

Exhibit 5

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Network Element Service Specification Template

Status of this Memo

This memo provides information for the Internet community. It does not specify an Internet standard of any kind. Distribution of this memo is unlimited.

Abstract

This document defines a framework for specifying services provided by network elements, and available to applications, in an internetwork which offers multiple qualities of service. The document first provides some necessary context -- including relevant definitions and suggested data formats -- and then specifies a "template" which service specification documents should follow. The specification template includes per-element requirements such as the service's packet handling behavior, parameters required and made available by the service, traffic specification and policing requirements, and traffic ordering relationships. It also includes evaluation criteria for elements providing the service, and examples of how the service might be implemented (by network elements) and used (by applications).

Introduction

This document defines the framework used to specify the functionality of internetwork system components which support the the ability to provide multiple, dynamically selectable qualities of service to applications using an internetwork. The behavior of individual routers and subnetworks is captured as a set of "services", some or all of which may be offered by each element. The concatenation of these services along the end-to-end data paths used by an application provides overall quality of service control.

The definition of a service states what is required of a router (or, more generally, any network element; a router, switch, subnet, etc.) which supports a particular service. The service definition also

specifies parameters used to invoke the service, the relationship between those parameters and the service delivered, and the end-to-end behavior obtained by concatenating several instances of the service.

Each service definition also specifies the interface between that service and the environment. This includes the parameters needed to invoke the service, informational parameters which the service must make available for use by setup, routing, and management mechanisms, and information which should be carried between end-nodes and network elements by those mechanisms in order to achieve the desired end-to-end behavior. However, a service definition does not describe the specific protocols or mechanisms used to establish state in the network elements for flows that use the described service.

Services defined following the guidelines of this document are intended for use both within the global Internet and private IP networks. In certain cases a concatenation of network element services may be used to provide a range of end-to-end behaviors, some more suited to a decentralized internet and some more appropriate for a tightly managed private network. This document points out places where such distinction may be appropriate.

This document is comprised of three parts. The first defines some terms used both in this document and in the various service specification documents. The second discusses data formats and representations. The third portion of the document describes the various components of the service specification template.

Definitions

The following terms are used throughout this document. Service specification documents should employ the same terms to express these concepts.

- o Quality of Service (QoS)

In the context of this document, quality of service refers to the nature of the packet delivery service provided, as described by parameters such as achieved bandwidth, packet delay, and packet loss rates. Traditionally, the Internet has offered a single quality of service, best-effort delivery, with available bandwidth and delay characteristics dependent on instantaneous load. Control over the quality of service seen by applications is exercised by adequate provisioning of the network infrastructure. In contrast, a network with dynamically controllable quality of service allows individual application sessions to request network packet delivery characteristics according to their perceived needs, and may provide

different qualities of service to different applications. It should be understood that there is a range of useful possibilities between the two endpoints of providing no dynamic QoS control at all and providing extremely precise and accurate control of QoS parameters.

- o Network Element

A "Network Element" (or the equivalent shorter form "Element"), is any component of an internetwork which directly handles data packets and thus is potentially capable of exercising QoS control over data flowing through it. Network elements include routers, subnetworks, and end-node operating systems. A QoS-capable network element is one which offers one or more of the services defined according to the rules given in this document. Note that this definition, by itself, preclude QoS-capable network elements that meet performance goals purely through adequate provisioning rather than active admission and traffic control mechanisms. A "QoS-aware" network element is one which supports the interfaces (described below) required by the service definitions. Thus, a QoS-aware network element need not actually offer any of the services defined according to the format of this document; it merely needs to know how to deny service requests.

- o Flow

For the purposes of this document a flow is a set of packets traversing a network element all of which are covered by the same request for control of quality of service. At a given network element a flow may consist of the packets from a single application session, or it may be an aggregation comprising the combined data traffic from a number of application sessions.

NOTE: this definition of a flow is different from that used in IPv6, where a flow is defined as those packets with the same source address and FlowID.

Mechanisms used to associate a request for quality of service control with the packets covered by that request are beyond the scope of this document.

- o Service

The phrase "service" or "QoS Control Service" describes a named, coordinated set of QoS control capabilities provided by a single network element. The definition of a service includes a specification of the functions to be performed by the network

element, the information required by the element to perform these functions, and the information made available by the element to other elements of the system. A service is conceptually implemented within the "service module" contained within the network element.

NOTE: The above defines a precise meaning for the word "service". Service is a word which has a variety of meanings throughout the networking community; the definition of "service" given here refers specifically to the actions and responses of a single network element such as a router or subnet. This contrasts with the more end-to-end oriented definition of the same word seen in some other networking contexts.

- o Behavior

A "behavior" is the QoS-related end-to-end performance seen by an application session. This behavior is the end result of composing the services offered by each network element along the path of the application's data flow.

When each network element along a data flow path offers the same service, it is frequently possible to explain the resulting end-to-end behavior in a straightforward fashion. The behavior of a data flow path comprised of elements using different services is more complicated, and may in fact be undefined. A future version of this document may impose additional requirements on the service specification relating to multi-service concatenation.

- o Characterization

A characterization is a computed approximation of the actual end-to-end behavior which would be seen by a flow requesting specific QoS services from the network. By providing additional information to the end-nodes before a flow is established, characterizations assist the end-nodes in choosing the services to be requested from the network.

- o Characterization Parameters

Characterizations are computed from a set of characterization parameters provided by each network element on the flow's path, and a composition function which computes the end-to-end characterization from those parameters. The composition function may in practice be executed in a distributed fashion by the setup or routing protocol, or the characterization parameters may be gathered to a single point and the characterization computed at that point.

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