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SERIES Y: GLOBAL INFORMATION
INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS
AND NEXT-GENERATION NETWORKS

Internet protocol aspects – Transport

QoS support for VPN services – Framework and characteristics

ITU-T Recommendation Y.1315



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ITU-T Recommendation Y.1315

QoS support for VPN services – Framework and characteristics

Summary

ITU-T Recommendation Y.1315 describes the characteristics and applicability of various QoS (quality of service) service scenarios in the VPN (virtual private network) environment. The QoS service scenarios cover various QoS models in single or multiple service provider configurations. The QoS models described in this Recommendation encompass the pipe model, the hose model, and a combination and/or concatenation of both.

Source

ITU-T Recommendation Y.1315 was approved on 13 September 2006 by ITU-T Study Group 13 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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Introduction

There are several QoS models available for VPN services. In this Recommendation, the pipe model and the hose model are studied. The objectives of such studies are to provide precise definitions for these QoS models, to construct the VPN using the toolset provided in [ITU-T Y.1291], and to outline applicability of these QoS models in the VPN environment.

The architectural components needed to build these QoS models are defined in [ITU-T Y.1291] while the mechanisms to coordinate the resources to ensure QoS between sites are defined in the related IETF and ITU-T documents.

In order to provide VPN services with QoS, the first step is to define the QoS in parametric terms. This is construed as objectives of the services to be provided. The next step is to use the architecture building blocks provided in [ITU-T Y.1291] to construct the VPN with QoS, and the final step is to evaluate the service performance provided by the network. This Recommendation refers to [ITU-T Y.1291] on the functions and features of the QoS architectural components.

This Recommendation takes input from the various VPN related ITU-T deliverables, including approved Recommendations (e.g., [ITU-T Y.1311], [ITU-T Y.1311.1], [ITU-T Y.1312], and [ITU-T Y.1314]).

ITU-T Recommendation Y.1315

QoS support for VPN services – Framework and characteristics

1 Scope

The scope of this Recommendation is to provide guidelines on how the QoS architecture tools, mostly provided in [ITU-T Y.1291], can be used to support VPN services with QoS characteristics between the network ingress points to the network egress points. In this Recommendation, different QoS service models, including the pipe model and the hose model, are studied. The characteristics and applicability of VPN services using those QoS models and concatenation of multiple QoS models in a single or multiple provider scenarios are also studied, including some application examples.

While this Recommendation discusses the QoS issues related to VPN applications, the mechanisms to ensure QoS assurance are out of the scope of this Recommendation.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T E.800] ITU-T Recommendation E.800 (1994), *Terms and definitions related to quality of service and network performance including dependability*.
- [ITU-T G.1000] ITU-T Recommendation G.1000 (2001), *Communications Quality of Service: A framework and definitions*.
- [ITU-T H.360] ITU-T Recommendation H.360 (2004), *An architecture for end-to-end QoS control and signalling*.
- [ITU-T Y.1291] ITU-T Recommendation Y.1291 (2004), *An architectural framework for support of Quality of Service in packet networks*.
- [ITU-T Y.1311] ITU-T Recommendation Y.1311 (2002), *Network-based VPNs – Generic architecture and service requirements*.
- [ITU-T Y.1311.1] ITU-T Recommendation Y.1311.1 (2001), *Network-based IP VPN over MPLS architecture*.
- [ITU-T Y.1312] ITU-T Recommendation Y.1312 (2003), *Layer 1 Virtual Private Network generic requirements and architecture elements*.
- [ITU-T Y.1314] ITU-T Recommendation Y.1314 (2005), *Virtual private network functional decomposition*.

3 Definitions

This Recommendation defines the following terms:

3.1 arrival curve: A mechanism to serve as a measure of traffic arriving at provider's ingress network interface.

3.2 service curve: A mechanism to serve as a measure of the packet forwarding services provided by the service provider.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms.

