to claim 64, wherein the server device comprises a web server, and wherein the client device comprises a smartphone, a tablet computer, a personal computer, a laptop computer, or a wearable computing device.
66. (Previously presented) The method according to claim 64, wherein the communication with the controller is based on, or uses, a standard protocol.
67. (Previously presented) The method according to claim 66, wherein the standard protocol is according to, based on, or compatible with, an OpenFlow protocol version 1.3.3 or 1.4.0.
68. (Previously presented) The method according to claim 67, wherein the instruction comprises a Type-Length-Value (TLV)

structure.

69. (Previously presented) The method according to claim 51, wherein the network node comprises a router, a switch, or a bridge.

70. (Previously presented) The method according to claim 51, wherein the packet network is an Internet Protocol (IP) network, and the packet is an IP packet.

71. (Previously presented) The method according to claim 70, wherein the packet network is a Transmission Control Protocol (TCP) network, and the packet is an TCP packet.

72. (Previously presented) The method according to claim 51, further comprising: receiving, from the first entity over the packet network, one or more additional packets; checking, if any one of the one or more additional packets satisfies the criterion; responsive to an additional packet not satisfying the criterion, sending over the packet network, the additional packet to the second entity; and responsive to the additional packet satisfying the criterion, sending the additional packet over the packet network, in response to the instruction.

73. (Previously presented) The method according to claim 51, wherein the packet network is a Software Defined Network (SDN), the packet is routed as part of a data plane and the communication with the controller serves as a control plane.

REMARKS / ARGUMENTS

The Examiner's Action dated April 15, 2019, has been received, and its content carefully noted.

Without agreeing with the Action, for the sake of furtherance of the prosecution, claim 20 is amended to recite that responsive to satisfying the criterion, the packet is sent to an entity other than the second entity to which the packet is addressed. It is noted that neither the Dolganow reference nor the Nguyen reference teach any sending of the packet to an entity or node that is not addressed to.

Office action, Section 12, pages 4-22

Claims 20-73 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dolganow *et al.* (US 2010/0208590 - "Dolganow") in view of Nguyen *et al.* (US 2014/0052836 - "Nguyen").

Combining Dolganow and Nguyen.

a. The former Action clearly stated that the references are being in a 'similar field of endeavor'. However, the current Action seems to state that the references are analogous as solving the same problem of "*… efficient deep packet inspection of traffic in cloud-based networks utilizing software defined networks (SDN)*" (Section 6 of the Action). The Action is clearly improperly shifting its position' resulting in 'moving target rejections for [applicant] to traverse'. [See In re Durance, No. 2017-1486, 2018 (Fed. Cir. June 1, 2018)].

b. It is noted that the Dolganow reference is silent regarding any '*cloud-based networks*' or regarding any '*software defined* *networks (SDN)'*. Similarly, the Nguyen reference does not mention or involves any '*cloud-based networks*' as stated in the problem definition. Hence, the stated problem is rendered moot regarding both references.

c. Further, claim 20 is clearly silent regarding any '*cloud-based networks*' or regarding any '*software defined networks (SDN)*', rendering the stated problem moot regarding the present application.

d. Further, it would not be appropriate to base this rejection on a combination of these references because the devices and networks described in the Dolganow and Nguyen references are each self-contained and independently operate effectively to solve the stated problem of DPI of traffic, and:

> *Because each device independently operates effectively, a person having ordinary skill in the art, who was merely seeking to create a better device to drain fluids from a wound, would have no reason to combine the features of both devices into a single device.*

[*Kinetic Concepts v. Smith and Nephew,* 688 F.3d 1342, at 1369 (CAFC, 2012).] - See MPEP §2143.01.

e. Applicant submits that the Dolganow and Nguyen references are directed towards respectively different purposes and are based on respectively different structures, and thus are not analogous to one another and cannot logically be combined. The Dolganow reference involves DPI, where packets are handled based on their content, while the Nguyen reference involves SDN, where packets are handled based on externally received instructions. For example, the Dolganow reference involves **OSI Layer 3** or above analysis, while the Nguyen reference involves local routing (**OSI Layer 2**) without any analysis of the packet content.

Further, while the Dolagnow reference is directed to **network traffic handling or routing devices**, such as routers or switches (Figure 1 and paragraphs 25 and 27), the Nguyen reference is directed to HIS which is an **end devices**, intended to generate of received information, such as '*personal computer, a PDA, a consumer electronic device, a display device*' as described in Figure 1 and paragraph 0015.

Hence, the two references are directed to different devices having different functionalities and differently handling traffic, and thus cannot be combined. It is respectfully submitted that it is simply not appropriate to select a secondary reference that happens to disclose, in isolation, a single feature, and conclude, without a proper basis, that it would be obvious to add that feature to another device in a different field.

f. It is further noted that MPEP §808.02(A) explicitly recites that **different classes** "… *shows that each invention has attained recognition in the art as a* ***separate subject*** *for inventive effort, and also a* ***separate field*** *of search.*" (Emphasis added). Furthermore, there is no suggestion or motivation to combine:

> *[W]hen art is directed to* ***a different purpose then a claimed invention,*** *an inventor would have less motivation or occasion to consider it.*

In re Oetiker, 977 F.2d 1443 (Fed. Cir. 1992).

The Dolganow reference is classified under U.S. Class 370/235 associated with "MULTIPLEX COMMUNICATIONS – DATA FLOW CONGESTION PREVENTION OR CONTROL", mainly focusing on regulating the amount of information transmitted through the network, while the Nguyen reference is classified under U.S. Class 709/223 associated with "ELECTRICAL COMPUTERS AND DIGITAL PROCESSING SYSTEMS: MULTICOMPUTER DATA TRANSFERRING - COMPUTER NETWORK MANAGING" - relating mainly to the managing the resources of the computers connected by a computer network. Thus, the two reference are in different fields.

g. The Action fails to explain HOW the device described in the Dolganow reference is being modified to include the limitations taught by the Nguyen reference. The Action only states that the missing limitations are disclosed by the Nguyen reference and as such may be combined. A clear explanation is required according to the rules.

Rationale for Combining Dolganow and Nguyen.

a. The rationale for combining is stated on page 6 as "… *to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality*". Assuming *arguendo* that such combination is properly made in accordance with prevailing U.S. patent law, it is respectfully submitted that SDN functionality is a technical functionality *per se*, and the Action fails to explain WHY such feature is required or is beneficial, and as such the rationale fails to explain **why** one of ordinary skill in the art at the time the invention was made would see any reason to combine the references in an attempt to arrive at the claimed invention. It is noted that "*Absent some articulated rationale for doing so, the Examiner's conclusory assertion is inadequate to support a conclusion of obviousness.*" See KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398, 418 (2007); see also In re Warner, 379 F.2d 1011, 1017 (CCPA 1967) ("*The legal conclusion of obviousness must be* *supported by facts. Where the legal conclusion is not supported by facts it cannot stand."*). Further, even if the SDN is kind of advantage, none of the cited prior art references suggested that the primary reference could benefit from that advantage or was in need of that advantage. [See, e.g., Ex parte Saiki, No. 2000-0373, 2002 WL 32102452, at *3 (B.P.A.I. Jan. 17, 2002); Ex parte Burak, No. 2004-0823, 2004 WL 4981768, at *4 (Dec. 8, 2004)].

b. It is trivial, inherent, and self-evident that **always** adding a feature A to any device results in a device having a capability of feature A. Similarly, it is trivial, inherent, and self-evident that always adding the functionality of SDN to ANY system results in "*a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality*". Hence, the rationale provides no link to the specific present application, as required in MPEP 2143 that clearly states that "*Any rationale employed must provide* ***a link between the factual findings and the legal conclusion of obviousness.***" (Emphasis added), and "… *there must be "some articulated reasoning with some rational underpinning" to support the Examiner's findings and conclusion of obviousness"*. See KSR Inti Co. v. Teleflex Inc., 550 U.S. 401, 418 (2007).

c. The Dolganow reference focuses on DPI of received packets, and acting upon the DPI analysis. However, the Dolganow reference is silent regarding any receiving any instruction of how to deal with received packet as known in SDN, and is in particular silent regarding routing any packet based on any received instruction or criteria. Adding such SDN functionalities inherently changes the scheme from DPI scheme, thus such modifications would change the principle of operation of the system described in the Dolganow reference, see 2143.01:

> *If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious.*

In re Ratti, 270 F.2d 810, 123 USPQ 349 (CCPA 1959).

d. In particular, such modification of the router or switch described in the Dolganow reference requires massive change of the device, to include means for receiving instruction via an additional port, storing these instructions and criteria, applying dedicated SDN software (such as OpenFlow) requiring massive hardware, processing power and software, and forwarding packets based on this criteria. Such modifications fundamentally and inherently change the conventional routing / switching functionalities described in the Dolganow reference, and would require a substantial reconstruction and redesign of the elements shown in the Dolganow reference as well as a change in the basic principles under which the Dolganow reference construction was designed to operate. (In re Ratti, 270 F.2d 810, 813 (CCPA 1959)): *"a change in the basic principles" refers to change that is fundamental in scope so as to relate to scientific or technical principles under which the invention is designed to operate."*. Further, such changes would render the Dolganow reference inoperable for its intended purpose since it could only operate in an SDN supported network.

Regarding claim 20.

a. Single vs. multiple networks. Claim 20 clearly recites a single packet network. In contrast, the Dolganow reference expressly teaches two different networks, namely 120 and 140, connected via the node 130a. Hence the

b. Missing limitations. Claim 20 explicitly recites the limitation of: "*… sending, by the controller to the network node over the packet network, an instruction and a packet-applicable criterion*". This limitation is not addressed by the Action. A prima facie case for obviousness "*requires a suggestion of all limitations in a claim,*" CFMT, Inc. v. Yieldup Int'l Corp., 349 F.3d 1333, 1342 (Fed. Cir. 2003). It is noted that the Dolganow reference fails to disclose any controller in general or any "*an instruction and a packet-applicable criterion*", and in particular fails to disclose the recited "*… sending, by the controller to the network node over the packet network, an instruction and a packet-applicable criterion*". Further, claim 20 explicitly recites the limitation of: "*… receiving, by the network node from the controller, the instruction and the criterion*". The Action relies upon paragraphs 12, 30, and 81 of the Dolganow reference. HOWEVER, the Dolganow reference in general, and the cited paragraphs in particular, ONLY described receiving packets as part of the regular traffic to be analyzed, and are silent regarding any receiving from a controller in general, and receiving of '*the instruction and the criterion*' in particular.

Section 10 of the Action seems to state that controller is inherent. First, such statement is improper since "'*The mere "Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is* *not sufficient*." In re Robertson, 169 F.3d 743, 745 (Fed. Cir. 1999) (citations omitted). Further, "*To rely upon a theory of inherency, there must be "a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teachings of the applied prior art.*" Ex-parte Levy, 17 USPQ2d 1461, 1464 (BPAI 1990).

Second, even if such controller is arguendo available, this does NOT teach the recited steps of sending and receiving. However, in order to further differentiate over the prior art claim 20 is amended to recite that the controller is <u>external to the network node</u>, which is NOT the case in the Dolganow reference.

<u>Regarding claims 21-26, 28-30, 36, 44, 49-56, 59, 67, 72-73.</u>

On section 11 of the Action, it is stated that "*Then claim 20 is not allowable over the cited prior art of record.* ***Therefore, its dependent claim directly or indirectly are also not allowable*** *based on at least for the reasons provided above.*" (Emphasis added).

First, it is noted that this statement is improper, since non-patentable independent claim **DOES NOT render its dependent claims as not-allowable.**

Second, the MPEP requires a full response and patentability analysis for EACH claim - MPEP 2103(C) states that: "*USPTO personnel should begin claim analysis by identifying and evaluating each claim limitation …. USPTO personnel are to correlate each claim limitation to all portions of the disclosure that describe the claim limitation.*"

<u>Improper rationale.</u>

The rationale for combining for ALL these claims is stated as "… *to build a SDN application that provides all of the desired SDN functionality in a system in order to implement a new SDN functionality*".

First, it is noted that the Dolganow reference is silent regarding any '*software defined networks (SDN)*' or any SDN functionality. Second, this rationale amounts to nothing more than a conclusory statement, while tt is the Office *prima facie* burden to provide a "satisfactory explanation" for the motivation finding that includes an express and "rational" connection with the evidence presented. Third, the fact that the SAME rationale is used provides no link to the present application, as required in MPEP 2143 that clearly states that "*Any rationale employed must provide* ***a link between the factual findings and the legal conclusion of obviousness.***" (Emphasis added), and "… there must be "*some articulated reasoning with some rational underpinning" to support the Examiner's findings and conclusion of obviousness*". See KSR Inti Co. v. Teleflex Inc., 550 U.S. 401, 418 (2007).

The absence of a reply to a specific rejection, issue, or comment, does not signify agreement with that rejection, issue, or comment. In addition, because the arguments made above may not be exhaustive, there may be reasons for patentability of any or all pending claims that have not been expressed.

Nothing in this reply should be understood as conceding any issue with regard to any claim, except as specifically stated in this reply, and the amendment of any claims does not necessarily signify concession of unpatentability to the claim before its amendment. It should further be understood that any filing of a terminal disclaimer to obviate a rejection based on nonstatutory double patenting is not an admission of the propriety of the rejection.

If the above arguments should not now place the application in the condition for allowance, the examiner is invited to call undersigned counsel to resolve any remaining issues.

