On Providing End-to-End QoS introducing a set of Network Services in Large-Scale IP Networks

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Network Services

• Premium Constant Bit Rate: Support applications that require VLL-like services, i.e. voice flows, voice trunks, interactive multimedia applications with low bandwidth requirements. They characterized by an almost constant bit rate (CBR) and low bandwidth requirements, while a great number of them are unresponsive (UDP). They also have small packets (<256Bytes), so as not to provoke long transmission delays. The targeted quantitative value for end-to-end delay is less than 150msec for 99.99% of the packets, while packet loss is expected to be less than 10^{-6}.

• Premium Variable Bit Rate: Typical candidate applications are real time video and teleconferencing with unresponsive variable bit rate (VBR) sources. They are characterized by large packet size, which oscillates from 256 to 1024 bytes. The targeted end-to-end delay is limited to be less than 250msec for 99.99% of the packets, while packet loss should be less than 10^{-4}.

• Premium Multimedia: PMM is expected to carry a mixture of TCP and non-TCP traffic. It is supposed to serve adaptive applications (TCP), like low-quality video, non real time multimedia applications or file transfer (FTP). These flows require a minimum bandwidth, which must be delivered at a high probability. They require also throughput guarantees, which are translated into low packet loss only for the "in-profile" packets ($\leq 10^{-3}$).

• Premium Mission Critical: PMC is targeting to non-greedy adaptive applications that have great sensitivity concerning packet loss. It is thus suitable for transaction-oriented applications and interactive applications such as online games and chat-like applications. The main characteristics are the non-greediness of the flow, the responsive nature (TCP), the low use of bandwidth and the short life of the connection. The most important requirement is very low packet loss only for "in-profile" packets ($\leq 10^{-6}$) and low queuing delay.

• Standard Best Effort: There is no special treatment in the network for this NS.

Traffic Classes

A TCL is defined as a composition of a set of admission control rules, a set of traffic conditioning rules (Fig. 1) and a per-hop behavior (PHB). Five TCLs are introduced: TCL1, TCL2, TCL3, TCL4 and TCL5 which correspond to PCBR, PVBR, PMM, PMC and STD BE. Each TCL maintains a separate queue at the router output ports and allocates one or more DSCPs in order to enable differentiation of packets in the core network. A PHB implemented in the output port of a router is realized in the network with the use of scheduling and buffer management algorithms. The scheduling mechanism selected is a combination of the Priority Queuing and Weighted-Fair Queuing, which is called PQWFQ (Fig. 2). TCL1 has a strict priority over the other TCLs. The rest TCLs are scheduled with the WFQ and each queue is managed by different weight and queuing strategy.

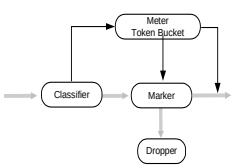


Fig. 1. Traffic Conditioning Mechanisms

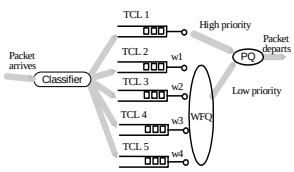
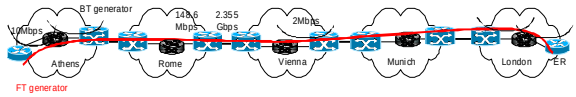


Fig. 2. Design of router output port

Simulation Topology

A large-scale network is used as a reference topology for studying the performance and effectiveness of the proposed services. It has five interconnected networks, which belong to five cities of Europe. The traffic generators are placed in the Athens network and the destination network is London for all TCLs, which is the longest path. Background generators are placed in different links and different domains, rising five different bottlenecks in the network.



QoS and DiffServ in IP Networks

History

• The Integrated Services (IntServ) architecture was the first significant step for the introduction of QoS in the Internet. IntServ uses the Resource Reservation Protocol (RSVP) for the explicit setup of reservation state on each network node along the path from the sender to the receiver. However, the constant exchange of RSVP messages, as well as the need for separate reservation establishment for each flow raised scalability concerns.

• The Differentiated Services (DiffServ) architecture emerged as a more scalable and manageable approach by providing relative prioritization of IP traffic. In DiffServ, IP flows with similar QoS requirements are grouped together under a common IP header field, the DiffServ Code Point (DSCP), and treated in the same queue inside the routers. DiffServ was also enhanced by the introduction of the Bandwidth Broker concept, a central entity that manages the resources of a domain and allocates them to requesting users.

Current activities

Definition and deployment of a set of **Network Services** within a DiffServ-enabled core network architecture, implementation of **Traffic Classes** and their **QoS requirements and characteristics**. Different traffic-handling mechanisms are proposed for each network service and are implemented with the use of the **OPNET** simulation tool.

Research Topics

• Quality of Service in IP Networks

• Network Services with a set of admission control rules, a set of traffic conditioning rules and a per-hop behavior (PHB)

Simulation Results

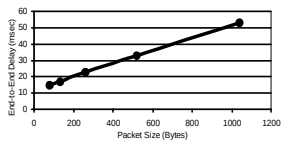


Fig. 3. Av. end-to-end delay of TCL1 vs. packet size

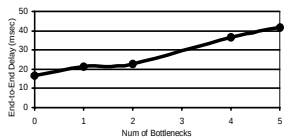


Fig. 4. Av. end-to-end delay of TCL1 vs. bottlenecks

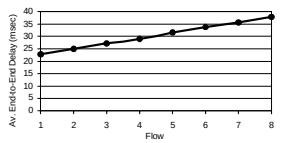


Fig. 5. Av. end-to-end delay of TCL2 for each flow

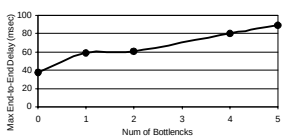


Fig. 6. Max. end-to-end delay of TCL2 vs. bottlenecks

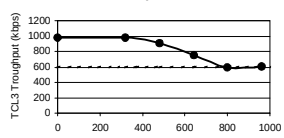


Fig. 7. TCL3 Throughput of five TCP flows vs. TCL-STD

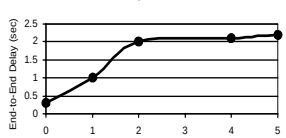


Fig. 8. Average end-to-end delay for TCL4