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(54) **METHOD AND APPARATUS FOR PROVIDING POLICY-BASED SERVICES FOR INTERNAL APPLICATIONS**

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(58) **Field of Search** 370/229–235, 370/351, 389–392, 412–418, 428, 401, 402, 465, 466; 709/227, 228, 238, 240

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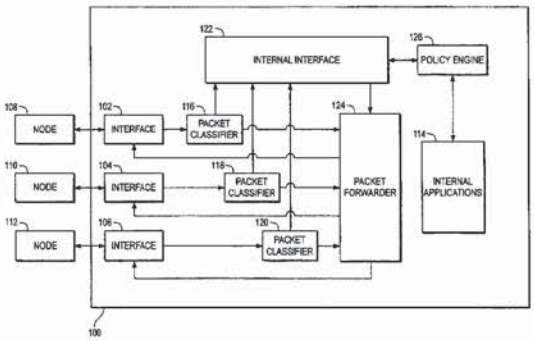
(57) **ABSTRACT**

A packet-forwarding device for providing policy-based services has at least a first interface, a second interface, and a packet forwarder for forwarding external packets between the first and second interfaces. The packet-forwarding device also runs internal applications that may be remotely accessed. The first and second interfaces transmit and receive internal and external packets, the internal packets being those packets generated or received by the internal applications during remote access, and the external packets being those packets destined for devices other than the packet-forwarding device. The packet forwarder forwards external packets between the first and second interfaces. An internal interface forwards internal packets between the internal applications and the first and second interfaces, and a policy engine logically connected to the internal interface applies a policy to the internal packets.

