~~PATENT~~

~~Attorney Docket No. 17814-10.00~~

METHOD FOR AUTOMATICALLY CLASSIFYING TRAFFIC IN A ~~POLICY BASED BANDWIDTH ALLOCATION SYSTEM~~ PACKET COMMUNICATIONS NETWORK

Cross-References to Related Applications

This application claims priority from a commonly owned U.S. Provisional Patent Application, Ser. No. 60/066,864, filed on Nov. 25 1997, in the name of Guy Riddle and Robert L. Packer, entitled "Method for Automatically Classifying Traffic in a Policy Based Bandwidth Allocation System."

The following related commonly-owned contemporaneously-filed co-pending U.S. Patent Application is hereby incorporated by reference in its entirety for all purposes: U.S. patent application Ser. No. 09/198,051, still pending, in the name of Guy Riddle, entitled "Method for Automatically Determining a Traffic Policy in a Packet Communications Network,".

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~~Cross-Reference~~ to ~~Related Applications~~

~~The~~the following ~~related~~ commonly~~-~~owned ~~copending~~ U.S. ~~Provisional~~ Patent Application ~~is being filed concurrently and is hereby incorporated by reference in its entirety for all purposes: U.S. Provisional Patent Application Serial No. _____, in the name of Guy Riddle, entitled "Method for Automatically Determining a Traffic Policy in a Policy Based Bandwidth Allocation System," (attorney docket number 17814-9.00), which relates to a determining a default traffic policy.~~

~~Further, this application makes reference to the following commonly owned U.S. Patent Applications~~, which are incorporated by reference herein in their entirety for all purposes:

~~Copending~~ U.S. ~~Patent Application Serial~~Pat. No. ~~08/762,828~~5,802,106, in the name of

Communication Environment Without Data Rate Supervision," relates to a technique for automatically determining the data rate of a TCP connection;

~~Copending~~ U.S. ~~Patent Application Serial~~patent application Ser. No. ~~_____~~,08/977,376, now U.S. Pat. No. 6,046,980, in the name of Robert L. Packer, entitled "Method for Managing Flow Bandwidth Utilization at Network, Transport and Application Layers in Store and Forward Network," ~~(attorney docket number 17814-5.10)~~ relates to a technique for automatically allocating bandwidth based upon data rates of TCP connections according to a hierarchical classification paradigm; and.

~~Further, this~~U.S. patent application ~~makes reference to the following U.S. Patent Application:~~

~~Copending U.S. Patent Application Serial~~Ser. No. 08/742,994, now U.S. Pat. No. 6,038,216 in the name of Robert L. Packer, entitled "Method for Explicit Data Rate Control in a Packet Communication Environment Without a Data Rate Supervision," relates to a technique for automatically scheduling TCP packets for transmission.

~~Paper Appendix~~

~~The following paper appendices are included herewith and incorporated by reference in their entirety for all purposes:~~

~~Appendix A: Source code listing of automatic classification processing in an embodiment of the invention comprising thirty-one (31) sheets.~~

BACKGROUND OF THE INVENTION

This invention relates to digital packet telecommunications, and particularly to management of network bandwidth based on information ascertainable from multiple layers of OSI network model. It is particularly useful in conjunction with bandwidth allocation mechanisms employing traffic classification in a digitally-switched packet telecommunications environment ~~normally not subject to data flow rate control~~, as well as in monitoriing, security and routing.

The ubiquitous TCP/IP protocol suite, which implements the world-wide data communication network environment called the Internet and is also used in private

networks (Intranets), intentionally omits explicit supervisory function over the rate of data transport over the various media which comprise the network. While there are certain perceived advantages, this characteristic has the consequence of juxtaposing very high-speed packet flows and very low-speed packet flows in potential conflict for network resources, which results in inefficiencies. Certain pathological loading conditions can result in instability, overloading and data transfer stoppage. Therefore, it is desirable to provide some mechanism to optimize efficiency of data transfer while minimizing the risk of data loss. Early indication of the rate of data flow which can or must be supported is imperative. In fact, data flow rate capacity information is a key factor for use in resource allocation decisions. For example, if a particular path is inadequate to accommodate a high rate of data flow, an alternative route can be sought out.

Internet/Intranet technology is based largely on the TCP/IP protocol suite, where IP, or Internet Protocol, is the network layer protocol and TCP, or Transmission Control Protocol, is the transport layer protocol. At the network level, IP provides a ""datagram"" delivery service. By contrast, TCP builds a transport level service over the datagram service to provide guaranteed, sequential delivery of a byte stream between two IP hosts.

TCP flow control mechanisms operate exclusively at the end stations to limit the rate at which TCP endpoints emit data. However, TCP lacks explicit data rate control. The basic flow control mechanism is a sliding window, superimposed on a range of bytes beyond the last explicitly-acknowledged byte. Its sliding operation limits the amount of unacknowledged transmissible data that a TCP endpoint can emit.

Another flow control mechanism is a congestion window, which is a refinement of the sliding window scheme, which employs conservative expansion to fully utilize all of the allowable window. A component of this mechanism is sometimes referred to as ""slow start"".

The sliding window flow control mechanism works in conjunction with the Retransmit Timeout Mechanism (RTO), which is a timeout to prompt a retransmission of unacknowledged data. The timeout length is based on a running average of the Round Trip Time (RTT) for acknowledgment receipt, i.e. if an acknowledgment is not received within (typically) the smoothed RTT+4*mean deviation, then packet loss is inferred and the data pending acknowledgment isretransmitted.

Data rate flow control mechanisms which are operative end-to-end without explicit data rate control draw a strong inference of congestion from packet loss (inferred,

typically, by RTO). TCP end systems, for example, will "back-off", i.e., inhibit transmission in increasing multiples of the base RTT average as a reaction to consecutive packet loss.

Bandwidth Management in TCP/IP Networks

Conventional bandwidth management in TCP/IP networks is accomplished by a combination of TCP end systems and routers which queue packets and discard packets when certain congestion thresholds are exceeded. The discarded, and therefore unacknowledged, packet serves as a feedback mechanism to the TCP transmitter. (TCP end systems are clients or servers running the TCP transport protocol, typically as part of their operating system.)

The term "bandwidth management" is often used to refer to link level bandwidth management, e.g. multiple line support for Point to Point Protocol (PPP). Link level bandwidth management is essentially the process of keeping track of all traffic and deciding whether an additional dial line or ISDN channel should be opened or an extraneous one closed. The field of this invention is concerned with network level bandwidth management, i.e. policies to assign available bandwidth from a single logical link to network flows.

In a copending U.S. patent application ~~Serial~~Ser. No. 08/742,994, now U.S. Pat. No. 6,038,216, in the name of Robert L. Packer, entitled "Method for Explicit Data Rate Control in a Packet Communication Environment Without Data Rate Supervision," a technique for automatically scheduling TCP packets for transmission is disclosed. Furthermore, in ~~a copending~~ U.S. ~~Patent Application Serial~~Pat. No. ~~08/762,828~~5,802,106, in the name of Robert L. Packer, entitled "Method for Rapid Data Rate Detection in a Packet Communication Environment Without Data Rate Supervision," a technique for automatically determining the data rate of a TCP

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