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Y.1541-QOSM -- Y.1541 QoS Model for Networks Using Y.1541 QoS Classes

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Abstract

This draft describes a QoS-NSLP QoS model (QOSM) based on ITU-T Recommendation Y.1541 QoS signaling requirements. Y.1541 specifies 6 standard QoS classes, and the Y.1541-QOSM extensions include additional QSPEC parameters and QOSM control processing guidelines.

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Conventions Used in This Document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

1. Introduction

This draft describes a QoS model (QOSM) for QoS-NSIS signaling layer protocol (QoS-NSLP) application based on ITU-T Recommendation Y.1541 QoS signaling requirements. Y.1541 currently specifies 6 standard QoS classes, and the Y.1541-QOSM extensions include additional QSPEC parameters and QOSM control processing guidelines. The extensions are based on standardization work in the ITU-T on QoS signaling requirements [Y.1541, TRQ-QoS-SIG, E.361].

[QoS-SIG] defines message types and control information for the QoS-NSLP generic to all QOSMs. A QOSM is a defined mechanism for achieving QoS as a whole. The specification of a QOSM includes a description of its QSPEC parameter information, as well as how that information should be treated or interpreted in the network. The QSPEC [QSPEC] contains a set of parameters and values describing the requested resources. It is opaque to the QoS-NSLP and similar in purpose to the TSpec, RSpec and AdSpec specified in [RFC2205, RFC2210]. The QSPEC object contains control information and the QoS parameters defined by the QOSM. A QOSM provides a specific set of parameters to be carried in the OSPEC - IntServ [RFC2210], DiffServ [RFC2475], and [Y.1541] are examples of QOSMs. At each QoS NSIS element (QNE), its contents are interpreted by the resource management function (RMF) for the purposes of policy control and traffic control (including admission control and configuration of the packet classifier and scheduler).

2. Summary of ITU-T Recommendations Y.1541 & Signaling Requirements

As stated above, Recommendation [Y.1541] is a specification of standardized QoS classes for IP networks (a summary of these classes is given below). Recommendation [TR0-QoS-SIG] specifies the requirements for achieving end-to-end QoS in IP networks, with Y.1541 QoS classes as a basis. Y.1541 recommends a flexible allocation of the end-to-end performance objectives (e.g., delay) across networks, rather than a fixed per-network allocation. NSIS protocols already address most of the requirements, this document identifies additional QSPEC parameters and control information needed to support the Y.1541 QOSM.

2.1 Y.1541 QoS Classes

[Y.1541] proposes grouping services into QoS classes defined

according to the desired QoS performance objectives. These QoS classes support a wide range of user applications. The classes group

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objectives for one-way IP packet delay, IP packet delay variation, IP packet loss ratio, etc. Classes 0 and 1, which generally correspond to the DiffServ EF PHB, support interactive real-time applications. Classes 2, 3, and 4, which generally correspond to the DiffServ AFxy PHB Group, support non-interactive applications. Class 5, which generally corresponds to the DiffServ best-effort PHB, has all the QoS parameters unspecified. These classes serve as a basis for agreements between end-users and service providers, and between service providers. They support a wide range of traffic applications including point-to-point telephony, data transfer, multimedia conferencing, and others. The limited number of classes supports the requirement for feasible implementation, particularly with respect to scale in global networks.

The QoS classes apply to a packet flow, where [Y.1541] defines a packet flow as the traffic associated with a given connection or connectionless stream having the same source host, destination host, class of service, and session identification. The characteristics of each Y.1451 QoS class are summarized here:

Class 0: Real-time, highly interactive applications, sensitive to jitter. Mean delay upper bound is 100 ms, delay variation is less than 50 ms, and loss ratio is less than 10^-3. Application examples include VoIP, Video Teleconference.

Class 1: Real-time, interactive applications, sensitive to jitter. Mean delay upper bound is 400 ms, delay variation is less than 50 ms, and loss ratio is less than 10^-3. Application examples include VoIP, video teleconference.