48 Claims, 3 Drawing Sheets



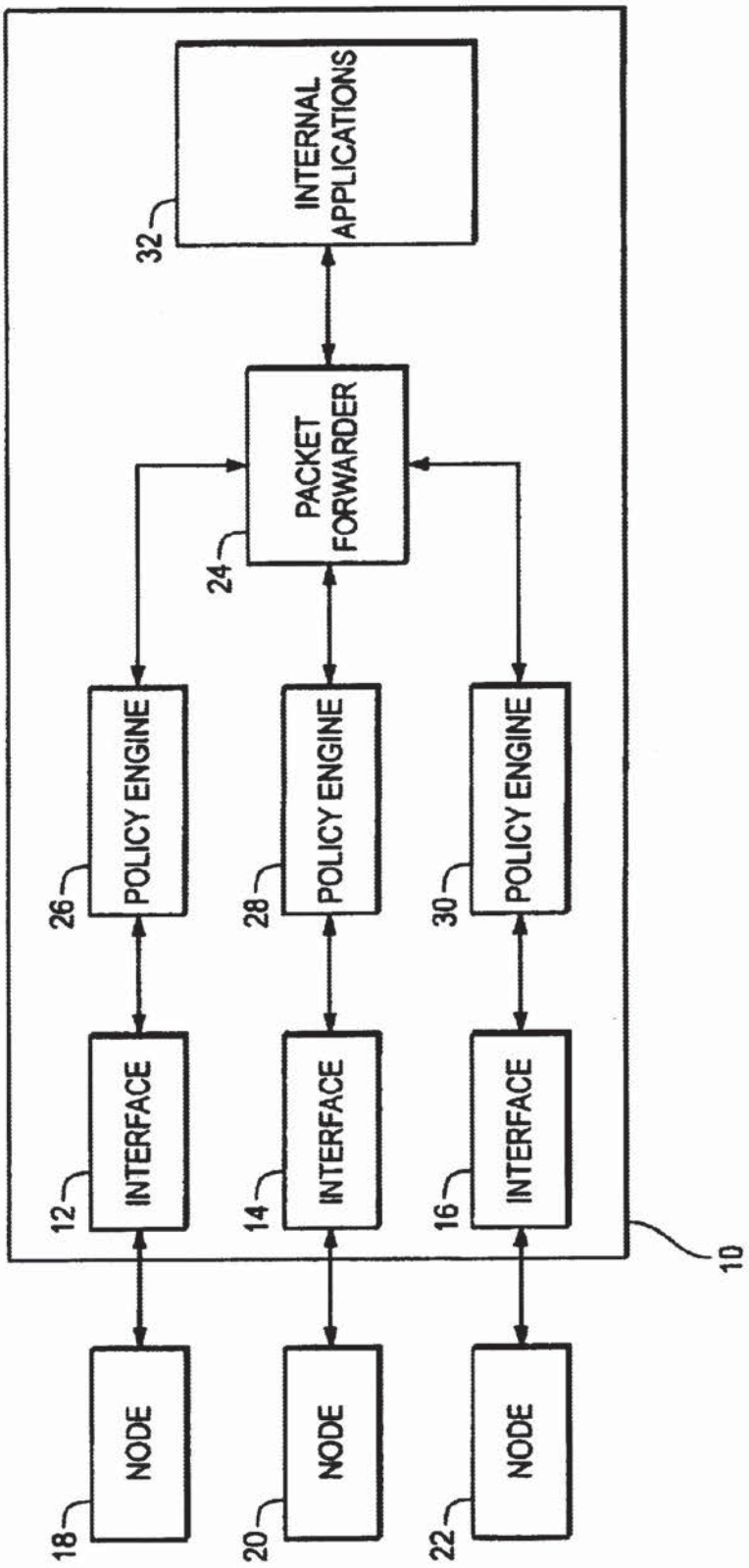


FIG. 1
PRIOR ART