Respectfully submitted,

By /Yehuda Binder/

Yehuda Binder
Registration No. 73,612

Tel: +972-9-7409241
Mobile: +972-54-4444577

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/126,288	Filing Date 09/15/2016	☐ To be Mailed

ENTITY: ☐ LARGE ☑ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	x $40 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	x $210 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED - PART II

AMENDMENT	05/07/2019	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 31	Minus	** 31	= 0	x $50 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0	x $230 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	0

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/GAIL D WOOTEN/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	15126288
	Filing Date	2016-09-15
	First Named Inventor	BARSHESHET, Yossi
	Art Unit	2466
	Examiner Name	VOLTAIRE, JEAN F
	Attorney Docket Number	ORCKIT-001-US

U.S.PATENTS

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	15126288
	Filing Date	2016-09-15
	First Named Inventor	BARSHESHET, Yossi
	Art Unit	2466
	Examiner Name	VOLTAIRE, JEAN F
	Attorney Docket Number	ORCKIT-001-US

	1	Minlan Yu et al, "Scalable flow-based networking with DIFANE", Proceedings of the ACM SIGCOMM 2010 Conference on Applications, Technologies, Architectures, and Protocols for Computer Communications, New Delhi, India, August 30-September 3, 2010, ACM, pages 351-362 XP058189957	

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15126288
	Filing Date	2016-09-15
	First Named Inventor	BARSHESHET, Yossi
	Art Unit	2466
	Examiner Name	VOLTAIRE, JEAN F
	Attorney Docket Number	ORCKIT-001-US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Yehuda Binder/	Date (YYYY-MM-DD)	2019-07-07
Name/Print	Yehuda Binder	Registration Number	73612

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	36510368
Application Number:	15126288
International Application Number:	
Confirmation Number:	9263
Title of Invention:	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS
First Named Inventor/Applicant Name:	Yossi BARSHESHET
Customer Number:	131926
Filer:	Yehuda Binder/Dorit Binder
Filer Authorized By:	Yehuda Binder
Attorney Docket Number:	ORCKIT-001-US
Receipt Date:	08-JUL-2019
Filing Date:	15-SEP-2016
Time Stamp:	04:45:23
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	IDS2.pdf	1035040 6f721acc01a39c718a2fcc9ddd32dfd0e5f480b2	no	4

Warnings:

Information:

A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.

2	Non Patent Literature	Scalable-Flow-Based-Networking.pdf	1532657 cea68c956cfae7070c757aff0ecee3930d53ba84	no	12

Warnings:

The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing

Information:

Total Files Size (in bytes):	2567697

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/126,288	09/15/2016	Yossi BARSHESHET	ORCKIT-001-US	9263

131926 7590 07/08/2019

May Patents Ltd. c/o Dorit Shem-Tov
P.O.B 7230
Ramat-Gan, 5217102
ISRAEL

EXAMINER	
VOLTAIRE, JEAN F	

ART UNIT	PAPER NUMBER
2466	

MAIL DATE	DELIVERY MODE
07/08/2019	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

PTOL-90A (Rev. 04/07)

Office Action Summary	**Application No.** 15/126,288	**Applicant(s)** BARSHESHET et al.	
	Examiner JEAN F VOLTAIRE	**Art Unit** 2466	**AIA (FITF) Status** Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 12/10/2018.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 20-73 is/are pending in the application.
5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 20-73 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Response to amendment

2. This is a Non-Final Office action in response to applicant's remarks/arguments filed on 05/07/2019.

3. Status of the claims:

- Claims 20 and 51 have been amended.
- Claims 20-73 are currently pending and have been examined.

Response to remarks/arguments

4. Applicant's remarks/arguments filed on 05/07/2019 with respect to the rejection of claims 20-73 have been fully considered but they are moot in view of the new ground(s) of rejection. Upon further search and consideration a new ground(s) of rejection is made in view of Huang et al. (US 20160219080 A1).

Please see the rejection below.

Claim Rejections - 35 USC § 103

5. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of

rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

6. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

7. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

8. This application currently names joint inventors. In considering patentability of the claims the examiner presumes that the subject matter of the various claims was commonly owned as of the effective filing date of the claimed invention(s) absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and effective filing dates of each claim that was not commonly owned as of the effective filing date of the later invention in order for the examiner to

consider the applicability of 35 U.S.C. 102(b)(2)(C) for any potential 35 U.S.C. 102(a)(2) prior art against the later invention.

9. Claims 20-73 is/are rejected under 35 U.S.C. 103 as being unpatentable over Dolganow et al. (US 2010/0208590 A1) in view of Huang et al. (US 20160219080 A1).

Regarding claim 20, Dolganow discloses a method for use with a packet network including a network node for transporting packets between first and second entities under control of a controller that is external to the network node, the method comprising: sending, by the controller to the network node over the packet network, an instruction and a packet-applicable criterion **(Dolganow, para. 30; DPI devices 134, 136 may include hardware, instructions encoded on a machine-readable medium, or a combination thereof, such that DPI devices 134, 136 may be configured to examine data packets sent to router/switch 132 to identify information associated with the packets)**; receiving, by the network node from the controller, the instruction and the criterion **(Dolganow, para. 12, 30, 81; receiving all relevant information associated with the packets)**; receiving, by the network node from the first entity over the packet network, a packet addressed to the second entity **(Dolganow, para. 59: network element 130a, 130b may receive a number of packets belonging to an IP flow between a P2P client 110 and a P2P central entity 150)**.

Dolganow does not appear to explicitly disclose checking, by the network node, if the packet satisfies the criterion; responsive to the packet not satisfying the criterion, sending, by the network node over the packet network, the packet to the second entity; and responsive to the packet satisfying the criterion, sending the packet, by the network node over the packet network, <u>to an entity that is included in the instruction and is other than the second entity.</u>

Huang from similar field of endeavor discloses checking, by the network node, if the packet satisfies the criterion **(Huang, Fig. 2, para. 52, 54: a traffic collection request is sent to an SDN controller via a network capacity control device according to a pre-set collection policy. The traffic collection request focuses on describing the application layer requirements, and the level of abstraction is relatively high)**; responsive to the packet not satisfying the criterion, sending, by the network node over the packet network, the packet to the second entity **(Huang, Fig. 2, para. 102: the traffic collection request is sent to the network controller via a network capacity control device according to the pre-set collection policy, wherein the traffic collection request is used for allowing the network controller to send the request for traffic collection to the one or more network devices to be analyzed and processed)**; responsive to the packet satisfying the criterion, sending the packet, by the network node over the packet network, <u>to an entity that is included in the instruction and is other than the second entity</u> **(Huang, Fig. 2, para. 54, 62, 69: after the network capacity control device receives the traffic collection request, parsing and processing are performed to form a traffic collection request which can be recognized by the SDN controller, and the traffic collection request which is parsed and processed is transmitted to the SDN controller via a northbound interface of the SDN controller)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Huang by using the above features into the system of Dolganow such as checking, by the network node, if the packet satisfies the criterion; responsive to the packet not satisfying the criterion, sending, by the network node over the packet network, the packet to the second entity; and responsive to the packet satisfying the criterion, sending the packet, by the network node over the packet network, to an entity that is included in the instruction and is other than the second entity as taught by Huang. The motivation for doing so would have been to realize data collection and transmission of a control policy for one end-to-multiple ends.

Regarding claims 21 and 52, Dolganow as modified by Huang discloses the method according to claim 20, wherein the instruction is 'probe', 'mirror', or 'terminate' instruction, and upon receiving by the network node the 'terminate' instruction, the method further comprising blocking, by the network node, the packet from being sent to the second entity and to the controller **(Dolganow, para. 50: this transmission may be accomplished by mirroring (i.e., duplicating) the packets in the IP flow that contain the key from DPI A 134 to DPI B 136. Alternatively, this transmission may be accomplished by redirecting (i.e., rerouting) the packets in the IP flow that contain the key from DPI A 134 to DPI B 136. As another alternative, DPI A 134 may build and send a message including the required information to DPI B 136)**.

Dolganow does not appear to disclose the packet is being sent to the controller.

Huang, from similar of endeavor, discloses the packet is being sent to the controller **(Huang, Fig. 1, 2, para. 36: the traffic collection request is sent to the SDN controller)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Huang by using the above features into the system of Dolganow such as sending the packet to the controller as taught by Huang. The motivation for doing so would have been to realize data collection and transmission of a control policy for one end-to-multiple ends.

Regarding claims 22 and 53, Dolganow as modified by Huang discloses the method according to claim 20, wherein the instruction is a 'probe', a 'mirror', or a 'terminate' instruction, and upon receiving by the network node the 'mirror' instruction and responsive to the packet satisfying the criterion, the method further comprising sending the packet, by the network node, to the second entity and to the controller **(Dolganow, para. 50, 59: Alternatively, this transmission may be accomplished by redirecting (i.e., rerouting) the packets in the IP flow that contain the key from DPI A 134 to DPI B 136. As another alternative, DPI A 134 may build and send a message including the required information to DPI B 136)**.

Dolganow does not appear to disclose the packet is being sent to the controller.

Huang, from similar of endeavor, discloses the packet is being sent to the controller **(Huang, Fig. 1, 2, para. 36: the traffic collection request is sent to the SDN controller)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Huang by using the above features into the system of Dolganow such as sending the packet to the controller as taught by Huang. The motivation for doing so would have been to realize data collection and transmission of a control policy for one end-to-multiple ends.

Regarding claims 23 and 54, Dolganow as modified by Huang discloses the method according to claim 20, however, Huang further discloses wherein the instruction is 'probe' , 'mirror', or 'terminate' instruction, and upon receiving by the network node the 'probe' instruction and responsive to the packet satisfying the criterion, the method further comprising: sending the packet, by the network node, to the controller **(Huang, Fig. 1, 2, para. 36: the traffic collection request is sent to the SDN controller)**; responsive to receiving the packet, analyzing the packet, by the controller **(Huang, Fig. 2, para. 41: the received traffic data are analyzed and processed by the SDN controller)**; sending the packet, by the controller, to the network node **(Huang, Fig. 2, para. 102: the traffic collection request is sent to the network controller via a network capacity control device according to the pre-set collection policy, wherein the traffic collection request is used for allowing the network controller to send the request for traffic collection to the one or more network devices to be analyzed and processed)**; and responsive to receiving the packet, sending the packet, by the network node, to the second entity **(Huang, Fig. 2, para. 54, 62, 69: after the network capacity control device receives the traffic collection request, parsing**

and processing are performed to form a traffic collection request which can be recognized by the SDN controller, and the traffic collection request which is parsed and processed is transmitted to the SDN controller via a northbound interface of the SDN controller).

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Huang by using the above features into the system of Dolganow such as sending the packet to the controller as taught by Huang. The motivation for doing so would have been to realize data collection and transmission of a control policy for one end-to-multiple ends.

Regarding claims 24, 25 and 55, Dolganow as modified by Huang discloses the method according to claim 20, further comprising responsive to the packet satisfying the criterion and to the instruction, sending the packet or a portion thereof, by the network node, to the controller **(Huang, Fig. 2, para. 54, 62, 69: after the network capacity control device receives the traffic collection request, parsing and processing are performed to form a traffic collection request which can be recognized by the SDN controller, and the traffic collection request which is parsed and processed is transmitted to the SDN controller via a northbound interface of the SDN controller)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Huang by using the above features into the system of Dolganow such as sending the packet to the controller as taught by Huang. The motivation for doing so would have been to realize data collection and transmission of a control policy for one end-to-multiple ends.

Regarding claims 26 and 56, Dolganow as modified by Huang discloses the method according to claim 24, however, Huang further comprising responsive to the packet satisfying the criterion and to the instruction, sending a portion of the packet, by the network node, to the controller **(Huang, Fig. 2, para. 54, 62, 69: after the network capacity control device receives the traffic collection request, parsing and processing are performed to form a traffic collection request which can be recognized by the SDN controller, and the traffic collection request which is parsed and processed is transmitted to the SDN controller via a northbound interface of the SDN controller)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Huang by using the above features into the system of Dolganow such as sending the packet to the controller as taught by Huang. The motivation for doing so would have been to realize data collection and transmission of a control policy for one end-to-multiple ends.

Regarding claims 27 and 57, Dolganow as modified by Huang discloses the method according to claim 26, wherein the portion of the packet consists of multiple consecutive bytes, and wherein the instruction comprises identification of the consecutive bytes in the packet **(Dolganow, para. 69: DPI B 136 performs deep packet inspection on the packets relating to the request to attempt to extract a key identifying the P2P content transmitted in the flow. For example, when the protocol is BitTorrent, DPI B 136 may perform deep packet inspection to determine whether an info_hash field is present in the packets of the flow)**.

Regarding claim 28, Dolganow as modified by Huang discloses the method according to claim 24, however, Huang further comprising responsive to receiving the packet, analyzing the packet, by the controller **(Huang, Fig. 2, para. 41: the received traffic data are analyzed and processed by the SDN controller)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Huang by using the above features into the system of Dolganow such as analyzing the packet, by the controller as taught by Huang. The motivation for doing so would have been to realize data collection and transmission of a control policy for one end-to-multiple ends.

Regarding claim 29, Dolganow as modified by Huang discloses the method according to claim 28, However, Huang further for use with an application server that communicates with the controller, wherein the analyzing comprising sending the packet, by the controller, to the application server, and analyzing the packet by the application server **(Huang, para. 98, 99: the network device can be an independent server, and can also be a server used for realizing a network controller)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Huang by using the above features into the system of Dolganow such as sending the packet, by the controller, to the application server, and analyzing the packet by the application server as taught by Huang. The motivation for doing so would have been to realize data collection and transmission of a control policy for one end-to-multiple ends.