Class 2: Highly interactive transaction data. Mean delay upper bound is 100 ms, delay variation is unspecified, and loss ratio is less Than 10^-3. Application examples include signaling.

Class 3: Interactive transaction data. Mean delay upper bound is 400 ms, delay variation is unspecified, and loss ratio is less than 10^-3. Application examples include signaling.

Class 4: Low Loss Only applications. Mean delay upper bound is 1s, delay variation is unspecified, and loss ratio is less than 10^-3. Application examples include short transactions, bulk data, video streaming

Class 5: Unspecified applications with unspecified mean delay, delay variation, and loss ratio. Application examples include traditional applications of Default IP Networks

These classes enable SLAs to be defined between customers and network service providers with respect to QoS requirements. The service

provider then needs to ensure that the requirements are recognized and receive appropriate treatment across network layers.

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Recommendation Y.1541 is currently being enhanced to provide support for extremely loss-sensitive user applications, such as high quality digital television, TDM circuit emulation, and high capacity transfers using TCP. The plan is to add a minimal number of classes to meet these needs.

2.2 Y.1541 Signaling Requirements

[TRQ-QoS-SIG] provides the requirements for signaling information regarding IP-based QoS at the interface between the user and the network (UNI) and across interfaces between different networks (NNI). To meet specific network performance requirements specified for the Y.1541 QoS classes, a network needs to provide specific user plane functionality at UNI, NNI, and INI interfaces. Dynamic network provisioning at a UNI and/or NNI node allows the ability to dynamically request a traffic contract for an IP flow from a specific source node to one or more destination nodes. In response to the request, the network determines if resources are available to satisfy the request and provision the network.

The call/session control signaling includes an indication of the QoS requirements for each session. Obtaining user-to-user QoS will require standard signaling protocols for communicating the requirements among the major entities. These entities include users and their end terminal equipment, and network service providers and their equipment, especially equipment implementing the inter-working and signaling function between networks, and between users and networks.

It MUST be possible to derive the following service level parameters as part of the process of requesting service:

- a. Y.1541 QoS class
- b. peak data rate (p)
- c. peak bucket size (Bp)
- d. sustainable rate (Rs)
- e. sustainable bucket size (b)
- f. token bucket rate (r)
- g. maximum allowed packet size (M)
- h. DiffServ field [RFC2475]
- i. reservation priority class (urgency of establishing service connection) can be requested
- j. restoration priority class (urgency of restoring service connection under failure) can be requested

All parameters except <Bp>, <Rs>, and <Restoration Priority> have already been specified in [QSPEC]. These additional parameters are specified in <u>Section 3</u>.

It MUST be possible to perform the following QoS-NSLP signaling

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functions to enable Y.1541-QOSM requirements:

- a. accumulate delay, delay variation and loss ratio across the end-to-end connection, which may span multiple domains
- b. enable negotiation of Y.1541 QoS class across domains.
- c. enable negotiation of delay, delay variation, and loss ratio across domains.

Additional signaling functions beyond those already specified in [QSPEC] are discussed in <u>Section 4</u>.

3. Additional QSPEC Parameters for Y.1541 QOSM

3.1 <Token Bucket Extensions> Parameters

The <Token Bucket Extensions> parameters are represented by two floating point numbers in single-precision IEEE floating point format.

When the Bp and Rs terms are represented as IEEE floating point values, the sign bit MUST be zero (all values MUST be non-negative). Exponents less than 127 (i.e., 0) are prohibited. Exponents greater than 162 (i.e., positive 35) are discouraged, except for specifying a peak rate of infinity. Infinity is represented with an exponent of all ones (255) and a sign bit and mantissa of all zeroes.