FIG. 2

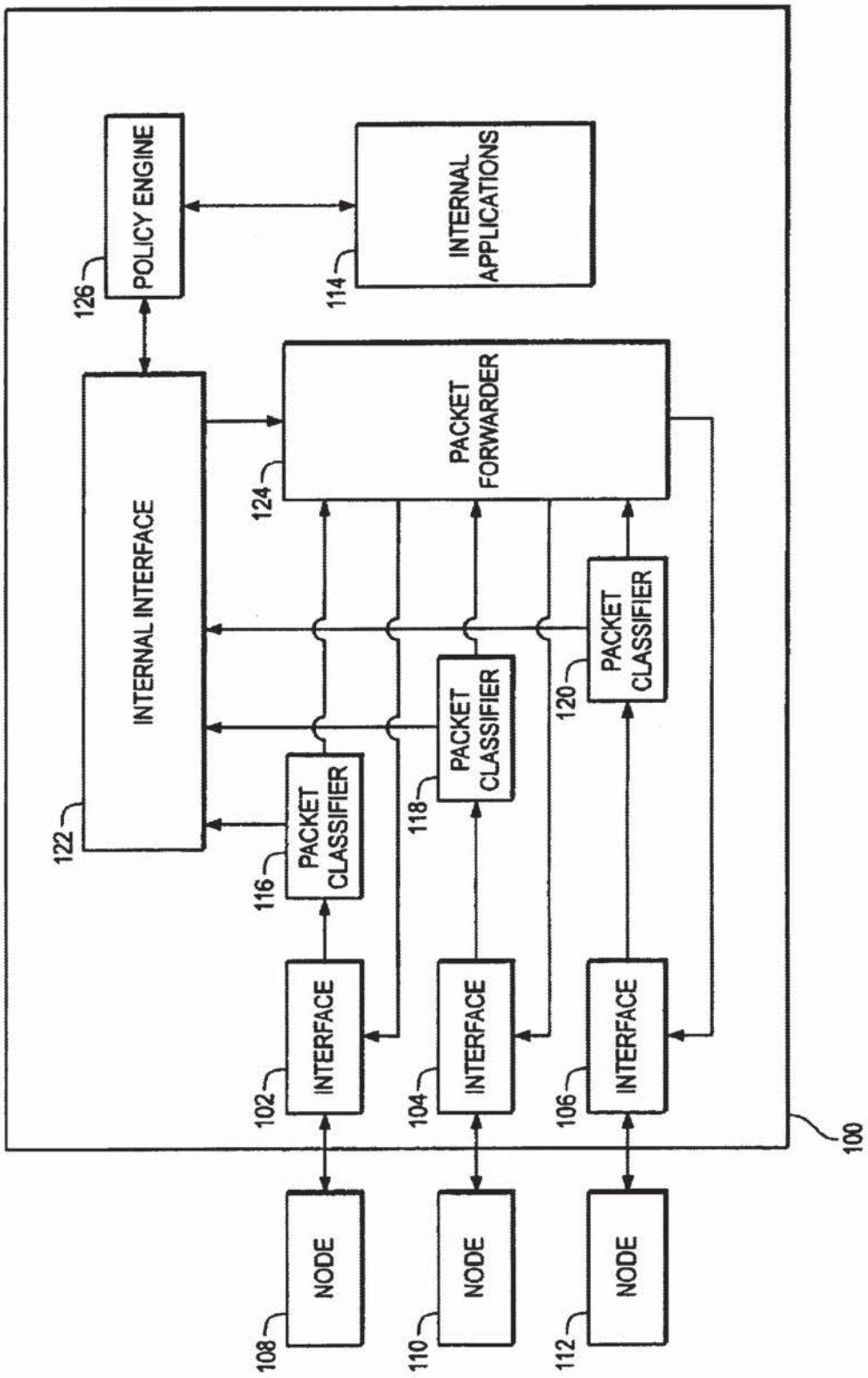
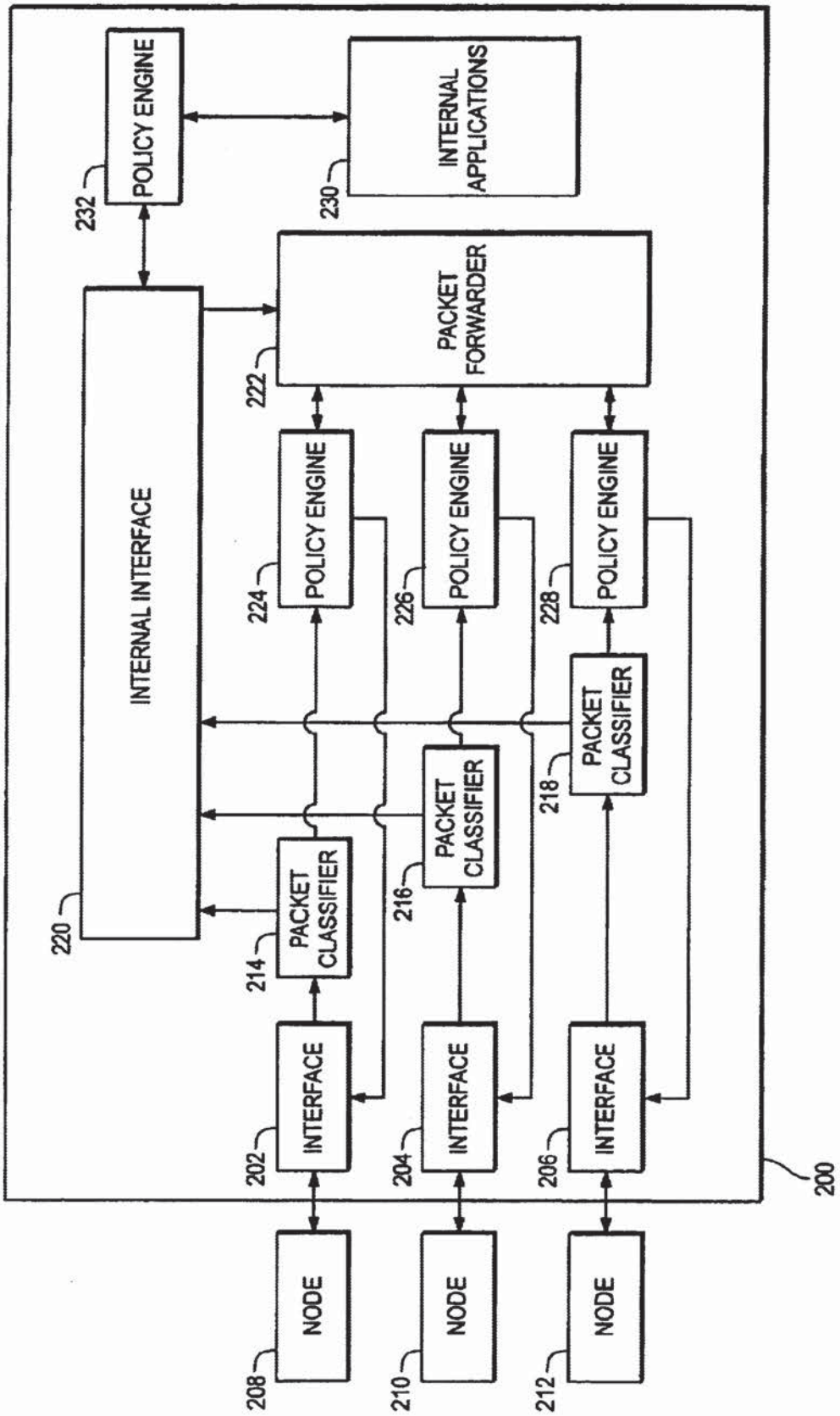