Regarding claim 30, Dolganow as modified by Huang discloses the method according to claim 29, however, Huang wherein the analyzing further comprising sending the packet after analyzing by the application server to the controller, and sending the packet, after receiving from the controller by the network node, to the second entity **(Huang, para. 98, 99: the network device can be an independent server, and can also be a server used for realizing a network controller)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Huang by using the above features into the system of Dolganow such as sending the packet, by the controller, to the application server, and analyzing the packet by the application server as taught by Huang. The motivation for doing so would have been to realize data collection and transmission of a control policy for one end-to-multiple ends.

Regarding claim 31, Dolganow as modified by Huang discloses the method according to claim 28, wherein the analyzing comprises applying security or data analytic application **(Dolganow, Fig. 4A, para. 60: DPI A 134 identifies an application protocol associated with the IP flow using one or more packets belonging to the IP flow or any other related information, such as packets belonging to other flows)**.

Regarding claim 32, Dolganow as modified by Huang discloses the method according to claim 28, wherein the analyzing comprises applying security application that comprises firewall or intrusion detection functionality **(Dolganow, Fig. 4A, para. 60: DPI A 134 identifies an application protocol associated with the IP flow using one or more packets belonging to the IP flow or any other related information, such as packets belonging to other flows)**.

Regarding claim 33, Dolganow as modified by Huang discloses the method according to claim 28, wherein the analyzing comprises performing Deep Packet Inspection (DPI) or using a DPI engine on the packet **(Dolganow, para. 12: performing DPI to extract a key from one or more of the first plurality of packets)**.

Regarding claim 34, Dolganow as modified by Huang discloses the method according to claim 28, wherein the packet comprises distinct header and payload fields, and wherein the analyzing comprises checking part of, or whole of, the payload field **(Dolganow, para. 52-54, 57: Key field 210 may indicate the value of a key used to**

uniquely identify a P2P content item. This field 210 may be populated when extracted from a request sent from P2P client 110 to P2P central entity 150, provided that the request includes the key).

Regarding claims 35 and 58, Dolganow as modified by Huang discloses the method according to claim 20, wherein the packet comprises distinct header and payload fields, the header comprises one or more flag bits, and wherein the packet-applicable criterion is that one or more of the flag bits is set **(Dolganow, para. 34, 43: P2P central entity 150 may be a BitTorrent tracker configured to receive a request including an info_hash from P2P client 110 and respond with a list containing location information of P2P client peers 160 that maintain the requested P2P content)**.

Regarding claims 36 and 59, Dolganow as modified by Huang discloses the method according to claim 35, wherein the packet is an Transmission Control Protocol (TCP) packet, and wherein the one or more flag bits comprises comprise a SYN flag bit, an ACK flag bit, a FIN flag bit, a RST flag bit, or any combination thereof **Huang, para. 36: the traffic collection request contains some parameters for assigning contents to be collected, such as service flows from regular users, interconnection Internet Protocol (IP) flows between regular networks and traffics from regular ports. After the SDN controller receives the traffic collection request, the SDN controller parses and processes the same to determine one or more network devices which need the traffic collection request)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Huang by using the above features into the system of Dolganow such as the packet is an Transmission Control Protocol (TCP) packet, and wherein the one or more flag bits comprises comprise a SYN flag bit, an ACK flag bit, a FIN flag bit, a RST flag bit, or any combination thereof as taught by Huang. The motivation for doing so would have been to realize data collection and transmission of a control policy for one end-to-multiple ends.

Regarding claims 37 and 60, Dolganow as modified by Huang discloses the method according to claim 20, wherein the packet comprises distinct header and payload fields, the header comprises at least the first and second entities addresses in the packet network, and wherein the packet-applicable criterion is that the first entity address, the second entity address, or both match a predetermined address or addresses **(Dolganow, para. 39, 55, 62: DPI A 134 may determine whether the source or destination address of the packets is the address of a system known to operate as a P2P central entity 150, such as a BitTorrent tracker. Suitable alternatives for determining whether the exchange is between a P2P client 110 and a P2P central entity 150 will be apparent to those of skill in the art)**.

Regarding claims 38 and 61, Dolganow as modified by Huang discloses the method according to claim 37, wherein the addresses are Internet Protocol (IP) addresses **(Dolganow, para. 39, 55, 62: addresses are IP addresses)**.

Regarding claims 39 and 62, Dolganow as modified by Huang discloses the method according to claim 20, wherein the packet is an Transmission Control Protocol (TCP) packet that comprises source and destination TCP ports, a TCP sequence number, and a TCP sequence mask fields, and wherein the packet-applicable criterion is that the source TCP port, the destination TCP port, the TCP sequence number, the TCP sequence mask, or any combination thereof, matches a predetermined value or values **(Dolganow, para. 39, 55, 62: It should be apparent that an IP flow may be any IP flow between P2P client 110 and P2P central entity 150 or P2P client 110 and a P2P client peer 160, as identifiable by IP 5-tuple information, which includes the source IP address, source port, destination IP address, destination port, and protocol of the IP flow. This IP flow may be further tunneled inside another networking layer, such as IP, Ethernet, ATM, and the like)**.

Regarding claims 40 and 63, Dolganow as modified by Huang discloses the method according to claim 20, wherein the packet network comprises a Wide Area Network (WAN), Local Area Network (LAN), the Internet, Metropolitan Area Network (MAN), Internet Service Provider (ISP) backbone, datacenter network, or inter-datacenter network **(Dolganow, Figs 1, 2, para. 28: Network element 130a may be an entity containing components configured to receive, process, and forward packets belonging to an IP flow received from packet-switched network 120. As an example, network element 130a may be owned and/or operated by an Internet Service Provider (ISP) providing services to P2P client 110. Network element 130a**

may include a router/switch 132, DPI A 134, DPI B 136, and key storage module 138).

Regarding claims 41 and 64, Dolganow as modified by Huang discloses the (New) The method according to claim 20, wherein the first entity is a server device and the second entity is a client device, or wherein the first entity is a client device and the second entity is a server device **(Dolganow, Fig. 1: entity 150 is a central entity (such as a server) and entity 160 is a client device)**.

Regarding claims 42 and 65, Dolganow as modified by Huang discloses the method according to claim 41, wherein the server device comprises a web server, and wherein the client device comprises a smartphone, a tablet computer, a personal computer, a laptop computer, or a wearable computing device **(Dolganow, para. 34: P2P central entity 150 may store a database of information maintained within a particular P2P network, such that a user may search P2P central entity 150 to determine the location of desired content based on the file key)**.

Regarding claims 43 and 66, Dolganow as modified by Huang discloses the method according to claim 41, wherein the communication between the network node and the controller is based on, or uses, a standard protocol **(Dolganow, Fig. 2, para. 18: the OpenFlow communications protocol, separate the data plane and the control plane, with the data plane remaining on the networking device and the**

control plane (containing the routing protocol and forwarding logic) moved to a controller platform typically running on an IHS coupled to the networking device).

Regarding claims 44 and 67, Dolganow as modified by Huang discloses the method according to claim 43, Huang further discloses wherein the standard protocol is according to, based on, or compatible with, an OpenFlow protocol version 1.3.3 or 1.4.0 **(Huang, para. 36: the traffic collection request is sent to the SDN controller according to the pre-set collection policy. The traffic collection request contains some parameters for assigning contents to be collected, such as service flows from regular users, interconnection Internet Protocol (IP) flows between regular networks and traffics from regular ports. After the SDN controller receives the traffic collection request, the SDN controller parses and processes the same to determine one or more network devices which need the traffic collection request)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Huang by using the above features into the system of Dolganow such as the standard protocol is according to, based on, or compatible with, an OpenFlow protocol as taught by Huang. The motivation for doing so would have been to realize data collection and transmission of a control policy for one end-to-multiple ends.

Regarding claims 45 and 68, Dolganow as modified by Huang discloses the method according to claim 44, wherein the instruction comprises a Type-Length-Value (TLV) structure **(Dolganow, para. 53: Key field 210 may indicate the value of a key**

used to uniquely identify a P2P content item. This field 210 may be populated when extracted from a request sent from P2P client 110 to P2P central entity 150, provided that the request includes the key).

Regarding claims 46 and 69, Dolganow as modified by Huang discloses the method according to claim 20, wherein the network node comprises a router, a switch, or a bridge **(Dolganow, Fig. 1, para. 25, 27: network element 130a may include a router, a switch, or a bridge)**.

Regarding claims 47 and 70, Dolganow as modified by Huang discloses the method according to claim 20, wherein the packet network is an Internet Protocol (IP) network, and the packet is an IP packet **(Dolganow, para. 60, 62: DPI A 134 identifies an application protocol associated with the IP flow using one or more packets belonging to the IP flow or any other related information, such as packets belonging to other flows)**.

Regarding claims 48 and 71, Dolganow as modified by Huang discloses the method according to claim 47, wherein the packet network is an Transmission Control Protocol (TCP) network, and the packet is an TCP packet **(Dolganow, para. 39, 55, 62: It should be apparent that an IP flow may be any IP flow between P2P client 110 and P2P central entity 150 or P2P client 110 and a P2P client peer 160, as identifiable by IP 5-tuple information, which includes the source IP address, source port, destination IP address, destination port, and protocol of the IP flow.**

This IP flow may be further tunneled inside another networking layer, such as IP, Ethernet, ATM, and the like).

Regarding claims 49 and 72, Dolganow as modified by Huang discloses the method according to claim 20, further comprising: receiving, by the network node from the first entity over the packet network, one or more additional packets **(Dolganow, para. 12: a network element may receive a first and second plurality of packets transmitted between a peer-to-peer (P2P) client and a P2P central entity)**.

Dolganow does not appear to explicitly disclose checking, by the network node, if any one of the one or more additional packets satisfies the criterion; responsive to an additional packet not satisfying the criterion, sending, by the network node over the packet network, the additional packet to the second entity; and responsive to the additional packet satisfying the criterion, sending the additional packet, by the network node over the packet network, in response to the instruction.

Huang from similar field of endeavor discloses checking, by the network node, if any one of the one or more additional packets satisfies the criterion **(Huang, Fig. 2, para. 52, 54: a traffic collection request is sent to an SDN controller via a network capacity control device according to a pre-set collection policy. The traffic collection request focuses on describing the application layer requirements, and the level of abstraction is relatively high)**; responsive to an additional packet not satisfying the criterion, sending, by the network node over the packet network, the additional packet to the second entity **(Huang, Fig. 2, para. 102: the traffic collection request is sent to the network controller via a network capacity control device**

according to the pre-set collection policy, wherein the traffic collection request is used for allowing the network controller to send the request for traffic collection to the one or more network devices to be analyzed and processed); and responsive to the additional packet satisfying the criterion, sending the additional packet, by the network node over the packet network, in response to the instruction **(Huang, Fig. 2, para. 54, 62, 69: after the network capacity control device receives the traffic collection request, parsing and processing are performed to form a traffic collection request which can be recognized by the SDN controller, and the traffic collection request which is parsed and processed is transmitted to the SDN controller via a northbound interface of the SDN controller)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Huang by using the above features into the system of Dolganow such as checking, by the network node, if any one of the one or more additional packets satisfies the criterion; responsive to an additional packet not satisfying the criterion, sending, by the network node over the packet network, the additional packet to the second entity; and responsive to the additional packet satisfying the criterion, sending the additional packet, by the network node over the packet network, in response to the instruction as taught by Huang. The motivation for doing so would have been to realize data collection and transmission of a control policy for one end-to-multiple ends.

Regarding claims 50 and 73, Dolganow as modified by Huang discloses the method according to claim 20, Huang further discloses wherein the packet network is a

Software Defined Network (SDN), the packet is routed as part of a data plane and the network node communication with the controller serves as a control plane **(Huang, para. 43: each of the network control policies is sent to the SDN controller. After the SDN controller receives the network control policies, parsing and processing are performed to determine one or more network devices which need the network control policies. Each of the network control policies is converted into an instruction capable of being transmitted via the southbound interface of the SDN controller, and the converted network control policy is further sent to the corresponding network device via the southbound interface of the SDN controller)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Huang by using the above features into the system of Dolganow such as the packet network is a Software Defined Network (SDN), the packet is routed as part of a data plane and the network node communication with the controller serves as a control plane as taught by Huang. The motivation for doing so would have been to realize data collection and transmission of a control policy for one end-to-multiple ends.

Regarding claim 51, Dolganow discloses a method for use with a packet network including a network node for transporting packets between first and second entities under control of a controller <u>that is external to the network node</u>, the method by the network node comprising: receiving, from the controller, the instruction and the criterion **(Dolganow, para. 30; DPI devices 134, 136 may include hardware,**

instructions encoded on a machine-readable medium, or a combination thereof, such that DPI devices 134, 136 may be configured to examine data packets sent to router/switch 132 to identify information associated with the packets); receiving, from the first entity over the packet network, a packet addressed to the second entity **(Dolganow, para. 59; network element 130a, 130b may receive a number of packets belonging to an IP flow between a P2P client 110 and a P2P central entity 150)**.

Dolganow does not appear to explicitly disclose checking if the packet satisfies the criterion; responsive to the packet not satisfying the criterion, sending over the packet network, the packet to the second entity; and responsive to the packet satisfying the criterion, sending the packet over the packet network, <u>to an entity that is included in the instruction and is other than the second entity</u>.

