Chapter 3

IP Quality of Service Models

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ABSTRACT

Currently the Internet offers a point-to-point delivery service, which is based on the “best effort” delivery model. In this model, data will be delivered to its destination as soon as possible, but with no commitment about bandwidth or latency. Using protocols such as the Transmission Control Protocol (TCP), the highest guarantee the network provides is reliable data delivery. This is adequate for traditional data applications like e-mail, web browsing, File Transfer Protocol (FTP) and Telnet, but inadequate for applications requiring timeliness. For example, multimedia conferencing or audio and video streaming applications, which require high bandwidth capacity and are sensitive to delay and delay variation. For these applications to perform adequately, Quality of Services (QoS) must be quantified and managed, and the Internet must be modified to support real-time QoS and controlled end-to-end delays.

The efforts to enable end-to-end QoS over the Internet Protocol version 4 (IPv4) networks have led to the development of two different architectures, the Integrated services architecture (Intserv) and the Differentiated services architecture (Diffserv), which although different, support services that go beyond the best effort service. This chapter will present a detailed discussion on these IPv4 quality of services models. First, the Integrated services architecture with its related issues such as the reservation setup protocol will be demonstrated. Second, the Differentiated services architecture with a description of the services they provide will be described. Finally, a comparison between the Best-effort, the Integrated and Differentiated services will be done.

INTRODUCTION

The current Internet consists of multitude of networks built from various link-layer technologies and relies on the Internet protocol to interwork between them. IPv4 makes no assumptions about the underlying protocol stacks and offers an unreliable, connectionless network-layer service that is subject to packet loss, reordering, packet duplication, and
queuing delay in router buffers, all of these will increase with the network load. Because of the lack of any firm guarantees, the traditional IP delivery model is often referred to as Best-Effort (BE), so additional higher-layer end-to-end protocol such as TCP required to provide end-to-end reliability. TCP does this through the use of such mechanisms as packet retransmission, which further adds to the overall information transfer delay.

For traditional non-real-time Internet traffic such as FTP data, the best-effort delivery model of IPv4 has not been a problem. However, as we move further into the age of multimedia communications, many real-time applications are being developed that are delay-sensitive to the point where the best-effort delivery model of IP can be inadequate (Kamel, Elzarki, Eissa, & Abd Elkader, 2002). So there is still a firm need to provide many applications with additional service classes offering enhanced QoS with regard to bandwidth, packet queuing delay, and loss (Huston, 2000). These additional enhanced QoS delivery classes would supplement the BE delivery service in what could be described as an Integrated services Internet (Braden, Clark, & Shenker, 1994) and Differentiated services Internet (Blake, Black, Carlson, Davies, Wang, & Weiss, 1998).

The Integrated Services architecture provides QoS guarantees, but due to per flow management of traffic introduces severe scalability in the core network element, i.e. router where the number of flows reaches up to millions. It has proven to be easily deployable only in access networks where the number of flows is rather moderate in terms of scalability issues. Learning from the first experiences with Intserv, researchers developed a new architecture, i.e. Diffserv, which is intended to avoid the scalability problems and complexity of Intserv Architecture. Diffserv provides quality differentiation on aggregates without strict guarantees on individual flows, where QoS is attained by marking packets at the boundaries. Even though it seems that the Diffserv architecture has lots of obvious advantages towards Intserv as being relatively simple and more scalable, Intserv has also advantages applicable to specific network environments. Intserv provides end-to-end per-flow guarantees on the applications requirements and consequently achieves high utilization of the network resources, while Diffserv is not intended to provide end-to-end per application guarantees, rather it provides service differentiation on aggregates. These Intserv characteristics are especially desirable in an environment where the network resources are scarce, the available bandwidth is difficult to predict and where the guaranteed service for flows and high utilization is essential for the overall operation.

INTEGRATED SERVICE

The Internet Integrated services framework provides the ability for applications to choose among multiple, controlled levels of delivery service for their data packets. To support this capability, two things are required; first, individual network elements (subnets and IP routers) along the path followed by an application’s data packets must support mechanisms to control the quality of service delivered to those packets. Second, a way to communicate the application’s requirements to network elements along the path and to convey QoS management information between network elements and the application must be provided.

In the integrated services framework the first function is provided by QoS control services such as Controlled-Load service (Wroclawski, 1997) and Guaranteed service (Shenker, Partridge, & Guerin, 1997). The second function may be provided in a number of ways, but it is frequently implemented by a Resource Reservation Setup Protocol such as RSVP (Black, Brim, Carpenter, & Le Faucheur, 2001).

Reference Implementation Framework

A reference implementation framework is proposed to realize the Intserv mode. This framework
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