3.2 <Restoration Priority> Parameter

Restoration priority is the urgency with which a service requires successful restoration under failure conditions. Restoration priority is achieved by provisioning sufficient backup capacity, as necessary, and allowing relative priority for access to available bandwidth when there is contention for restoration bandwidth. Restoration priority is defined as follows:

```
Restoration Priority: 8 bits
3 priority values are listed here in the order of lowest priority to
```

highest priority:

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- 2 best effort
- 1 normal
- 0 high

Each restoration priority class has two parameters:

a. Time-to-Restore: Total amount of time to restore traffic streams belonging to a given restoration class impacted by the failure. This time period depends on the technology deployed for restoration. A fast recovery period of < 200 ms is based on current experience with SONET rings and a slower recovery period of 2 seconds is suggested in order to enable a voice call to recover without being dropped. Accordingly, candidate restoration objectives are:

High Restoration Priority: Time-to-Restore <= 200 ms Normal Restoration Priority: Time-to-Restore <= 2 s. Best Effort Restoration Priority: Time-to-Restore = Unspecified

b. Extent of Restoration: Percentage of traffic belonging to the restoration class that can be restored. This percentage depends on the amount of spare capacity engineered. All high priority restoration priority traffic, for example, may be "guaranteed" at 100% by the service provider. Other classes may offer lesser chances for successful restoration. The restoration extent for these lower priority classes depend on SLA agreements developed between the service provider and the customer.

4. Control Processing for Y.1541 QOSM

In this Section we illustrate the operation of the Y.1541 QOSM, and show how current QoS-NSLP and QSPEC functionality is used. No new control processing capabilities or parameters are required to enable the Y.1541 00SM.

As described in the example given in [QSPEC], Section 4.3, and as illustrated in Figure 1, the QoS NSIS initiator (QNI) initiates an end-to-end, inter-domain QoS NSLP RESERVE message containing the Initiator QSPEC. In the case of the Y.1541 QOSM, the Initiator QSPEC specifies the <Y.1541 QOS Class>, <Token Bucket>, <Token Bucket</pre> Extensions>, <Reservation Priority>, <Restoration Priority>, and perhaps other generic QSPEC parameters for the flow. As described in Section 3, the <Token Bucket Extensions> object contains the optional, Y.1541-QOSM-Specific parameters <Bp> and <Rs>; <Restoration Priority> is also an optional, Y.1541-QOSM-Specific parameter.

As illustrated in Figure 1, the RESERVE message may cross multiple domains supporting different QOSMs. In this illustration, the Initiator QSPEC arrives in an QoS NSLP RESERVE message at the ingress node of the Local-QOSM domain. As described in [QoS-SIG] and

[QSPEC], at the ingress edge node of the Local-QOSM domain, the end-to-end, inter-domain QoS-NSLP messages trigger the generation of

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a Local QSPEC, which is pushed on top of the Initiator QSPEC. That is, the Initiator OSPEC is translated into a Local-OOSM OSPEC. For example, if the Local-QOSM is the RMD-QOSM [RMD], then the <Y.1541 QOS Class> parameter would be translated to the <PHB Class> parameter. The Local QSPEC is used for QoS processing in the Local-QOSM domain, and then popped at the egress edge node of the Local-QOSM domain. The Initiator QSPEC is then used for QoS processing at the QoS NSIS receiver (QNR).

Each node on the data path checks the availability of resources and accumulating the delay, delay variation, and loss ratio parameters, as described below. If an intermediate node cannot accommodate the new request, it indicates it by marking a single bit, the <NON QOSM Hop> bit specified in [QSPEC], in the message, and continues forwarding the message. When the message reaches the egress edge node of the Local-QOSM domain, if no intermediate node has denied the reservation, the Initiator OSPEC is forwarded to the next domain, as described above. If an intermediate node has denied the reservation, by setting the <NON QOSM Hop> bit, the reservation is denied.