Huang from similar field of endeavor discloses checking, by the network node, if the packet satisfies the criterion **(Huang, Fig. 2, para. 52, 54: a traffic collection request is sent to an SDN controller via a network capacity control device according to a pre-set collection policy. The traffic collection request focuses on describing the application layer requirements, and the level of abstraction is relatively high)**; responsive to the packet not satisfying the criterion, sending, by the network node over the packet network, the packet to the second entity **(Huang, Fig. 2, para. 102: the traffic collection request is sent to the network controller via a network capacity control device according to the pre-set collection policy, wherein the traffic collection request is used for allowing the network controller to send the request for traffic collection to the one or more network devices to be**

analyzed and processed); responsive to the packet satisfying the criterion, sending the packet, by the network node over the packet network, to an entity that is included in the instruction and is other than the second entity **(Huang, Fig. 2, para. 54, 62, 69: after the network capacity control device receives the traffic collection request, parsing and processing are performed to form a traffic collection request which can be recognized by the SDN controller, and the traffic collection request which is parsed and processed is transmitted to the SDN controller via a northbound interface of the SDN controller)**.

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filling date of the claimed invention to combine the teaching of Dolganow with the teaching of Huang by using the above features into the system of Dolganow such as checking, by the network node, if the packet satisfies the criterion; responsive to the packet not satisfying the criterion, sending, by the network node over the packet network, the packet to the second entity; and responsive to the packet satisfying the criterion, sending the packet, by the network node over the packet network, to an entity that is included in the instruction and is other than the second entity as taught by Huang. The motivation for doing so would have been to realize data collection and transmission of a control policy for one end-to-multiple ends.

Conclusion

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to JEAN F VOLTAIRE whose telephone number is (571)272-3953. The examiner can normally be reached on M-F 9:00-6:45 PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, FARUK HAMZA can be reached on (571)272-7969. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/JEAN F VOLTAIRE/
Examiner, Art Unit 2466
/JAE Y LEE/
Primary Examiner, Art Unit 2466

Notice of References Cited	Application/Control No. 15/126,288	Applicant(s)/Patent Under Reexamination BARSHESHET et al.	
	Examiner JEAN F VOLTAIRE	Art Unit 2466	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20100208590-A1	08-2010	Dolganow; Andrew	H04L43/026	370/235
*	B	US-20160219080-A1	07-2016	Huang; Sunliang	H04L41/0893	1/1
*	C	US-20150124812-A1	05-2015	Agarwal; Kanak B.	H04L45/24	370/392
*	D	US-20160020998-A1	01-2016	BIFULCO; Roberto	H04L45/64	370/235
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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
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NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No. 15/126,288	Applicant(s)/Patent Under Reexamination BARSHESHET et al.
	Examiner JEAN F VOLTAIRE	Art Unit 2466

CPC - Searched*		
Symbol	**Date**	**Examiner**
H04L43/026 H04L12/6418 H04L43/028 H04L49/70 H04L69/161	08/29/2018	JV

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**
370	389	08/29/2018	JV

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
Inventorship search for double patenting issue	08/29/2018	JV
Text search in East	08/29/2018	JV
Text search in 3gpp.org, ieee.org, google.com for NPL publication	08/29/2018	JV
Consulted with primary examiner Candal Elpenord	08/24/2018	JV
Update text search	03/27/2019	JV
Consulted with Jae Y LEE	03/28/2019	JV
Update text search	05/26/2019	JV

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**

/JEAN F VOLTAIRE/ Examiner, Art Unit 2466	

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✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/21/2018	03/26/2019	05/28/2019						
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	37	✓	✓	✓						
	38	✓	✓	✓						
	39	✓	✓	✓						
	40	✓	✓	✓						
	41	✓	✓	✓						
	42	✓	✓	✓						

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CLAIM		DATE									
Final	Original	07/21/2018	03/26/2019	05/28/2019							
	43	✓	✓	✓							
	44	✓	✓	✓							
	45	✓	✓	✓							
	46	✓	✓	✓							
	47	✓	✓	✓							
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	73	✓	✓	✓							

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
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L7	4716	(SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/05/28 13:01
L8	1299	(OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/05/28 13:02
L9	497	DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/05/28 13:02
L10	3	370/389.ccls. and DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/05/28 13:03
L11	837	DPI and ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT; USOCR; FPRS;	ADJ	OFF	2019/05/28 13:04

			EPO; JPO; DERWENT; IBM_TDB			
L12	31	different entit$3 AND DPI and ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/05/28 13:05
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S3	4	((Doctori)NEAR3(Simhon)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/08/14 20:00
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S10	2	"20100212006"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:08
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S24	3	"20080263424"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:19
S26	5	"20120020301"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:20
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S28	4	"20140181282"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:20
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			DERWENT; IBM_TDB			
S32	6	"20040090923"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:22
S33	5	"20130152187"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:22
S34	6	"20130121298"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:22
S35	10	"15126288"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/08/24 11:07
S36	7	"20140052836"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/08/24 11:22
S37	1140	(OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/24 11:26
S38	340	S37 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/24 11:26
S39	382	(SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/24 11:26
S40	91	S37 and (SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1	US-PGPUB; USPAT; USOCR;	OR	OFF	2018/08/24 11:27

		polic$3))	FPRS; EPO; JPO; DERWENT; IBM_TDB			
S41	6	"L12" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:45
S42	4	"L13" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:45
S43	4	"L14" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:45
S44	3	"L15" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S45	3	"L16" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S46	4	"L17" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S47	4	"L18" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S48	3	"L19" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S49	39979	(H04L43/026 H04L12/6418 H04L43/028	US-PGPUB;	OR	OFF	2018/08/27

		H04L49/70 H04L69/161).CPC.	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			07:46
S50	416	S49 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S51	4	S46 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:47
S53	7	"L6" and (OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:48
S54	1	"L12" and (OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:49
S55	404	DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/09/03 20:14
S56	1	"20170099196"	DERWENT	OR	OFF	2019/03/27 16:32
S57	1	"20100208590"	DERWENT	OR	OFF	2019/03/27 16:33
S58	1	"20140052836"	DERWENT	OR	OFF	2019/03/27 16:33
S59	3	"20100208590"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 16:59
S60	7	"20140052836"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2019/03/27 17:04

			IBM_TDB			
S61	7	"L6" and (OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S62	4	"L17" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S63	4	S62 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S64	1524	"20170099196" "20020009053" "20150117313" "20180102976" "20130315237" "20080263424" "9391912" "20120020301" "9871734" "7417948" "8031593" "9178661" "20150350048" "20140181282" "9112807" "20170171085" "9853903" "20060153204" "20150289159" "9503365" "20040090923" "7242668" "8036107" "20130152187" "20130121298" "9220110" "8677489" "8577363" "20080049619" "20020196789" "20130198805" "20120142341" "20180167337" "6965666" "9277538" "10027559" "20160127223" "20170331750" "7852767" "20170104692" "6400681" "20150089048" "20150207724" "20140304776" "7917471" "20150085655" "7116661" "9894694" "20140194068" "20150305006" "20180167987" "20080052387" "20130100797" "20120201140" "20150295808" "20150207677" "9667556" "20150365879" "20150304209" "20140297847" "9485185" "20110116405" "9100285" "20160278140" "20170317933" "20170063660" "20080049624" "5282270" "20080049769" "20180091388" "9088581" "8780721" "20100085887" "20140064086" "9479506" "9661514" "20100054140" "9872185" "8743703" "20130322265" "9112729" "20110238985" "20080052401" "8670313" "20140050106" "20140043999" "20080052394" "20110289578" "20080049776" "20170257319" "20140071977" "20160134502" "20080049615" "9979595"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42

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S65	370	"20070076653" "20080049630" "20130033984" "7933214" "20130003538" "7203190" "20120127881" "20080049748" "20140092723" "20110032821" "20130135993" "20080052393" "9596169" "20140321273" "8687614" "20080052206" "20090067399" "20080049649" "20170324674" "9479341" "20110317580" "20080049640" "20120236729" "20170310600" "9014204" "20130322249" "20080049753" "20160057062" "20160044095" "7684332" "20150295998" "20120082161" "20130294243" "20170339217" "8015294" "20150110097" "20080049775" "20120182864" "20140226485" "20080049632" "8194555" "8223654" "20120321052" "20080049637"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S66	1264	(OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S67	104	S66 and (SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S68	1264	(OpenFLow near5 (control$4))	US-PGPUB;	OR	OFF	2019/03/27

		same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			22:43
S69	478	DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:43
S70	3	370/389.ccls. and DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:44
S71	17590	370/389.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:44
S72	1	"15497119"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/28 10:50
S73	2	"15769777"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/28 13:55
S74	4	370/389.ccls. and DPI and (SDN) and (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:18
S75	776	DPI and (SDN) and (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:18
S78	815	DPI and ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	OFF	2019/04/12 21:25

			IBM_TDB			
S79	249	DPI same (SDN) and (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:27
S80	460	(SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:29
S81	4	"L17" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:29
S82	403	"7852767" "20080052394" "20110289578" "20080049776" "20170257319" "20140071977" "20080049628" "20120230328" "20120314573" "20030108030" "8015294" "20150110097" "20080049775" "20120182864" "20140226485" "20080049632" "8194555" "8223654" "20120321052" "20080049637" "20160113006" "8358580" "9602265" "8520603" "20080049626" "9253661" "20150138955" "20120327816" "20160380878" "20080002677"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:30
S83	73	"9088581" "8780721" "20100085887" "20140064086" "9479506" "9661514" "20100054140" "9872185" "8743703" "20130322265" "9112729" "20110238985" "20080052401" "8670313"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:31

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Visuals Query Results 0 Selected Relevance None None

1 - 50 14,692,437 results

1. **A method and system for deep packet inspection in software defined networks**

A method for deep packet inspection (DPI) in a software defined network (SDN). The method includes configuring a plurality of network nodes operable in the SDN with at least one probe instruction; receiving from a network node a first packet of a flow, the first packet matches the at least one probe...

CURRENT ASSIGNEES: ORCKIT CORRIGENT LTD (+1)
US20170099196 | US APPLICATIONS | 06-APR-2017

2. **Controlled data network error recovery**

A method, a system and network nodes using indication of possible duplicates (IPD) of units, so that these units can be handled differently than other units. The unit is indicated to be a possible duplicate to the entity to which it is resent because no response was received from the entity it was...

CURRENT ASSIGNEES: MICROSOFT TECH LICENSING LLC
US20020009053 | US APPLICATIONS | 24-JAN-2002

3. **Controlled data network error recovery**

A method, a system and network nodes using indication of possible duplicates (IPD) of units, so that these units can be handled differently than other units. The unit is indicated to be a possible duplicate to the entity to which it is resent because no response was received from the entity it was...

CURRENT ASSIGNEES: MICROSOFT TECH LICENSING LLC
US7417948 | US PATENTS | 26-AUG-2008

4. **Controlled data network error recovery**

A method, a system and network nodes use an indication of possible duplicates of units, so that these units can be handled differently than other units. The unit is indicated to be a possible duplicate to the entity to which it is resent because no response was received from the entity it was sent...

CURRENT ASSIGNEES: MICROSOFT TECH LICENSING LLC
US20080263424 | US APPLICATIONS | 23-OCT-2008

5. **Supervised data network fault recovery**

A method, a system and network nodes use an indication of possible duplicates of units, so that these units can be handled differently than other units. The unit is indicated to be a possible duplicate to the entity to which it is resent because no response was received from the entity it was sent...

CURRENT ASSIGNEES: NOKIA CORP
FI1138228 | FINLAND PATENTS | 15-JUN-2004

6. **Selective Bicasting**

A method including receiving a packet and determining whether a bicast indication associated with the packet indicates that the packet has been transmitted to two or more access points; and dropping the packet in dependence on at least one criterion.

