Internet Protocol Quality of Service Problem Statement

<draft-bradner-qos-problem-00.txt>

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Abstract
   This document outlines the requirements for a Quality of Service
   (QoS) function for the Internet Protocol, and is the product of an ad
   hoc Internet 2 working group meeting held August 25-27, 1997 hosted
   by Cisco Systems, Inc. This document is offered to the IP community
   for its consideration and comments.

   This document is organized as follows: Section 1 proposes a simple
   classification scheme to describe QoS models. Subsequent sections
   discuss requirements for Measurement, Administrative Policy,
   Provisioning Issues, Network Environment and Implementation Issues.

1.0 QoS Model Classification
   A QoS model can be conceptualized as a point in the following three-
   space: (Scope, Control Model, Transmission Parameters) Each of the
   these dimensions will be considered below.

   I. Scope
      The scope defines the boundaries of the QoS service. For example,
      an end-to-end scope is accessible to applications on end systems.
      An example of end-to-end scope is an RSVP reservation between
      hosts to deliver a pre-specified level of QoS. An intermediate

scope service, on the other hand, does not necessarily allow end
systems access to the service interface. An example of
intermediate scope is an RSVP tunnel between two routers.

II. Control Model
A QoS Control Model describes the granularity, duration, and locus
of control of QoS requests. For example, QoS requests may be made
from either endpoints or intermediate locations (proxy control).
In addition, the effects of such requests may vary in both
granularity and duration. The granularity of a request may extend
from a single flow between hosts to a site level aggregation,
while the duration may extend from less than the lifetime of a
single flow to several months.

III. Transmission Parameters
Transmission parameters can be expressed either quantitatively or
qualitatively. They describe the definable and configurable
metrics of a QoS Model. Typical parameters are packet loss rate,
bandwidth, delay average and variation, and MTU.

The specification of transmission parameters must support
consistent interpretation and interoperability.

2.0 Measurement

Any network-provided differentiated service must be measurable from
the point of view of the user on an end system as well as by the
operators of any transit networks. The service requester needs to be
able to find out using a combination of load-generating tests and
user-readable network management variables if the service quality
that has been requested and granted is actually being delivered.
Notification of QoS failures to both end users and network operators
is encouraged.

The network operators need to be able to monitor their networks to be
sure that they are delivering the requested service and to be able to
bill for QoS usage. In the cases where the requested service is not
being delivered, interoperable mechanisms and tools are needed so
that fault isolation can be performed. The use of such tools may
require that the network operators make available particular access
to their network components so that they can be probed.

Implementation of these tools may require the development of new SNMP
MIBs that enable access to underlying QoS mechanisms on the
intermediate routers and end systems. Note that end system effects
such as poor interrupt response on desktop computers must be
considered when trying to understand the performance of the network
itself.

3.0 Administrative Policy
   In order for QoS to be an effective tool, a rationing mechanism must
   be in place to allow network management to control the use of
   enhanced QoS capabilities. This mechanism must be enforced in the
   routing systems but should rely on a locally defined admission
   control mechanism that can take into account user authentication,
   priviledge, ability to pay, etc. Initially, these mechanisms could be
   manual or semi-automatic and could vary widely in granularity.

   A critical element of any widely-deployed differentiated QoS support
   is a scalable and interoperable administrative policy mechanism. The
   granting or possible revocation of QoS requests is dependent on a
   number of policy issues including authentication, authorization,
   prioritization, preemption, and accounting.

   QoS policy must be extensible eventually from a local network and the
   campus network through the Gigapop to backbone networks and other
   ISPs. A distributed set of QoS policy servers would be one means of
   supporting this level of functionality. Implementation mechanisms
   such as drop policy must be coordinated across administrative domains
   for consistent behavior.

   QoS mechanisms must be robust in the face of theft-of-service
   attempts and various other attacks.

4.0 Provisioning considerations
   A network operator must design and provision sufficient network
   capacity for the quality of service that is offered or that quality
   will not be delivered.   We anticipate that provisioning a network
   offering differential quality of service will be more difficult than
   a best effort network.

   Feedback mechanisms must exist within an administrative domain to
   advise the network operator of situations when aggregate QoS
   commitments approach or exceed network capacity. For example drop
   rate must be able to be monitored, and if drops as a percentage of
   load offered exceeds some threshold rate, then human intelligence
   must be applied to determine why and what to do about it.

5.0 Network environment
   A networking offering differential QoS must be designed so that
   misbehaving applications do not adversely affect established QoS
   commitments. In addition, it is desirable to have mechanisms to
   limit the impact of such applications on best effort service.

   We recognize that there are many multicast applications and the QoS
   function should support them. For example, in many multicast
   environments, there could be a heterogeneity of receivers with

different QoS requirements.

6.0 Implementation Notes

The implementation mechanisms for services of this type must be not be constrained by Layer-2 substrates that are or will be deployed across campus networks, Gigapops, and other provider backbones. On the other hand, mechanisms should be able to exploit any QoS features present in any substrates.

7.0 Security Considerations

There are many security issues concerning the use of any QoS service on a real network. At the very least any preference of one user's traffic over another's' opens the door for a denial of service situation if the QoS controls are not secure. The full extent of the security concerns remains to be determined. (also see section 3.0)

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