As specified in [QSPEC], if any QNE does not support the Y.1541 QOSM, it sets the <NON QOSM Hop> flag to one to indicate that it does not support the Y.1541 QOSM. The <NON QOSM Hop> flag is normally set to zero. As specified in [OSPEC], if any ONE cannot meet the requirements designated by the Initiator QSPEC to support an optional QSPEC parameter, for example, it cannot support the accumulation of end-to-end delay with the <Path Latency> parameter, the QNE sets the <Path Latency Flag> to one. The <Path Latency Flag> is normally set to zero.

Also, the Y.1541-QOSM requires negotiation of the <Y.1541 QoS Class> across domains. This negotiation can be done with the use of the existing procedures already defined in [QoS-SIG]. For example, the QNI sets <Desired QoS>, <Minimum QoS>, <Available QoS> objects to include <Y.1541 QoS Class>, <Path Latency>, <Path Jitter>, <Path BER> parameters. The QNE/domain SHOULD set the Y.1541 class and cumulative parameters, e.g., <Path Latency>, that can be achieved in the <QoS Available> object (but not less than specified in <Minimum QoS>). This could include, for example, setting the <Y.1541 QoS Class> to a lower class than specified in <QoS Desired> (but not lower than specified in <Minimum QoS>). If the <Available QoS> fails to satisfy one or more of the <Minimum QoS> objectives, the QNE/domain notifies the QNI and the reservation is aborted. Otherwise, the QNR notifies the QNI of the <QoS Available> for the reservation.

When the available <Y.1541 QoS Class> must be reduced from the desired <Y.1541 QoS Class>, say because the delay objective

has been exceeded, then there is an incentive to respond with an available value for delay in the <Path Latency> parameter. If the available <Path Latency> is 150 ms (still useful for many

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applications) and the desired QoS is Class 0 (with its 100 ms objective), then the response would be that Class 0 cannot be achieved and Class 1 is available (with its 400 ms objective). In addition, this QOSM allows the response to include an available <Path Latency> = 150 ms, making acceptance of the available <Y.1541 QoS Class> more likely. There are many long paths where the propagation delay alone exceeds the Y.1541 Class 0 objective, so this feature adds flexibility to commit to exceed the Class 1 objective when possible.

This example illustrates Y.1541-QOSM negotiation of <Y.1541 QoS Class> and cumulative parameter values that can be achieve end-to-end. The example illustrates how the QNI can use the cumulative values collected in <QoS Available> to decide if a lower <Y.1541 QoS Class> than specified in <QoS Desired> is acceptable.

e2e <->	e2e <				>	e2e	<->	e2e	
QoS	QoS					QoS		QoS	
	local <->	local	<->	local	<->	local			
	QoS	QoS		QoS		QoS			
NSLP	NSLP	NSLP		NSLP		NSLP		NSLP	
Y.1541	local	local		local		local		Y.1541	
QOSM	QOSM	QOSM		QOSM		QOSM		QOSM	
NTLP <->	NTLP <->	NTLP	<->	NTLP	<->	NTLP	<->	NTLP	
QNI	QNE	QNE		QNE		QNE		QNR	
(End) (Ing	ress Edge)	(Interio	r) ((Interio	r) (E	Egress I	Edge) (End)	ļ

Figure 1 Protocol Model of Y.1541-QOSM Operation

5. Security Considerations

There are no new security considerations based on this draft.

6. IANA Considerations

This section provides guidance to the Internet Assigned Numbers Authority (IANA) regarding registration of values related to the QSPEC template, in accordance with <u>BCP 26 RFC 2434</u> [RFC2434].

[QoS-SIG] requires IANA to create a new registry for QoS Model Identifiers. The QoS Model Identifier (QOSM ID) is a 32-bit value carried in a QSPEC object. The allocation policy for new QOSM IDs is TBD.

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This document also defines 3 new objects for the QSPEC Template, as detailed in <u>Section 3</u>. Values are to be assigned for them from the NTLP Object Type registry.

7. Acknowledgements

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8. Normative References

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