CURRENT ASSIGNEES: NOKIA TECH OY
US20150117313 | US APPLICATIONS | 30-APR-2015

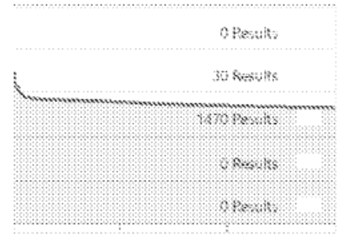
7. **Controlled data network error recovery**

A method, a system and network nodes use an indication of possible duplicates of units, so that these units can

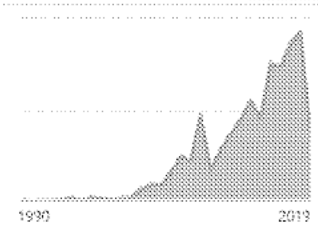
Result #1 PREV NEXT

Top 1500 results

Relevance VIEW



Publication Date VIEW



Cur Assignee by Relevance VIEW

ORCKIT CORRIGENT LTD **(1)**
MICROSOFT TECH LICENSI... **(40)**
NOKIA CORP **(34)**
NOKIA TECH OY **(31)**
ALCATEL LUCENT **(17)**
NOKIA NETWORKS INC **(3)**
NOKIA SOLUTIONS & NET... **(17)**

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	0	370/$.ccls. AND mirror$3 WITH DPI AND SDN	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/07/03 22:43
L2	13	mirror$3 WITH DPI AND SDN	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/07/03 22:44
L3	3	370/389.ccls. and DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/07/03 22:44
L4	63	370/$.ccls. and DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/07/03 22:44
S1	10	"15126288"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 19:58
S2	9	((Barsheshet)NEAR3(Yossi)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/08/14 19:59
S3	4	((Doctori)NEAR3(Simhon)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/08/14 20:00
S4	91	((Solomon)NEAR3(Ronen)).INV.	US-PGPUB;	ADJ	OFF	2018/08/14

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			20:00
S5	18764	(H04L43/028 H04L49/70 H04L69/161).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:02
S6	39906	(H04L43/026 H04L12/6418 H04L43/028 H04L49/70 H04L69/161).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:04
S7	3	"20130329734"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:05
S8	3	"20100208590"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:07
S9	2	"20110264802"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:07
S10	2	"20100212006"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:08
S11	37	"2672668"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:08
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S15	982	"20060153204" "20150289159" "9503365" "20040090923" "7242668" "8036107" "20130152187" "20130121298" "9220110" "8677489" "8577363" "20080049619" "20020196789" "20130198805" "20120142341" "20180167337" "6965666" "9277538" "10027559" "20160127223" "20170331750" "7852767" "20170104692" "6400681" "20150089048" "20150207724" "20140304776" "7917471" "20150085655" "7116661" "9894694"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:14

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S18	740	"20170099196" "20020009053" "20150117313" "20180102976" "20130315237" "20080263424" "9391912" "20120020301" "9871734" "7417948" "8031593" "9178661" "20150350048" "20140181282" "9112807" "20170171085" "9853903" "20060153204" "20150289159" "9503365" "20040090923" "7242668" "8036107" "20130152187" "20130121298" "9220110" "8677489" "8577363" "20080049619" "20020196789" "20130198805" "20120142341" "20180167337" "6965666" "9277538" "10027559" "20160127223" "20170331750" "7852767" "20170104692" "6400681" "20150089048" "20150207724" "20140304776" "7917471"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:15

		"20150085655" "7116661" "9894694" "20140194068" "20150305006" "20180167987" "20080052387" "20130100797"				
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S20	5	"20020009053"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:18
S21	6	"20150117313"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:18
S22	2	"20180102976"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:18
S23	3	"20130315237"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:19
S24	3	"20080263424"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:19
S26	5	"20120020301"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:20
S27	2	"20150350048"	US-PGPUB; USPAT; USOCR;	OR	OFF	2018/08/14 20:20

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S28	4	"20140181282"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:20
S29	2	"20170171085"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:21
S30	3	"20060153204"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:21
S31	2	"20150289159"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:21
S32	6	"20040090923"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:22
S33	5	"20130152187"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:22
S34	6	"20130121298"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:22
S35	10	"15126288"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/08/24 11:07
S36	7	"20140052836"	US-PGPUB;	ADJ	OFF	2018/08/24

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			11:22
S37	1140	(OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/24 11:26
S38	340	S37 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/24 11:26
S39	382	(SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/24 11:26
S40	91	S37 and (SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/24 11:27
S41	6	"L12" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:45
S42	4	"L13" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:45
S43	4	"L14" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:45
S44	3	"L15" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2018/08/27 07:46

			IBM_TDB			
S45	3	"L16" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S46	4	"L17" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S47	4	"L18" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S48	3	"L19" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S49	39979	(H04L43/026 H04L12/6418 H04L43/028 H04L49/70 H04L69/161).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S50	416	S49 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S51	4	S46 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:47
S53	7	"L6" and (OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:48
S54	1	"L12" and (OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS;	OR	OFF	2018/08/27 07:49

			EPO; JPO; DERWENT; IBM_TDB			
S55	404	DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/09/03 20:14
S56	1	"20170099196"	DERWENT	OR	OFF	2019/03/27 16:32
S57	1	"20100208590"	DERWENT	OR	OFF	2019/03/27 16:33
S58	1	"20140052836"	DERWENT	OR	OFF	2019/03/27 16:33
S59	3	"20100208590"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 16:59
S60	7	"20140052836"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 17:04
S61	7	"L6" and (OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S62	4	"L17" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S63	4	S62 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S64	1524	"20170099196" "20020009053" "20150117313" "20180102976" "20130315237" "20080263424" "9391912" "20120020301" "9871734" "7417948" "8031593" "9178661" "20150350048" "20140181282" "9112807" "20170171085" "9853903" "20060153204" "20150289159" "9503365" "20040090923" "7242668"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42

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S66	1264	(OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S67	104	S66 and (SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S68	1264	(OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:43
S69	478	DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:43
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S71	17590	370/389.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:44
S72	1	"15497119"	US-PGPUB; USPAT; USOCR; FPRS;	OR	OFF	2019/03/28 10:50

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S74	4	370/389.ccls. and DPI and (SDN) and (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:18
S75	776	DPI and (SDN) and (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:18
S78	815	DPI and ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/04/12 21:25
S79	249	DPI same (SDN) and (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:27
S80	460	(SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:29
S81	4	"L17" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:29
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S87	6	"20150117313"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/05/28 12:30
S88	5	"20120020301"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/05/28 12:31
S89	4716	(SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/05/28 13:01
S90	1299	(OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/05/28 13:02
S91	497	DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/05/28 13:02
S92	3	370/389.ccls. and DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/05/28 13:03
S93	837	DPI and ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT; USOCR;	ADJ	OFF	2019/05/28 13:04

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S94	31	different entit$3 AND DPI and ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/05/28 13:05
S95	1320	(OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/07/01 14:58
S96	32	different entit$3 AND DPI and ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/07/01 15:04
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S99	3	"20100208590"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/07/01 15:05
S100	7	"20140052836"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/07/01 15:06
S101	5	"20120020301"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/07/01 15:06
S102	10	"15126288"	US-PGPUB;	OR	OFF	2019/07/01

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			15:25
S103	1	"20170099196"	DERWENT	OR	OFF	2019/07/01 15:26
S104	3	"20160219080"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/07/01 16:15
S105	13	mirror$3 WITH DPI AND SDN	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/07/01 16:23
S106	4	"20140094183"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/07/01 16:35
S107	5	"20170034834"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/07/01 16:36

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

ATTY.'S DOCKET: ORCKIT-001-US

In re Application of:	)	Confirmation No. 9263
Ronen Solomon	)	Art Unit: 2466
Appln. No.: 15/126,288	)	Examiner: Voltaire, Jean F.
Filed: September 15, 2016	)	Washington, D.C.
For: A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION …	)	October 2, 2019

AMENDMENT

Customer Service Window, Mail Stop Amendment
Honorable Commissioner for Patents
U.S. Patent and Trademark Office
Randolph Building, 401 Dulany Street
Alexandria, Virginia 22314

Sir:

This is in response to the examiner’s action of July 8, 2019 (“Action”).

Remarks / Arguments begin on page **2** of this paper.

REMARKS / ARGUMENTS

The Examiner's Action dated July 8, 2019, has been received, and its content carefully noted.

Office action, Section 9, pages 4-24

Claims 20-73 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dolganow *et al.* (US 2010/0208590 - "Dolganow") in view of Huang *et al.* (US 2016/0219080 - "Huang").

a. Improper rationale.

1. Same rationale for different limitations

The Action relies on the Huang reference for the missing limitations of claims 1, 21, 52, 22, 53, 23, 54, 24, 25, 55, 26, 56, 28, 29, 30, 49, 72, 50, 73, and 51. In all these cases, the same rationale of "… *to realize data collection and transmission of a control policy for one end-to-multiple ends*." is stated. First, this rationale amounts to nothing more than a conclusory statement, while is the Office *prima facie* burden to provide a "satisfactory explanation" for the motivation finding that includes an express and "rational" connection with the evidence presented. Second, the missing limitations are different and distinct, and thus the SAME rationale is improper, since the SAME rationale provides no link to the present application, as required in MPEP 2143 that clearly states that "*Any rationale employed must provide* ***a link between the factual findings and the legal conclusion of obviousness.***" (Emphasis added), and "… there must be "*some articulated reasoning with some rational underpinning" to support the Examiner's findings and conclusion of obviousness*". See KSR Inti Co. v. Teleflex Inc., 550 U.S. 401, 418 (2007). Further, it is noted that "*Absent some articulated rationale for doing so, the Examiner's conclusory assertion is inadequate to support a conclusion of obviousness.*" See KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398, 418 (2007); see also In re Warner, 379 F.2d 1011, 1017 (CCPA 1967) ("*The legal conclusion of obviousness must be supported by facts. Where the legal conclusion is not supported by facts it cannot stand.*").

2. Changing operation principle.

The rationale is stated as "… *to realize data collection and transmission of a control policy for* ***one end-to-multiple ends****.'* (Emphasis added). However, as implied by its title and described throughout the disclosure, the Dolganow reference is directed to 'peer-to-peer' communication, and NOT to any '*one end-to-multiple ends*. As stated by the rationale. Modifying the Dolganow reference to support point-to-multipoint clearly changes its principle of operation, while MPEP 2143.01 states:

> *If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious.*

In re Ratti, 270 F.2d 810, 123 USPQ 349 (CCPA 1959).

Further, such changes would render the Dolganow reference inoperable for its intended purpose since it could only operate in an SDN supported network.

3. Not required feature

Claims 21, 52, 22, 53, 23, 54, 24, 25, 55, 26, 56, 28, 29, 30, 49, 72, 50, 73, and 51 are rejected under the rationale of "*… to realize data collection and transmission of a control policy for one end-to-multiple ends*", which is the SAME rationale stated for claim 1. Since claim 1 is already admitted in the Action to provide this motivation, the added features in these claims are unneeded and redundant - Unneeded advantage: Where the secondary reference disclosed an advantage, but where none of the cited prior art references suggested that the primary reference could benefit from that advantage or was in need of that advantage. [See, e.g., Ex parte Saiki, No. 2000-0373, 2002 WL 32102452, at *3 (B.P.A.I. Jan. 17, 2002); Ex parte Burak, No. 2004-0823, 2004 WL 4981768, at *4 (Dec. 8, 2004)]. Redundant advantage - Where the secondary reference disclosed an advantage, and where the primary reference already possessed that advantage. See, e.g., Ex parte Anttila & Jung, No. 2010-006328, 2012 WL 4718520, at *3 (B.P.A.I. Sept. 27, 2012); Kastelewicz, 2009 WL 1719394, at *5-7; Ex parte Levine, No. 2010-001240, 2012 WL 4483329, at *3 (B.P.A.I. Sept. 25, 2012).

4. Unclear rationale

The rationale is stated as - "*… to realize data collection and transmission of a control policy for one end-to-multiple ends*". The Examiner's articulated reasoning namely, to is conclusory, as it is not clear how the stated limitations are relevant technically and logically to the stated rationale, See In re Nuvasive, 842 F.3d 1376, 1383 (Fed. Cir. 2016) (noting that "'conclusory statements' alone are insufficient and, instead, the finding must be supported by a 'reasoned explanation"') (quoting In re Lee, 277 F.3d 1338, 1342, 1345 (Fed. Cir. 2002)); see also Active Video Networks, Inc., v. Verizon Communications, Inc., 694 F.3d

1312, 1328 (Fed. Cir. 2012) (noting that "[t]he testimony is generic and bears no relation to any specific combination of prior art elements").

b. Combining the Dolganow and Huang references.

1. The Action contends that the Dolganow and Huang are combined being in a 'similar field of endeavor'. **The applicant respectfully request a clear definition of the 'field of endeavor' as required by the rules.** (MPEP 2141.01(a)(I) – '*The examiner must determine what is "analogous prior art" for the purpose of analyzing the obviousness of the subject matter at issue*').

2. Applicant submits that the Dolganow and Huang references are directed towards respectively different purposes and are based on respectively different structures, and thus are not analogous to one another and cannot logically be combined. The Dolganow reference involves DPI, where packets are handled based on their content, while the Huang reference involves SDN, where packets are handled based on externally received instructions. For example, the Dolganow reference involves **OSI Layer 3** or above analysis, while the Huang reference involves local routing (**OSI Layer 2**) without any analysis of the packet content.

Hence, the two references are directed to different devices having different functionalities and differently handling traffic, and thus cannot be combined. It is respectfully submitted that it is simply not appropriate to select a secondary reference that happens to disclose, in isolation, a single feature, and conclude, without a proper basis, that it would be obvious to add that feature to another device in a different field.

3. The Action is clearly improperly shifting its position to relying on the Huang reference, resulting in 'moving target rejections for [applicant] to traverse'. [See In re Durance, No. 2017-1486, 2018 (Fed. Cir. June 1, 2018)].

4. Further, it would not be appropriate to base this rejection on a combination of these references because the devices and networks described in the Dolganow and Huang references are each self-contained and independently operate effectively to solve the stated problem of DPI of traffic, and:

> *Because each device independently operates effectively, a person having ordinary skill in the art, who was merely seeking to create a better device to drain fluids from a wound, would have no reason to combine the features of both devices into a single device.*

[Kinetic Concepts v. Smith and Nephew, 688 F.3d 1342, at 1369 (CAFC, 2012).] - See MPEP §2143.01.

5. It is further noted that MPEP §808.02(A) explicitly recites that **different classes** "*... shows that each invention has attained recognition in the art as a **separate subject** for inventive effort, and also a **separate field** of search.*" (Emphasis added). Furthermore, there is no suggestion or motivation to combine:

> *[W]hen art is directed to **a different purpose then a claimed invention,** an inventor would have less motivation or occasion to consider it.*

In re Oetiker, 977 F.2d 1443 (Fed. Cir. 1992).