FIG. 3



METHOD AND APPARATUS FOR PROVIDING POLICY-BASED SERVICES FOR INTERNAL APPLICATIONS

BACKGROUND OF THE INVENTION

A. Field of the Invention

This invention relates to the field of digital telecommunications. More particularly, this invention relates to a method and apparatus for applying policies in packet forwarding devices, such as routers and remote access servers.

B. Description of Related Art

Packet-switched networks, such as the Internet, typically include one or more packet forwarding devices, such as routers or remote access servers. Viewed at the simplest level, a router is a device having a plurality of interfaces, with each interface typically connected to a wide area network (WAN), a local area network (LAN), or a host. Internally, the router forwards packets from one interface to another based on the destination address contained in the header of each packet. A remote access server is similar to a router, except that, in addition to interfaces to WANs and/or LANs, a remote access server also includes one or more interfaces to the public switched telephone network (PSTN) to provide dial-in access to the network. Remote access servers also forward packets from one interface to another based on the destination addresses of the packets.

Increasingly, routers and remote access servers are also performing more sophisticated handling of packets than simply routing them on the basis of destination address. In particular, some packets may be selected for special treatment in order to provide "policy-based services." "Policy-based services" encompass any disposition of packets that involves more than simply routing them based on their destination addresses. For example, routers and remote access servers may perform packet filtering, in which certain packets are dropped, diverted, and/or logged. The router or remote access server may also perform network address translation (NAT), in which the source and/or destination addresses are changed. Certain packets may be encrypted or decrypted, such as provided for in the IPsec protocols. Finally, certain packets may be prioritized in the queue of the router or remote access server in order to provide a particular quality of service (QoS) level. Many other types of special handling of packets could also be performed.

To identify the packets that are to be subject to such special handling, the router or remote access server typically examines more than the destination address of the packet. In general, the packet-forwarding device examines one or more "selector fields" within each packet, such as the source address, destination address, source port, destination port, and protocol type. User name, more particularly the IP address allocated to a particular user, may also be used as a selector filed in remote access servers. The packet-forwarding device then enforces a "policy" by applying a set of rules to packets whose selector fields meet predefined criteria. The rules specify how the packets are to be handled. As a result of this policy enforcement, packets may be dropped, logged, translated, encrypted, decrypted, or prioritized, if the selector fields within the packets match certain predefined criteria.

Typically, the "policy" is applied to all interfaces of the packet-forwarding device. For example, Abraham et al., U.S. Pat. No. 5,983,270 discloses a network server through which all traffic between a LAN and the Internet passes. A filter engine in the network server applies a policy, embodied in a set of rules, to all outbound packets transmitted from the LAN to the Internet and to all inbound packets from the Internet to the LAN.

Similarly, Haddock et al., PCT Publication No. WO 99/11003 discloses a packet-forwarding device having a comparison engine. The comparison engine examines the packets arriving at each input port to determine with which traffic group each packet is associated, the traffic groups defining different QoS levels.

A packet-forwarding device **10** that typifies the prior art approach of applying policies to packets is shown in FIG. **1**. FIG. **1** is a functional block diagram in which arrows illustrate the flow of packets between functional blocks. Device **10** may be a router, a remote access server, or other such device that forwards packets. Device **10** includes interfaces **12**, **14**, and **16**, that connect device **10** to nodes **18**, **20**, and **22**, respectively. Nodes **18–22** may represent hosts connected via a LAN or WAN or via the PSTN. Nodes **18–22** may also represent other packet forwarding devices. Although device **10** is shown in FIG. **1** with three interfaces, device **10** may, in general, have a greater or fewer number of interfaces.

As indicated by the double-headed arrows, interfaces **12–16** are able to send packets to and to receive packets from nodes **18–22**, respectively. Interfaces **12–16**, in turn, are logically connected to a packet forwarder **24** via policy engines **26**, **28**, and **30**. Internal applications **32** are also logically connected to packet forwarder **24**. Internal applications **32** include the applications on device **10**, such as applications for controlling and configuring device **10**, that are accessible remotely, such as by SNMP or by Telnet.

Packet forwarder **24** receives packets forwarded by interfaces **12–16**, via policy engines **26–30**, and by internal applications **32**. Packet forwarder **24**, in turn, is able to forward packets to internal interfaces **12–16**, via policy engines **26–30**, and to internal applications **32**. Packet forwarder **24** performs a routing functionality. Specifically, packet forwarder **24** determines, for each packet it receives, whether to forward the packet to one or more of interfaces **12–16** and/or internal applications **32**. Packet forwarder **24** makes this routing determination for each packet based on the packet's destination address. Typically, packet forwarder **24** has access to routing tables that specify where to send each destination address. Normally, packet forwarder **24** will forward a packet to internal applications **32** when the packet's destination address matches one of the packet-forwarding device's own IP addresses.

Policy engines **26–30** apply policies to all packets forwarded between interfaces **12–16** and packet forwarder **24**. In this process, policy engines **26–30** trap each packet and examine various selector fields in each packet, such as source address, destination address, source port, destination port, and protocol type. Based on this information, policy engines **26–30** apply a set of rules that specify the manner in which the packets are to be handled. In general, policy engines **26–30** may be separately configured so as to apply different policies.

The problem with this approach is that there is a high overhead associated with applying policies to all incoming and outgoing packets. This high overhead may increase the latency of each packet and may degrade the throughput of the packet-forwarding device. Another disadvantage with the prior art approach is the time and effort required to develop and manage policies for each interface. Finally, the overhead and management difficulties serve to limit the complexity of the policies that a packet-forwarding device can apply.

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