BE	Best Effort
CE	Customer Edge
CoS	Class of Service
CR-LDP	Constraint-based Routing – Label Distribution Protocol
Diffserv	Differentiated Services
DSCP	DiffServ Code Point
EF PHB	Expedited Forwarding Per Hop Behaviour
FIFO	First In, First Out
FILO	First In, Last Out
Intserv	Integrated Services
LAPS	Link Access Procedure – SDH
LIFO	Last In, First Out
LILO	Last In, Last Out
LSP	Label Switched Path
MPLS	Multi-Protocol Label Switching
P	Provider (node)
PE	Provider Edge
QoS	Quality of Service
RSVP	Resource reSerVation Protocol
SLA	Service Level Agreement
TE	Traffic Engineering
UNI	User Network Interface
VF	Virtual Forwarder
VPN	Virtual Private Network

5 QoS definitions

The concept of quality of service is a multi-dimensional measure of user satisfaction of the network. The various definitions of QoS have been discussed in different ITU-T Recommendations (e.g., [ITU-T E.800] and [ITU-T G.1000]). Under those Recommendations, the network performance characteristics, network operability, network support, network serviceability, and network security are all part of the quality of service.

In this Recommendation, only the parametric aspects of QoS under the VPN environment for packet-based networks are discussed. The following subclauses provide details about the QoS metrics.

5.1 Packet-network-related QoS parameters

Among various aspects of quality of service definitions, this Recommendation focuses on the performance aspects of the service provider's network in the VPN environment for the packet-based networks. The measure of the QoS for a particular service provider's packet network providing VPN services should encompass the following aspects:

- **Delay:** There are various means to measure the time delay experienced by the user traffic. It should be noted that those definitions are not equivalent (e.g., consider if the packet is fragmented inside the network or LAPS-based framing). It should be noted that the service providers are free to use any of those definitions but a consistent definition needs to be provided to the clients if multiple service providers are involved.
 - [FIFO delay] First-in, first-out: The time difference between the first bit accepted by the network and the first bit delivered to the user across the network.
 - [LILO delay] Last-in, last-out: The time difference between the last bit accepted by the network and the last bit delivered to the user across the network.
 - [FILO delay] First-in, last-out: The time difference between the first bit accepted by the network and the last bit delivered to the user across the network. It is possible to define the FILO delay but should not be used because it is packet size sensitive.
 - [LIFO delay] Last-in, first-out: The time difference between the last bit accepted by the network and the first bit delivered to the user across the network. It is possible to define the LIFO delay but should not be used because it is packet size sensitive.
- **Delay variation (jitter):** Once a specific type of delay is defined by the network, the delay variation may be further divided into the following sub-categories:
 - Maximum delay variation: The difference between the maximum delay and minimum delay experienced by the user traffic within a specific time window.
 - Mean delay variation: Within a specific time window $[0, T]$, if each individual packet delay can be denoted as $d(k)$ for the k th packet in the time window, the mean delay variation can then be denoted as $D_{[0, T]} = \sum_{i=0}^N |d(i) - \bar{D}|$ where N denotes that there are N packets arriving in the time interval $[0, T]$ and $\bar{D}$ is the average delay endured by each packet arriving in the time window $[0, T]$ (i.e., $\bar{D} = \sum_{k=0}^N d(k)$ where N is the total number of packets arrived in the time interval $[0, T]$).
 - Medium delay variations: $(\bar{M})$: Within a specific time window $[0, T]$, 50% of the packet have delay more than $\bar{M}$ and 50% packet will have delay less than $\bar{M}$.
- **Packet loss probability:** The definition of packet loss probability (as opposed to the pure packet loss counts as some service providers are considering) is also subject to the time window constraint. In this Recommendation, the "packet delivery probability" is defined as the total number of packets successfully delivered divided by the total number of the eligible packets received by the network for a given and well-defined time interval. The eligible packets are then subject to the input constraint. Hence the "packet loss probability" is one minus the "packet delivery probability".

The particular value of delay, delay variation, and packet loss probability are not specified and are also application specific.

For delay measurement, the FIFO delay may be ensured analytically for arbitrary packets. Even the LILO delay measurement may be useful for applications; such a delay will be packet content sensitive and difficult to be ensured analytically.