The Dolganow reference is classified under U.S. Class 370/235 associated with "*MULTIPLEX COMMUNICATIONS - DATA FLOW CONGESTION PREVENTION OR CONTROL*", mainly focusing on regulating the amount of information transmitted through the network, while the Huang reference is classified under U.S. Class H04L 63/20 associated with "*Network architectures or network communication protocols for network security for managing network security; network security policies in general*" - relating mainly to the DPI for security purposes. Thus, the two reference are in different fields.

6. The Action fails to explain HOW the device described in the Dolganow reference is being modified to include the limitations taught by the Huang reference. The Action only states that the missing limitations are disclosed by the Huang reference and as such may be combined. A clear explanation is required according to the rules.

c. Non-consistent rejections.

Claim 20 recites communication between first and second entities. The rejection of claim 20 equates these entities to '*P2P client 110 and a P2P central entity 150*' (see at the bottom of page 4). However, in the rejection of claims 21, 52, 22, 53, 27, 57, 37, 60, 47, 70 and other claims, the entities are improperly equated to DPI A 134 and DPI B 136.

Regarding claim 20.

a. Single vs. multiple networks. Claim 20 clearly recites a single packet network. In contrast, the Dolganow reference expressly teaches two different networks, namely 120 and 140, connected via the node 130a.

b. Missing limitations. Claim 20 explicitly recites the limitation of: "… *sending, by the controller to the network node over the packet network, an instruction and a packet-applicable criterion*". This limitation is not addressed by the Action. A prima facie case for obviousness "*requires a suggestion of all limitations in a claim,*" CFMT, Inc. v. Yieldup Int'l Corp., 349 F.3d 1333, 1342 (Fed. Cir. 2003). It is noted that the Dolganow reference fails to disclose any controller in general or any "*an instruction and a packet-applicable criterion*", and in particular fails to disclose the recited "… *sending, by the controller to the network node over the packet network, an instruction and a packet-applicable criterion*". Further, claim 20 explicitly recites the limitation of: "… *receiving, by the network node from the controller, the instruction and the criterion*". The Action relies upon paragraphs 12, 30, and 81 of the Dolganow reference. HOWEVER, the Dolganow reference in general, and the cited paragraphs in particular, ONLY described receiving packets as part of the regular traffic to be analyzed, and are silent regarding any receiving from a controller in general, and receiving of '*the instruction and the criterion*' in particular.

Section 10 of the Action seems to state that controller is inherent. First, such statement is improper since "'*The mere "Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient*." In re Robertson, 169 F.3d 743, 745 (Fed. Cir. 1999) (citations omitted). Further, "*To rely upon a theory of inherency, there must be "a basis in fact and/or technical reasoning to reasonably support the determination that the* *allegedly inherent characteristic necessarily flows from the teachings of the applied prior art.*" Ex-parte Levy, 17 USPQ2d 1461, 1464 (BPAI 1990).

Second, even if such controller is arguendo available, this does NOT teach the recited steps of sending and receiving. However, in order to further differentiate over the prior art claim 20 is amended to recite that the controller is <u>external to the network node</u>, which is NOT the case in the Dolganow reference.

c. In particular, such modification of the router or switch described in the Dolganow reference requires massive change of the device, to include means for receiving instruction via an additional port, storing these instructions and criteria, applying dedicated SDN software (such as OpenFlow) requiring massive hardware, processing power and software, and forwarding packets based on this criteria. Such modifications fundamentally and inherently change the conventional routing / switching functionalities described in the Dolganow reference, and would require a substantial reconstruction and redesign of the elements shown in the Dolganow reference as well as a change in the basic principles under which the Dolganow reference construction was designed to operate. (In re Ratti, 270 F.2d 810, 813 (CCPA 1959)): *"a change in the basic principles" refers to change that is fundamental in scope so as to relate to scientific or technical principles under which the invention is designed to operate.".* Further, such changes would render the Dolganow reference inoperable for its intended purpose since it could only operate in an SDN supported network.

The absence of a reply to a specific rejection, issue, or comment, does not signify agreement with that rejection, issue, or comment. In addition, because the arguments made above may not be exhaustive, there may be reasons for patentability of any or all pending claims that have not been expressed.

Nothing in this reply should be understood as conceding any issue with regard to any claim, except as specifically stated in this reply, and the amendment of any claims does not necessarily signify concession of unpatentability to the claim before its amendment. It should further be understood that any filing of a terminal disclaimer to obviate a rejection based on nonstatutory double patenting is not an admission of the propriety of the rejection.

If the above arguments should not now place the application in the condition for allowance, the examiner is invited to call undersigned counsel to resolve any remaining issues.

Respectfully submitted,

By /Yehuda Binder/

Yehuda Binder
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Electronic Acknowledgement Receipt

EFS ID:	37339577
Application Number:	15126288
International Application Number:	
Confirmation Number:	9263
Title of Invention:	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS
First Named Inventor/Applicant Name:	Yossi BARSHESHET
Customer Number:	131926
Filer:	Yehuda Binder/Dorit Binder
Filer Authorized By:	Yehuda Binder
Attorney Docket Number:	ORCKIT-001-US
Receipt Date:	02-OCT-2019
Filing Date:	15-SEP-2016
Time Stamp:	07:23:36
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		7-2019-NFOA-Response.pdf	58160 e5a4fe136cece4deb126247afa44c43197e3fc02	yes	10

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Applicant Arguments/Remarks Made in an Amendment	2	10
Warnings:			
Information:			
	Total Files Size (in bytes):	58160	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

131926 7590 01/07/2020
May Patents Ltd. c/o Dorit Shem-Tov
P.O.B 7230
Ramat-Gan, 5217102
ISRAEL

EXAMINER	
VOLTAIRE, JEAN F	
ART UNIT	PAPER NUMBER
2466	

DATE MAILED: 01/07/2020

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/126,288	09/15/2016	Yossi BARSHESHET	ORCKIT-001-US	9263

TITLE OF INVENTION: A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0.00	$0.00	$500	04/07/2020

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

131926 7590 01/07/2020
May Patents Ltd. c/o Dorit Shem-Tov
P.O.B 7230
Ramat-Gan, 5217102
ISRAEL

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)

(Signature)

(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/126,288	09/15/2016	Yossi BARSHESHET	ORCKIT-001-US	9263

TITLE OF INVENTION: A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0.00	$0.00	$500	04/07/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
VOLTAIRE, JEAN F	2466	370-389000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1______________________________

2______________________________

3______________________________

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑Issue Fee ❑Publication Fee (if required) ❑Advance Order - # of Copies ____________________

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. __________

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature ____________________________ Date ____________________________

Typed or printed name ____________________________ Registration No. ____________________________

PTOL-85 Part B (08-18) Approved for use through 01/31/2020 OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/126,288	09/15/2016	Yossi BARSHESHET	ORCKIT-001-US	9263

131926 7590 01/07/2020

May Patents Ltd. c/o Dorit Shem-Tov
P.O.B 7230
Ramat-Gan, 5217102
ISRAEL

EXAMINER	
VOLTAIRE, JEAN F	
ART UNIT	**PAPER NUMBER**
2466	

DATE MAILED: 01/07/2020

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)

(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

PTOL-85 (Rev. 02/11)

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	**Application No.** 15/126,288	**Applicant(s)** BARSHESHET et al.	
	Examiner JEAN F VOLTAIRE	**Art Unit** 2466	**AIA (FITF) Status** Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1.☑ This communication is responsive to Applicant's arguments filed on 10/02/2019.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on ______.

2.☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on ______; the restriction requirement and election have been incorporated into this action.

3.☑ The allowed claim(s) is/are 20-73 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4.☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a) ☐All b) ☐ Some *c) ☐ None of the:

1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ______ .
3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: ______ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5.☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date ______ .

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6.☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1.☑ Notice of References Cited (PTO-892)
2.☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date ______.
3.☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material ______.
4.☐ Interview Summary (PTO-413), Paper No./Mail Date. ______.
5. ☐ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other ______.

/JEAN F VOLTAIRE/ Examiner, Art Unit 2466	/JAE Y LEE/ Primary Examiner, Art Unit 2466

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Allowable Subject Matter

2. Claims 20-73 are allowed.

3. The following is an examiner's statement of reasons for allowance: Claims 20-73 are allowed for the reasons as set forth in Applicant's amendment and remarks/arguments filed 10/02/2019.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

4. Any inquiry concerning this communication or earlier communications from the examiner should be directed to JEAN F VOLTAIRE whose telephone number is (571)272-3953. The examiner can normally be reached on M-F 9:00-6:45 PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, FARUK HAMZA can be reached on (571)272-7969. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see https://ppair-my.uspto.gov/pair/PrivatePair. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/JEAN F VOLTAIRE/
Examiner, Art Unit 2466
/JAE Y LEE/
Primary Examiner, Art Unit 2466

Notice of References Cited	Application/Control No. 15/126,288	Applicant(s)/Patent Under Reexamination BARSHESHET et al.	
	Examiner JEAN F VOLTAIRE	Art Unit 2466	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20100208590-A1	08-2010	Dolganow; Andrew	H04L43/026	370/235
*	B	US-20160219080-A1	07-2016	Huang; Sunliang	H04L63/20	1/1
*	C	US-20150124812-A1	05-2015	Agarwal; Kanak B.	H04L45/24	370/392
*	D	US-20160020998-A1	01-2016	BIFULCO; Roberto	H04L45/64	370/235
*	E	US-20160197831-A1	07-2016	DE FOY; Xavier	H04L45/7453	370/392
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No. 15/126,288	Applicant(s)/Patent Under Reexamination BARSHESHET et al.
	Examiner JEAN F VOLTAIRE	Art Unit 2466

CPC - Searched*		
Symbol	**Date**	**Examiner**
H04L43/026 H04L12/6418 H04L43/028 H04L49/70 H04L69/161	08/29/2018	JV

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**
370	389	08/29/2018	JV

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
Inventorship search for double patenting issue	08/29/2018	JV
Text search in East	08/29/2018	JV
Text search in 3gpp.org, ieee.org, google.com for NPL publication	08/29/2018	JV
Consulted with primary examiner Candal Elpenord	08/24/2018	JV
Update text search	03/27/2019	JV
Consulted with Jae Y LEE	03/28/2019	JV
Update text search	05/26/2019	JV
Update text search in East	12/23/2019	JV
Update text search in 3gpp.org, ieee.org, google.com for NPL publication	12/23/2019	JV

/JEAN F VOLTAIRE/ Examiner, Art Unit 2466	

Search Notes	Application/Control No. 15/126,288	Applicant(s)/Patent Under Reexamination BARSHESHET et al.
	Examiner JEAN F VOLTAIRE	Art Unit 2466

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
	See East Interference Text Search Printout History	12/23/2019	JV

/JEAN F VOLTAIRE/ Examiner, Art Unit 2466	

Issue Classification	Application/Control No. 15/126,288	Applicant(s)/Patent Under Reexamination BARSHESHET et al.
	Examiner JEAN F VOLTAIRE	Art Unit 2466

CPC

Symbol					Type	Version
H04L	/	43	/	028	F	2013-01-01
H04L	/	12	/	6418	I	2013-01-01
H04L	/	43	/	026	I	2013-01-01
H04L	/	47	/	2483	I	2013-01-01
H04L	/	49	/	70	I	2013-01-01
H04L	/	69	/	161	I	2013-01-01

CPC Combination Sets

Symbol					Type	Set	Ranking	Version
	/		/					

/JEAN F VOLTAIRE/ Examiner, Art Unit 2466 (Assistant Examiner)	23 December 2019 (Date)	**Total Claims Allowed:** 54	
/JAE Y LEE/ Primary Examiner, Art Unit 2466 (Primary Examiner)	26 December 2019 (Date)	O.G. Print Claim(s) 20	O.G. Print Figure 1

U.S. Patent and Trademark Office

Part of Paper No.: 20191223

Issue Classification	**Application/Control No.** 15/126,288	**Applicant(s)/Patent Under Reexamination** BARSHESHET et al.
	Examiner JEAN F VOLTAIRE	**Art Unit** 2466

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H04L	/	12	/	26

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

/JEAN F VOLTAIRE/ Examiner, Art Unit 2466 (Assistant Examiner)	23 December 2019 (Date)	**Total Claims Allowed:** 54	
/JAE Y LEE/ Primary Examiner, Art Unit 2466 (Primary Examiner)	26 December 2019 (Date)	O.G. Print Claim(s) 20	O.G. Print Figure 1

U.S. Patent and Trademark Office

Part of Paper No.: 20191223

Issue Classification	Application/Control No. 15/126,288	Applicant(s)/Patent Under Reexamination BARSHESHET et al.
	Examiner JEAN F VOLTAIRE	Art Unit 2466

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
-	1	-	11	2	21	12	31	22	41	32	51	42	61	52	71
-	2	-	12	3	22	13	32	23	42	33	52	43	62	53	72
-	3	-	13	4	23	14	33	24	43	34	53	44	63	54	73
-	4	-	14	5	24	15	34	25	44	35	54	45	64		
-	5	-	15	6	25	16	35	26	45	36	55	46	65		
-	6	-	16	7	26	17	36	27	46	37	56	47	66		
-	7	-	17	8	27	18	37	28	47	38	57	48	67		
-	8	-	18	9	28	19	38	29	48	39	58	49	68		
-	9	-	19	10	29	20	39	30	49	40	59	50	69		
-	10	1	20	11	30	21	40	31	50	41	60	51	70		

/JEAN F VOLTAIRE/ Examiner, Art Unit 2466 (Assistant Examiner)	23 December 2019 (Date)	**Total Claims Allowed:** 54	
/JAE Y LEE/ Primary Examiner, Art Unit 2466 (Primary Examiner)	26 December 2019 (Date)	O.G. Print Claim(s) 20	O.G. Print Figure 1

U.S. Patent and Trademark Office

Part of Paper No.: 20191223

Index of Claims	Application/Control No. 15/126,288	Applicant(s)/Patent Under Reexamination BARSHESHET et al.
	Examiner JEAN F VOLTAIRE	Art Unit 2466

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

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23	42	✓	✓	✓	=					

Index of Claims	Application/Control No. 15/126,288	Applicant(s)/Patent Under Reexamination BARSHESHET et al.
	Examiner JEAN F VOLTAIRE	Art Unit 2466

CLAIM		DATE								
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52	71	✓	✓	✓	=					
53	72	✓	✓	✓	=					
54	73	✓	✓	✓	=					

Discover | P&T | A method for use with a p... | + 0 mods | 0 filters

STIC

Visuals | Query | Results | 0 Selected | Relevance | None | None

6. Controlled data network error recovery

A method, a system and network nodes use an indication of possible duplicates of units, so that these units can be handled differently than other units. The unit is indicated to be a possible duplicate to the entity to which it is resent because no response was received from the entity it was sent...

CURRENT ASSIGNEES: MICROSOFT TECH LICENSING LLC (+1)
US20120020301 | US APPLICATIONS | 26-JAN-2012

7. Selective Bicasting

A method including receiving a packet and determining whether a bicast indication associated with the packet indicates that the packet has been transmitted to two or more access points; and dropping the packet in dependence on at least one criterion.

CURRENT ASSIGNEES: NOKIA TECH OY
US20150117313 | US APPLICATIONS | 30-APR-2015

8. Controlled data network error recovery

A method, a system and network nodes using indication of possible duplicates (IPD) of units, so that these units can be handled differently than other units. The unit is indicated to be a possible duplicate to the entity to which it is resent because no response was received from the entity it was...

CURRENT ASSIGNEES: NOKIA CORP
EP1147635B1 | EPO PATENTS | 12-NOV-2003

9. System and method for managing network information

A method for managing information in a network includes identifying a first network entity storing a requested object, receiving the object from the first network entity, and storing the object in a storage area based on a parameter. The storage area is coupled to a second network entity which...

CURRENT ASSIGNEES: ALCATEL LUCENT
US20140181282 | US APPLICATIONS | 26-JUN-2014

10. Prioritized handling of incoming packets by a network interface controller

A network interface controller includes a host interface, which is configured to be coupled to a host processor having a host memory. A network interface is configured to receive data packets from a network, each data packet including a header, which includes header fields, and a payload including...

CURRENT ASSIGNEES: MELLANOX TECH LTD
US20180102976 | US APPLICATIONS | 12-APR-2018

11. Controlled data network error recovery

A method, a system and network nodes use an indication of possible duplicates of units, so that these units can be handled differently than other units. The unit is indicated to be a possible duplicate to the entity to which it is resent because no response was received from the entity it was sent...

CURRENT ASSIGNEES: MICROSOFT TECH LICENSING LLC
US8031593 | US PATENTS | 04-OCT-2011

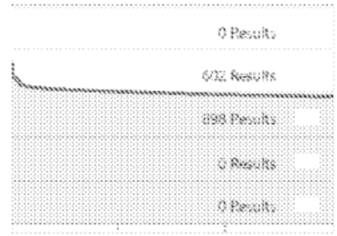
12. Prioritized Handling of Incoming Packets by a Network Interface Controller

A network interface controller includes a host interface, which is configured to be coupled to a host processor having a host memory. A network interface is configured to receive data packets from a network, each data packet including a header, which includes header fields, and a payload including...

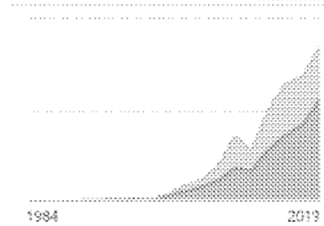
Result #1 | PREV | NEXT

Top 1500 results

Relevance VIEW



Publication Date VIEW



First Cur Assignees by Relevance VIEW

- ORCKIT CORRIGENT LTD **(1)**
- ORCKIT IP LLC **(3)**
- MICROSOFT TECH LICENSI... **(30)**
- NOKIA TECH OY **(26)**
- NOKIA CORP **(49)**
- ALCATEL LUCENT **(23)**
- MELLANOX TECH LTD **(4)**

More Visuals

EAST Search History

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L3	212	DPI same (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT	OR	OFF	2019/12/24 23:55
L4	6	"L19" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT	OR	OFF	2019/12/24 23:55
S129	3	370/389.ccls. and DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT	OR	OFF	2019/12/23 20:16
S130	6	"L16" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT	OR	OFF	2019/12/23 20:17
S131	38	different entit$3 AND DPI and ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT	ADJ	OFF	2019/12/23 20:18
S132	14	mirror$3 WITH DPI AND SDN	US-PGPUB; USPAT	ADJ	OFF	2019/12/23 20:49
S133	11	different entit$3 and ((deep packet inspection) or DPI) same ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT	ADJ	OFF	2019/12/23 20:53

12/24/2019 11:56:26 PM
C:\Users\jvoltaire\Documents\EAST\Workspaces\15126288.wsp

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	15126288
	Filing Date	2016-09-15
	First Named Inventor	BARSHESHET, Yossi
	Art Unit	2466
	Examiner Name	VOLTAIRE, JEAN F
	Attorney Docket Number	ORCKIT-001-US

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Examiner Initial*	Cite No	Patent Number	Kind Code1	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.F.V/

Receipt date: 07/08/2019

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15126288
	Filing Date	2016-09-15
	First Named Inventor	BARSHESHET, Yossi
	Art Unit	2466
	Examiner Name	VOLTAIRE, JEAN F
	Attorney Docket Number	ORCKIT-001-US

	1	Minlan Yu et al, "Scalable flow-based networking with DIFANE", Proceedings of the ACM SIGCOMM 2010 Conference on Applications, Technologies, Architectures, and Protocols for Computer Communications, New Delhi, India, August 30-September 3, 2010, ACM, pages 351-362 XP058189957	

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature	/JEAN F VOLTAIRE/	Date Considered	12/23/2019

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.F.V/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15126288
	Filing Date	2016-09-15
	First Named Inventor	BARSHESHET, Yossi
	Art Unit	2466
	Examiner Name	VOLTAIRE, JEAN F
	Attorney Docket Number	ORCKIT-001-US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Yehuda Binder/	Date (YYYY-MM-DD)	2019-07-07
Name/Print	Yehuda Binder	Registration Number	73612

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.F.V/

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.F.V/

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	11	different entit$3 and ((deep packet inspection) or DPI) same ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/12/24 23:54
L2	236	DPI same (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/12/24 23:55
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S2	9	((Barsheshet)NEAR3(Yossi)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/08/14 19:59
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S10	2	"20100212006"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:08
S11	37	"2672668"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:08
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S14	1178	"20060153204" "20150289159" "9503365" "20040090923" "7242668" "8036107" "20130152187" "20130121298" "9220110" "8677489" "8577363" "20080049619" "20020196789" "20130198805" "20120142341" "20180167337" "6965666" "9277538" "10027559" "20160127223" "20170331750" "7852767" "20170104692" "6400681"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:14

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S16	808	"20080049619" "20020196789" "20130198805" "20120142341" "20180167337" "6965666" "9277538" "10027559" "20160127223" "20170331750" "7852767" "20170104692" "6400681" "20150089048" "20150207724" "20140304776" "7917471" "20150085655" "7116661" "9894694" "20140194068" "20150305006" "20180167987" "20080052387" "20130100797" "20120201140" "20150295808" "20150207677" "9667556" "20150365879" "20150304209" "20140297847" "9485185" "20110116405" "9100285" "20160278140" "20170317933" "20170063660" "20080049624" "5282270" "20080049769" "20180091388" "9088581" "8780721" "20100085887" "20140064086" "9479506" "9661514" "20100054140" "9872185" "8743703" "20130322265" "9112729" "20110238985" "20080052401" "8670313" "20140050106" "20140043999" "20080052394" "20110289578"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:14
S18	740	"20170099196" "20020009053" "20150117313" "20180102976" "20130315237" "20080263424" "9391912" "20120020301" "9871734" "7417948" "8031593" "9178661" "20150350048" "20140181282" "9112807" "20170171085" "9853903" "20060153204" "20150289159" "9503365" "20040090923" "7242668" "8036107" "20130152187" "20130121298" "9220110" "8677489" "8577363" "20080049619" "20020196789" "20130198805" "20120142341" "20180167337" "6965666" "9277538" "10027559" "20160127223" "20170331750" "7852767" "20170104692" "6400681" "20150089048" "20150207724" "20140304776" "7917471" "20150085655" "7116661" "9894694" "20140194068" "20150305006" "20180167987" "20080052387" "20130100797"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:15
S19	254	"20170099196" "20020009053" "20150117313" "20180102976" "20130315237" "20080263424" "9391912" "20120020301" "9871734" "7417948" "8031593" "9178661" "20150350048" "20140181282" "9112807" "20170171085" "9853903" "20060153204" "20150289159" "9503365" "20040090923" "7242668" "8036107" "20130152187"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:16

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S20	5	"20020009053"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:18
S21	6	"20150117313"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:18
S22	2	"20180102976"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:18
S23	3	"20130315237"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:19
S24	3	"20080263424"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:19
S26	5	"20120020301"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:20
S27	2	"20150350048"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:20
S28	4	"20140181282"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:20
S29	2	"20170171085"	US-PGPUB; USPAT; USOCR;	OR	OFF	2018/08/14 20:21

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S30	3	"20060153204"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:21
S31	2	"20150289159"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:21
S32	6	"20040090923"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:22
S33	5	"20130152187"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:22
S34	6	"20130121298"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/14 20:22
S35	10	"15126288"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/08/24 11:07
S36	7	"20140052836"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2018/08/24 11:22
S37	1140	(OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/24 11:26
S38	340	S37 and (SDN) same (packet PDU near2	US-PGPUB;	OR	OFF	2018/08/24

		(flow$1 stream$1))	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			11:26
S39	382	(SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/24 11:26
S40	91	S37 and (SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/24 11:27
S41	6	"L12" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:45
S42	4	"L13" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:45
S43	4	"L14" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:45
S44	3	"L15" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S45	3	"L16" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S46	4	"L17" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2018/08/27 07:46

			IBM_TDB			
S47	4	"L18" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S48	3	"L19" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S49	39979	(H04L43/026 H04L12/6418 H04L43/028 H04L49/70 H04L69/161).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S50	416	S49 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:46
S51	4	S46 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:47
S53	7	"L6" and (OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:48
S54	1	"L12" and (OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/08/27 07:49
S55	404	DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/09/03 20:14
S56	1	"20170099196"	DERWENT	OR	OFF	2019/03/27 16:32
S57	1	"20100208590"	DERWENT	OR	OFF	2019/03/27

						16:33
S58	1	"20140052836"	DERWENT	OR	OFF	2019/03/27 16:33
S59	3	"20100208590"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 16:59
S60	7	"20140052836"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 17:04
S61	7	"L6" and (OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S62	4	"L17" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S63	4	S62 and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S64	1524	"20170099196" "20020009053" "20150117313" "20180102976" "20130315237" "20080263424" "9391912" "20120020301" "9871734" "7417948" "8031593" "9178661" "20150350048" "20140181282" "9112807" "20170171085" "9853903" "20060153204" "20150289159" "9503365" "20040090923" "7242668" "8036107" "20130152187" "20130121298" "9220110" "8677489" "8577363" "20080049619" "20020196789" "20130198805" "20120142341" "20180167337" "6965666" "9277538" "10027559" "20160127223" "20170331750" "7852767" "20170104692" "6400681" "20150089048" "20150207724" "20140304776" "7917471" "20150085655" "7116661" "9894694" "20140194068" "20150305006" "20180167987" "20080052387" "20130100797" "20120201140" "20150295808" "20150207677"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42

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S66	1264	(OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S67	104	S66 and (SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:42
S68	1264	(OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:43
S69	478	DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:43
S70	3	370/389.ccls. and DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:44
S71	17590	370/389.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/27 22:44
S72	1	"15497119"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/28 10:50
S73	2	"15769777"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/03/28 13:55
S74	4	370/389.ccls. and DPI and (SDN) and (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS;	OR	OFF	2019/04/12 21:18

			EPO; JPO; DERWENT; IBM_TDB			
S75	776	DPI and (SDN) and (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:18
S78	815	DPI and ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/04/12 21:25
S79	249	DPI same (SDN) and (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:27
S80	460	(SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:29
S81	4	"L17" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:29
S82	403	"7852767" "20080052394" "20110289578" "20080049776" "20170257319" "20140071977" "20080049628" "20120230328" "20120314573" "20030108030" "8015294" "20150110097" "20080049775" "20120182864" "20140226485" "20080049632" "8194555" "8223654" "20120321052" "20080049637" "20160113006" "8358580" "9602265" "8520603" "20080049626" "9253661" "20150138955" "20120327816" "20160380878" "20080002677"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:30
S83	73	"9088581" "8780721" "20100085887" "20140064086" "9479506" "9661514" "20100054140" "9872185" "8743703" "20130322265" "9112729" "20110238985" "20080052401" "8670313"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/04/12 21:31
S84	2104	"20170099196" "20020009053" "7417948" "20080263424"	US-PGPUB; USPAT;	OR	OFF	2019/05/28 12:26

		"20150117313" "20120020301" "9112807" "9391912" "20140181282" "8031593" "9178661" "20170171085" "6965666" "20090067399" "20180102976" "20130315237" "9871734" "20050232222" "6944150" "9503365" "7471653" "20040090923" "7242668" "10165492" "20160036673" "20170104692" "20150305006" "10027559" "20180109565" "9479506" "8224371" "20130121298" "20180262924" "20060153204" "9220110" "9832092" "20060190612" "8045515" "20140194068" "9853903" "9584387" "20070058545" "9277538" "7492728" "20130100797" "9661514" "10193941" "9112729" "20160127223" "8036107" "20170331750" "20080052387" "7055174" "20150195185" "20110238985" "20110116405" "8913596" "10069736" "20080049769" "20170317933" "9872185" "20080049624" "20150089048" "20150254303" "20190089587" "10095878" "20150085655" "20080049776" "20100085887" "8670313" "20140297847" "20120230214" "20170364702" "20080049775" "8880115" "20140050106" "8743703" "20150207724" "20130322265" "20140064086" "8565805" "9374281" "8687614" "20140071977" "9667556" "20080049619" "20190037383" "20080052394" "9842135" "20190036888" "20190095478" "20140043999" "20190018975" "8520603" "20130152187" "20120127881" "20140064100" "10298476" "9485185" "20080049630" "20080049628" "20160080272" "8223654" "20150289159" "20120230328" "9014204" "20130135993" "20130033984" "20080049746" "20080049615" "7684332" "20160134502" "20110289578" "20180084475" "20140321273" "20080049649" "20080052401" "9479341" "20110317580" "20080052393" "8358580" "20120269071" "8619596" "20150127783" "9253661" "20110032821" "20080049777" "20150207677" "20080049748" "20120314573" "8102770" "9602265" "9241277" "9100285" "20130294243" "20170366395" "20080052206" "20180365040" "8194555" "8677489" "20150304209" "9042370" "20120236750" "8015294" "20150295998" "20080049637" "20150110097" "8576722" "7852767" "20020152315" "20150373061" "20120257617" "9054986" "8619820"	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB				

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S86	5	"20020009053"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2019/05/28 12:29

			DERWENT; IBM_TDB			
S87	6	"20150117313"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/05/28 12:30
S88	5	"20120020301"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/05/28 12:31
S89	4716	(SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/05/28 13:01
S90	1299	(OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/05/28 13:02
S91	497	DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/05/28 13:02
S92	3	370/389.ccls. and DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/05/28 13:03
S93	837	DPI and ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/05/28 13:04
S94	31	different entit$3 AND DPI and ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/05/28 13:05
S95	1320	(OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR;	OR	OFF	2019/07/01 14:58

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S96	32	different entit$3 AND DPI and ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/07/01 15:04
S97	857	DPI and ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/07/01 15:05
S98	3	370/389.ccls. and DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/07/01 15:05
S99	3	"20100208590"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/07/01 15:05
S100	7	"20140052836"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/07/01 15:06
S101	5	"20120020301"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/07/01 15:06
S102	10	"15126288"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/07/01 15:25
S103	1	"20170099196"	DERWENT	OR	OFF	2019/07/01 15:26
S104	3	"20160219080"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	OFF	2019/07/01 16:15

			IBM_TDB			
S105	13	mirror$3 WITH DPI AND SDN	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/07/01 16:23
S106	4	"20140094183"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/07/01 16:35
S107	5	"20170034834"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/07/01 16:36
S108	0	370/$.ccls. AND mirror$3 WITH DPI AND SDN	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/07/03 22:43
S109	13	mirror$3 WITH DPI AND SDN	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/07/03 22:44
S110	3	370/389.ccls. and DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/07/03 22:44
S111	63	370/$.ccls. and DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/07/03 22:44
S112	10	"L12" and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/12/23 20:16
S113	547	(SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	US-PGPUB; USPAT; USOCR; FPRS;	OR	OFF	2019/12/23 20:16

			EPO; JPO; DERWENT; IBM_TDB			
S114	966	DPI and ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/12/23 20:17
S115	1399	(OpenFLow near5 (control$4)) same(match$3 near3 (sequence near2 (number$1)) rule$1 polic$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/12/23 20:17
S116	128	S115 and (SDN) same (packet PDU near2 (flow$1 stream$1)) same(check$3 match$3 near2 (criteria criterion rule$1 polic$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/12/23 20:17
S117	38	different entit$3 AND DPI and ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/12/23 20:18
S118	17	mirror$3 WITH DPI AND SDN	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/12/23 20:50
S119	9	((Barsheshet)NEAR3(Yossi)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/12/23 20:50
S120	4	((Doctori)NEAR3(Simhon)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/12/23 20:50
S121	102	((Solomon)NEAR3(Ronen)).INV.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/12/23 20:50
S122	235	(SDN) same (packet PDU near2 (flow$1 stream$1))same DPI	US-PGPUB; USPAT;	OR	OFF	2019/12/23 20:51

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S123	561	DPI and (SDN) same (packet PDU near2 (flow$1 stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/12/23 20:51
S124	0	different entit$3 same ((deep packet inspection) or DPI) same ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/12/23 20:53
S125	11	different entit$3 and ((deep packet inspection) or DPI) same ((software defined network$3) or(SDN)) and (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/12/23 20:53
S126	24	different entit$3 and ((deep packet inspection) or DPI) and ((software defined network$3) or(SDN)) same (packet or PDU near2 (flow$1 or stream$1))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/12/23 20:54
S127	1882	"20020009053" "20080263424" "7417948" "20120020301" "20150117313" "20140181282" "8031593" "20130315237" "9112807" "9871734" "9391912" "9178661" "20170171085" "20150350048" "10129122" "9853903" "20130152187" "8677489" "20060153204" "20130198805" "20150289159" "20040090923" "20080049619" "7242668" "6965666" "10193941" "20140304776" "9872185" "7852767" "9503365" "20170331750" "8036107" "8577363" "20150089048" "20170104692" "20130121298" "20120142341" "5282270" "20060018318" "20150085655" "20150207724" "7917471" "9220110" "20120201140" "20150305006" "20170063660" "20160127223" "10484289" "10419965" "9088581" "9667556" "8780721" "7835745" "10027559" "9485185" "20130003538" "20140194068" "20150207677" "20150304209" "9479506" "9100285" "20150139085" "20080052387" "20100054140" "20130100797" "20020196789" "20150365879" "20090067399" "20140237097"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/12/23 21:09

		"20110116405" "7933214" "9979595" "20070076653" "20180331965" "20080049769" "20140297847" "20080049776" "20080049624" "20160344611" "20060190612" "20110289578" "20170257319" "10178017" "9661514" "20080052394" "20140064086" "20080052401" "20100085887" "20140050106" "9118717" "9300453" "9596169" "20080049628" "20160134502" "20080049615" "20170310600" "20140043999" "20160277168" "20140071977" "8743703" "20180248788" "20120230214" "20120314573" "20080049777" "20120230328" "20120127881" "20160036673" "8670313" "20120257617" "20080049630" "7116661" "20130322265" "20080049746" "20140064100" "20050198217" "20170317933" "10069736" "20080049748" "8687614" "20130033984" "20020006114" "20110032821" "20050232222" "20070076667" "20110317580" "20160080272" "9277538" "9112729" "20140321273" "20130135993" "9479341" "7055174" "10374964" "10298476" "20080052393" "20080049649" "20080049753" "8015294" "20150110097" "9014204" "20080049775" "9621361" "20080049626" "8194555" "20130322249" "8576722" "20120182864" "20080052206" "20120236729" "8160055" "9596300" "20080049640" "7684332" "9602265" "20160057062" "20100037284" "20140341047" "9240906" "8619596" "8223654" "8520603" "20160112896" "20160380878" "6614784" "9253661" "20080049637" "20140226485" "20170324674" "20080049747" "7808918"				
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S134	1	"15672613"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/12/24 21:04

12/24/2019 11:56:08 PM
C:\Users\jvoltaire\Documents\EAST\Workspaces\15126288.wsp

Bibliographic Data

Application No: 15/126,288

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No | ☐ Met After Allowance

Verified and Acknowledged: Examiner's Signature | Initials

Title: A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
09/15/2016	370	2466	ORCKIT-001-US
RULE			

APPLICANTS

ORCKIT IP, LLC., Newton, MA, UNITED STATES

INVENTORS

Yossi BARSHESHET Ashdod, ISRAEL

Simhon DOCTORI Gan-Yavne, ISRAEL

Ronen SOLOMON Ranat-Gan, ISRAEL

CONTINUING DATA

This application is a 371 of PCT/US2015/026869 04/21/2015

PCT/US2015/026869 has PRO of 61982358 04/22/2014

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

12/27/2016

**** SMALL ENTITY ****

STATE OR COUNTRY

ISRAEL

ADDRESS

May Patents Ltd. c/o Dorit Shem-Tov
P.O.B 7230
Ramat-Gan, 5217102
ISRAEL

FILING FEE RECEIVED

$500

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

May Patents Ltd.
c/o Dorit Shem-Tov
P.O.B. 7230
Ramat-Gan 5217102,
Israel

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/126,288	09/15/2016	BARSHESHET, Yossi	ORCKIT-001-US	9263

TITLE OF INVENTION:

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0	$0	$500	04/07/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
   - ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
   - ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
   (1) the names of up to 3 registered patent attorneys or agents OR, alternatively,
   (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
   1 May Patents Ltd. c/o Dorit Shem-Tov
   2
   3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: ORCKIT IP, LLC

(B) RESIDENCE: (CITY and STATE OR COUNTRY): DOVER, DELAWARE, USA 19904-2778

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ■ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
- ☑ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies ______

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ☐ A check is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 600117 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.
- ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature /Yehuda Binder/ Date April 4, 2020

Typed or printed name Yehuda BINDER Registration No. 73,612

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
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5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	15126288
Filing Date:	15-Sep-2016
Title of Invention:	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS
First Named Inventor/Applicant Name:	Yossi BARSHESHET
Filer:	Yehuda Binder/Dorit Binder
Attorney Docket Number:	ORCKIT-001-US

Filed as Small Entity

Filing Fees for **U.S. National Stage under 35 USC 371**

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	2501	1	500	500

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
	Total in USD ($)			**500**

Electronic Acknowledgement Receipt

EFS ID:	39064541
Application Number:	15126288
International Application Number:	
Confirmation Number:	9263
Title of Invention:	A METHOD AND SYSTEM FOR DEEP PACKET INSPECTION IN SOFTWARE DEFINED NETWORKS
First Named Inventor/Applicant Name:	Yossi BARSHESHET
Customer Number:	131926
Filer:	Yehuda Binder/Dorit Binder
Filer Authorized By:	Yehuda Binder
Attorney Docket Number:	ORCKIT-001-US
Receipt Date:	04-APR-2020
Filing Date:	15-SEP-2016
Time Stamp:	15:40:51
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$500
RAM confirmation Number	E202044F41401971
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	ptol85b.pdf	75056 164ff9e170473ee5eb8ff6f727601aef2ceffe17	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30098 ad7e60ca5dbea32d9110da1ec254a449083d1156	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	105154	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	
	Filing Date	
	First Named Inventor	BARSHESHET, Yossi
	Art Unit	
	Examiner Name	
	Attorney Docket Number	ORCKIT-001-US

U.S.PATENTS						Remove
Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
Change(s) applied to document, /S.D./ 2/19/2020	1	20100208590	A1	2010-08-19	~~ALCATEL LUCENT~~ Dolganow et al.	
	2	20110264802	A1	2011-10-27	~~ALCATEL LUCENT~~ Dolganow et al.	
	3	20100212006	A1	2010-08-19	~~ALCATEL LUCENT~~ Dolganow et al.	
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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2672668	EP	A1	2013-12-11	JUNIPER NETWORKS INC		

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.F.V/

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/126,288	05/12/2020	10652111	ORCKIT-001-US	9263

131926 7590 04/22/2020

May Patents Ltd. c/o Dorit Shem-Tov
P.O.B 7230
Ramat-Gan, 5217102
ISRAEL

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 306 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Yossi BARSHESHET, Ashdod, ISRAEL;
ORCKIT IP, LLC., Newton, MA;
Simhon DOCTORI, Gan-Yavne, ISRAEL;
Ronen SOLOMON, Ranat-Gan, ISRAEL;

IR103 (Rev. 10/09)

AO 120 (Rev. 08/10)

TO: **Mail Stop 8** **Director of the U.S. Patent and Trademark Office** **P.O. Box 1450** **Alexandria, VA 22313-1450**	**REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK**

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Eastern District of Texas on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:22-cv-276	7/22/2022	Eastern District of Texas

PLAINTIFF	DEFENDANT
Orckit Corporation	Cisco Systems, Inc.

PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 6,680,904	1/20/2004	Orckit Corporation
2 7,545,740	6/9/2009	Orckit Corporation
3 8,830,821	9/9/2014	Orckit Corporation
4 10,652,111	5/12/2020	Orckit Corporation
5		

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	**DATE OF PATENT OR TRADEMARK**	**HOLDER OF PATENT OR TRADEMARK**
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy