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

Internet protocol aspects – Quality of service and network
performance

Quality of service mapping and interconnection between Ethernet, Internet protocol and multiprotocol label switching networks

Recommendation ITU-T Y.1566

ITU-T Y-SERIES RECOMMENDATIONS

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

GLOBAL INFORMATION INFRASTRUCTURE	
General	Y.100–Y.199
Services, applications and middleware	Y.200–Y.299
Network aspects	Y.300–Y.399
Interfaces and protocols	Y.400–Y.499
Numbering, addressing and naming	Y.500–Y.599
Operation, administration and maintenance	Y.600–Y.699
Security	Y.700–Y.799
Performances	Y.800–Y.899
INTERNET PROTOCOL ASPECTS	
General	Y.1000–Y.1099
Services and applications	Y.1100–Y.1199
Architecture, access, network capabilities and resource management	Y.1200–Y.1299
Transport	Y.1300–Y.1399
Interworking	Y.1400–Y.1499
Quality of service and network performance	**Y.1500–Y.1599**
Signalling	Y.1600–Y.1699
Operation, administration and maintenance	Y.1700–Y.1799
Charging	Y.1800–Y.1899
IPTV over NGN	Y.1900–Y.1999
NEXT GENERATION NETWORKS	
Frameworks and functional architecture models	Y.2000–Y.2099
Quality of Service and performance	Y.2100–Y.2199
Service aspects: Service capabilities and service architecture	Y.2200–Y.2249
Service aspects: Interoperability of services and networks in NGN	Y.2250–Y.2299
Numbering, naming and addressing	Y.2300–Y.2399
Network management	Y.2400–Y.2499
Network control architectures and protocols	Y.2500–Y.2599
Packet-based Networks	Y.2600–Y.2699
Security	Y.2700–Y.2799
Generalized mobility	Y.2800–Y.2899
Carrier grade open environment	Y.2900–Y.2999
FUTURE NETWORKS	Y.3000–Y.3499
CLOUD COMPUTING	Y.3500–Y.3999

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T Y.1566

Quality of service mapping and interconnection between Ethernet, Internet protocol and multiprotocol label switching networks

Summary

Existing quality of service (QoS) class standardization for packet-based layer 2 and layer 3 services is largely non binding or missing. Recommendation ITU-T Y.1566 intends to simplify technical Ethernet, multiprotocol label switching (MPLS) and internet protocol (IP) QoS interconnection negotiations. Four ordinary classes and four auxiliary classes have been defined. This set of classes covers a wide range of transport service offerings.

The Recommendation gives guidance on how to deal with issues resulting from differences in QoS deployments of interconnecting service providers, aiming at the preservation of the original intent of the service.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Recommendation ITU-T Y.1566

Quality of service mapping and interconnection between Ethernet, Internet protocol and multiprotocol label switching networks

1   Scope

This Recommendation defines a limited set of classes that provide a basis for interworking between the different traffic class aggregates of different service providers, while preserving the original intent of the service (although packet markings might change).

The scope includes interworking between layers and between networks using similar technologies.

Each QoS class is defined by its qualitative performance characteristics and the suggested groups of applications whose performance requirements match the characteristics of one or more classes.

The limit on the number of classes is imposed by the space available in the widely-used three-bit codepoint space.

End-to-end QoS requires a common understanding of the QoS class properties in all involved domains. While many similarities are expected between the deployed or planned QoS architectures of different providers, these are often not obvious when starting interconnection negotiations. This specification aims on enabling end-to-end QoS (by preserving the intended service properties) across different packet networks and on simplification of the technical QoS interconnection negotiations between providers.

Informational examples in the appendices provide:

•   Codepoint to class association, with an interworking example

•   ITU-T Y.1541 QoS class mapping to interworking classes

The allocation of numerical performance budgets among interworking networks in the user network interface to user network interface (UNI-UNI) path is out of the scope of this Recommendation.

The issue of matching [b-3GPP TS 23.203] standardized QoS class identifier (QCI) characteristics to interworking classes is for further study.

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 I.371]   Recommendation ITU-T I.371 (2000), *Traffic control and congestion control in B-ISDN*.

[ITU-T Y.1541]   Recommendation ITU-T Y.1541 (2006), *Network performance objectives for IP-based services*.

3   Definitions

3.1   Terms defined elsewhere

None.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 mapping table: A table with entries for each class exchanged at an interconnecting point between service providers, with a row indicating the codepoint of each service class, the matching Ordinary class (or Auxiliary class), and the codepoint of the class used by the other service provider on the interconnecting link.

3.2.2 matching: An operation performed to associate existing service classes with the Ordinary class set (or Auxiliary class set), and ultimately associate the classes of two different service providers.

3.2.3 remarking: An operation performed to replace the codepoint of an existing service class with the codepoint of the matching class used by another service provider on the interconnecting link.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AF   Assured Forwarding

CPE   Customer Premises Equipment

CS   Class Selector

DSCP   Differentiated Services Codepoint

EF   Expedited Forwarding

GSMA   Global System for Mobile Communications Alliance

IP   Internet Protocol

MPLS   Multiprotocol Label Switching

QCI   QoS Class Identifier

QoS   Quality of Service

TCP   Transmission Control Protocol

UNI   User to Network Interface

5 The Ordinary class proposal

Prior to development of this Recommendation, there was no single standard which provided:

1)   qualitative QoS class definitions

2)   example classification of widely-deployed applications and services

3)   coverage of interconnection and interworking of the most popular packet-based communication layers (IP, MPLS and Ethernet) and enabling transport technologies.

The last aspect is twofold: first, class properties need to match across interconnection boundaries and second, codepoint mapping should be deterministic and non-ambiguous (identical codepoints are not required).

The aim of this Recommendation is to simplify the production and negotiation of end-to-end QoS over a chain of retail, wholesale and inter-provider transport products. The Recommendation accomplishes this goal by defining a set of "ordinary" classes with the capability to support groups of commonplace user applications and/or services (with similar performance needs). This clause

briefly introduces existing standards and then proceeds to a proposal of classes, their properties and example uses. Codepoint and mapping proposals may be found in several appendices.

On IP and MPLS, IETF's Differentiated Services (Diffserv) architecture [b-IETF RFC 2475] resulted in first commercial deployments of QoS differentiating IP services. Diffserv tries to respect prior standardization of IP precedence [b-IETF RFC 791]. Some informative work has been produced suggesting mappings of services to QoS classes and aggregation of IP classes to MPLS classes [b-IETF RFC 4594], [b-IETF RFC 5127].

[ITU-T Y.1541] standardizes several generic QoS classes and specifies UNI-to-UNI performance objectives [ITU-T I.371].

IEEE standardized quality differentiating LAN services with strict priority scheduling, which was picked as a simple solution viable in local networks. While a QoS class concept similar to that of Diffserv was not mandatory within IEEE, an optional specification was provided (see Annex G of [b-IEEE 802.1Q]). [b-MEF 23.1] proposes three service oriented classes including an IP to Ethernet mapping.

[b-GSMA IR.34] alliance IR.34 proposes four service oriented interconnection IP QoS classes [b-GSMA IR.34]. [b-3GPP TS 23.203] defines nine classes with different properties and example usages.

All of these standards have commonalities. But attempting to produce end-to-end QoS by simply combining the available standards is a challenge. QoS schemes independently developed by separate providers usually are not identical (although most have many commonalities).

The inter-layer QoS mappings to be covered are IP over Ethernet, IP over MPLS, Ethernet over MPLS and Ethernet over IP. These mappings cover the most widespread layer 2 and layer 3 service deployments.

In general, codepoints of an interconnecting party whose QoS markings are trusted (i.e., the receiving network providers are sure that a given codepoint identifies a specific class) may only be re-marked, if the class interpretation remains absolutely identical after re-marking. This is required to allow non ambiguous reversion of the re-marking at other points in a communication path. If this cannot be done, end-to-end QoS with pre-defined performance properties cannot be guaranteed. No suggestions are made here how to remark codepoints of parties to which a provider has no trust relation.

In some cases, the number of classes may differ at an interconnection point. It is then up to the interconnecting parties to agree class mappings and non-revertible re-marking of traffic, if it cannot be avoided. Note that re-marking IP precedence within a DSCP offers limited chances for class transparency, if only a single precedence codepoint is re-marked and an AF class like DSCP differentiation is applied.

Any mapping of a QoS traffic to a class with different properties should be revertible by conserving the original codepoint. Tunnelling (and may be header stacking) may be appropriate mechanisms.

To simplify mapping of QoS classes, while being aware that neither classes nor codepoints are widely standardized, two tables below introduce lists of class definitions with properties of these classes and some usage examples.

Table 5-1 starts with well-defined QoS classes and their properties. It is expected that support of classes with the properties and usage examples shown in Table 5-1 are a commodity to a majority of carriers and service providers.

**Table 5-1 – Ordinary packet service QoS classes, their properties
and matching suggestions**

Class properties	Class name (usage example)	Recommended matching to connecting provider class (if per class mapping applies)
Extremely low loss. Very low bandwidth per flow or session.	Critical (Network management) See [b-IETF RFC 791], [b-IETF RFC 2474], [b-IETF RFC 4594], [b-IETF RFC 5127], [b-IEEE 802.1Q]. (Notes 2 and 4)	This may be a provider internal class (see [b-IETF RFC 791]). Match to Assured class.
Low loss, very low delay, very low jitter. Short packets. Strict resource control (Note 5)	Priority beta (Voice) See [b-IETF RFC 791], [b-ITU-T E.800-Sup.8], [b-GSMA IR.34], [b-IETF RFC 3246], [b-IETF RFC 4594], [b-IETF RFC 5127], [b-IEEE 802.1Q], [b-MEF 23.1]. (Note 1)	Match to Priority class. If not possible, match to Bulk inelastic class.
Very low loss, high bandwidth.	Assured alfa, (interactive data) See [b-GSMA IR.34], [b-IETF RFC 2597], [b-IETF RFC 4594], [b-IETF RFC 5127], [b-IEEE 802.1Q], [b-MEF 23.1]. (Notes 1, 2 and 4)	Match to Assured class. If not possible, may be matched to Bulk inelastic class.
Unspecified performance	Default beta (best effort) See [b-MEF 23.1], [b-ITU-T E.800-Sup.8], [b-GSMA IR.34], [b-IETF RFC 2474], [b-IETF RFC 4594], [b-IETF RFC 5127], [b-IEEE 802.1Q], [b-MEF 23.1]. (Notes 1, 3 and 4)	Match to Default class.

**Table 5-1 – Ordinary packet service QoS classes, their properties
and matching suggestions**

Note that statements related to bandwidth in table column "class properties" refer to provider internal interfaces. Class-specific bandwidth requirements on customer or interconnection interfaces may differ significantly.

NOTE 1 – Alfa and beta may be interpreted as separate classes with similar properties. They may also be interpreted as priorities of sub-classes (alfa with lower loss probability and beta with higher loss probability).

NOTE 2 – IETF recommends a rate queue for these services [b-IETF RFC 4594]. Queue configuration alone either allows optimization for low delay and low jitter or low loss.

NOTE 3 – The class description is either "Better than best effort" [b-MEF 23.1] for the more valuable class or "Low Priority Data/Background" for the one with higher loss probability [b-IETF RFC 4594], [b-IETF RFC 5127] and [b-IEEE 802.1Q]. MEF, IEEE, IETF and ITU agree that no performance targets are specified for "Best Effort or Standard" traffic. This definition is also applied here; Default alfa and Default beta are expected to offer "Class of Service" only, meaning they have different but unspecified packet loss probabilities if both are present (contrary to that, [b-MEF 23.1] specifies performance targets for the higher quality in a shared "Low" class). IEEE and IETF agree that the "Low Priority Data/Background" class has a higher packet drop probability than the Best Effort class.

NOTE 4 – This class may be optimized to transport traffic without bandwidth requirements. Retransmissions after losses characterize the class and influence the buffer design. Active queue management with probabilistic dropping may be deployed.

NOTE 5 – Traffic load in this class must be strictly controlled, e.g., by application servers. One example could be flow admission control, another one would be codec renegotiation. Congestion in this class may result in bursty packet loss.

Each individual class name (like Assured) identifies a single class. Each class may be produced via a single queue. An alfa and a beta sub-class may either be produced on separate queues or on the same queue (and may have different packet loss probability in the latter case).

The class Critical has the same properties as the Assured class, but is listed here separately to emphasize its extra role (it is the only class reserved for provider internal use).

Table 5-2 lists additional QoS classes which are known to be supported by some service providers and carriers, but not necessarily by a majority of those offering QoS differentiation. Some of these services may be transferred to Table 5-1 over time. Table 5-2 indicates widespread temporal trends, while Table 5-1 shows stable state.

**Table 5-2 – Proposed auxiliary packet service QoS classes, their properties
and mapping suggestions**

Class properties	Usage example	Recommended matching to connecting provider class (if per class mapping applies)
Very low loss, low delay.	Priority alfa (Emergency) (Note 1)	Match to Priority class. If not possible, match to Bulk inelastic class.
Low loss, low delay, low jitter. High bandwidth.	Bulk inelastic alfa, (Streaming) See [b-GSMA IR.34], [b-IETF RFC 2597], [b-IETF RFC 4594], [b-IETF RFC 5127], [b-IEEE 802.1Q]. (Notes 1, 2 and 5)	Match to Bulk inelastic class. If not possible, match to Assured class.
Very low loss, high bandwidth.	Assured beta, (Interactive data) See [b-GSMA IR.34], [b-IETF RFC 2597], [b-IETF RFC 4594], [b-IETF RFC 5127], [b-IEEE 802.1Q], [b-MEF 23.1]. (Notes 1, 2 and 4)	Match to Assured class. If not possible, may be matched to Bulk inelastic class.
Unspecified performance	Default alfa (Better Than Best Effort) See [b-IETF RFC 4594], [b-IETF RFC 5127], [b-IEEE 802.1Q], [b-MEF 23.1]. (Notes 1, 3 and 4)	Match to Default class.

Note that statements related to bandwidth in table column "class properties" refer to provider internal interfaces. Class specific bandwidth requirements on customer or interconnection interfaces may differ significantly.

NOTE 1 – Alfa and beta may be interpreted as separate classes with similar properties. They may also be interpreted as priorities of sub-classes (alfa with lower loss probability and beta with higher loss probability).

NOTE 2 – IETF recommends a rate queue for these services [b-IETF RFC 4594]. Queue configuration alone either allows optimisation for low delay and low jitter or low loss.

NOTE 3 – The class description is either "Better than best effort" [b-MEF 23.1] for the more valuable class or "Low Priority Data/Background" for the one with higher loss probability [b-IETF RFC 4594], [b-IETF RFC 5127] and [b-IEEE 802.1Q]. MEF, IEEE, IETF and ITU agree that no performance targets are specified for "Best Effort or Standard" traffic. MEF [b-MEF 23.1] specifies performance targets for the higher quality in a shared "Low" class. IEEE and IETF agree that the "Low Priority Data/Background" class has a higher packet drop probability than the Best Effort class. Please also be aware that MEF, IETF and IEEE may expect the classes Best Effort and Less/Better Than Best Effort to share the same queue.

NOTE 4 – This class may be optimised to transport traffic without bandwidth requirements. Retransmissions after losses characterise the class and influence the buffer design. Active queue management with probabilistic dropping may be deployed.

Table 5-2 – Proposed auxiliary packet service QoS classes, their properties and mapping suggestions

NOTE 5 – Traffic load in this class must be controlled, e.g., by application servers. One example could be flow admission control. There may be infrequent retransmissions requested by the application layer to mitigate low levels of packet losses. Discard of packets through active queue management should be avoided in this class. Congestion in this class may result in bursty packet loss. If used to carry multimedia traffic, it is recommended to carry audio and video traffic in a single class. All of these properties influence the buffer design.

Proposals on class mappings are made along the class properties. The codepoints to be applied are of secondary importance and may be mapped.

Three to four QoS classes are widely deployed by carriers. Tables 6-1 and 6-2 describe four classes (some of which have sub-classes identified as alfa and beta). Not all of the four classes and their sub-classes may be deployed by a single carrier or offered for interconnection. It is reasonable to assume that some sub-classes may share a queue with other sub-classes of a class or may be ordered by priority queuing (also if ordered aggregates are not supported for interconnection). The sub-classes indicated in the table should help to identify possibly grouped QoS classes.

The class Priority is expected to carry traffic being subjected to some kind of admission control. This may influence also interconnection negotiations.

The Priority class may be engineered for a rather limited bandwidth share on an interconnection link carrying multiple QoS classes. As an exception to this, links interconnecting service nodes exchanging mainly Priority class traffic may allow for large bandwidth share of Priority traffic.

A description of methods to engineer the class properties indicated in Tables 5-1 and 5-2 is out of scope. Relevant IP performance class properties are defined in [ITU-T Y.1541]. See Appendix II for more information.

6   Simplifying QoS mapping by a standard interconnection class and codepoint scheme

Due to the lack of a standardized class and codepoint scheme, interconnecting carriers or wholesale customers and carriers must negotiate individual service and codepoint mappings. This consumes time and resources, if such negotiations are repeatedly required on a bilateral basis. The task can be simplified by standardizing an interconnection class and codepoint scheme. Again, the aim is to preserve the original intent of the service at interconnection points.

Standardized interconnection classes and codepoints result in a single QoS class and codepoint mapping scheme per carrier or service provider instead of one per interconnection partner. This holds for the receiving as well as the sending party. Having done the QoS mapping once is sufficient for all other negotiations to come. The idea is simple:

•   The sending party maps its own QoS classes and codepoints to the standard QoS interconnection class and codepoint scheme. The traffic is re-marked to the interconnection codepoint scheme at the egress gateway.

•   The receiving party maps the standard QoS interconnection class and codepoint scheme to its own QoS class and codepoint scheme. The traffic is re-marked to the provider internal codepoint scheme at the ingress gateway.

The properties of the standardized QoS interconnection classes should be standardized to a degree reducing bilateral negotiations on fixing performance budget assignment.

The following are the provisional standardized interconnection classes (for usage examples and class properties refer to Tables 5-1 and 5-2):

- Priority (Conversational) beta service (codepoint 5 is recommended on interconnection links, as it is expected to minimize re-marking due to widespread deployment; See e.g., [b-ITU-T E.800-Sup.8], [b-GSMA IR.34], [b-IETF RFC 3246] and [b-MEF 23.1]).

- Bulk inelastic (streaming) alfa as single class without sub-classes; See Appendix I for a codepoint proposal.

- Assured (Interactive) beta as single class without sub-classes; See Appendix I for a codepoint proposal.

- Default (Background) class with codepoint 0.

The provisional interconnection classes should be reviewed and may be revised based on further study and experience.

The service class names of [b-GSMA IR.34] have been listed in brackets. While the "Interactive" class definition of [b-GSMA IR.34] may be controversial in its application of the AF classes, the generic 4-class proposal given there seems to reflect the state of the art QoS deployment fairly well.

If the above interconnection classes are not applied by negotiating parties, it is recommended to decide on QoS class mappings based on the qualities of configuration based queue properties. Class names, codepoints and performance guarantees are less useful when looking for a good match for a class.

The interconnection classes reflect commodity QoS deployments present in many networks. In combination with the codepoints suggested by Appendix I, aggregation of ordered aggregates (IP AF traffic classes, and MEF classes) is relatively simple. Some examples for such a class and codepoint mapping scheme are shown in Figure 6-1. The interconnection classes apply the codepoints suggested by Appendix I.

First Example: Provider A sends network management traffic to a remote CPE connected via a service offered by Provider B. The CPE is not shown.

1) Mapping from internal class to standardised interconnection class Assured beta (6 → 3).

2) Mapping from standardised interconnection class Assured beta to internal class ‚Premium' (having Assured properties) (3 → 2).
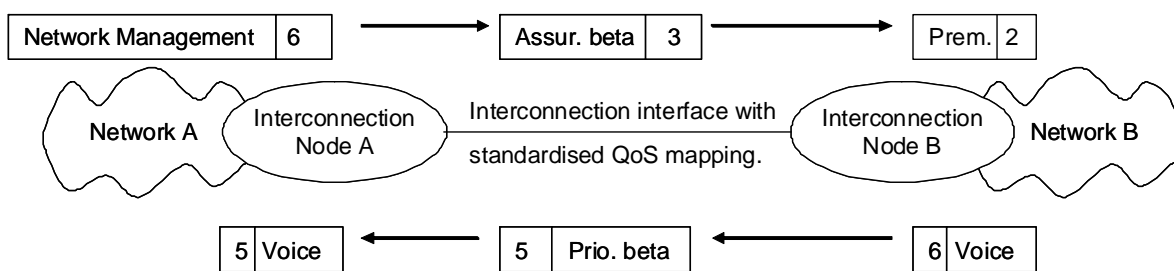
2) Mapping from standardised interconnection class Priority beta to internal class Voice (5 → 5).

1) Mapping from internal class Voice to standardised interconnection class Priority beta (6 → 5).

Second Example: Provider B sends Voice traffic to Provider A.

Figure 6-1 – Example usage of standardized QoS interconnection classes and codepoints

Appendix I

Example codepoint mapping for 3-bit codepoint classes

(This appendix does not form an integral part of this Recommendation.)

This appendix proposes codepoints and mappings for them on interconnection interfaces for all of the classes shown in Tables 5-1 and 5-2. A design criterion is a conservative consumption of 3-bit codepoints (hence the Assured service carries only one codepoint), leaving space for carrier internal classes or future extensions like Explicit or Pre-Congestion notification in 3-bit QoS schemes

Table I.1 – Suggested codepoints for the generic QoS classes

Received class name (usage example)	Received codepoint	Mapped to codepoint/class at interconnection points
Priority alfa (emergency)	7	Priority 7 (or 5)
Critical (network management) (Note 1)	6	Assured 3
Priority beta (VoIP)	5	Priority 5
Bulk inelastic alfa	4	Bulk inelastic 4
Assured alfa	3	Assured 3
Assured beta	2	Assured 2 or 3
Default beta	0	Default 0
Default alfa (Note 2)	1	Default 1 or 0
NOTE 1 – This class is regarded an "internal" in this table. A carrier may use different codepoints, especially for multimedia traffic. NOTE 2 – The author is not aware of the demand for this kind of service at interconnection points. Input is welcome.		

Ordered aggregates in a QoS class should be mapped onto a single class, if Ordered aggregates are not supported. Assured class with codepoint 3 (or 2) is suggested.

On IP level, the three-bit codepoint identifies the IP precedence. The IP precedence codepoint of e.g., DSCP AF41 or CS 4 is 4; the IP precedence of the EF class (Voice) is 5. See [b-IETF RFC 4594 for a brief explanation the relation of IP precedence and DSCP.

Appendix II

Example class mapping for [ITU-T Y.1541] to [ITU-T Y.1566]

(This appendix does not form an integral part of this Recommendation.)

This appendix proposes codepoints and mappings for the ITU-T Y.1541 classes. The assessment is based on Table 2 of [ITU-T Y.1541]. Note that the node mechanisms and the mapping of application examples to classes as proposed by Table 2 of [ITU-T Y.1541] are not explained in more detail in [ITU-T Y.1541]. Appendix IX of [ITU-T Y.1541] mentions a discussion on a future separate QoS class to carry IP TV traffic.

Table II.1 – Suggested class mapping for [ITU-T Y.1541]

ITU-T Y.1541 QoS class	ITU-T Y.1541 App. (examples)	ITU-T Y.1541 node mechanisms	ITU-T Y.1566
0	VoIP, VTC	Separate queue with preferential servicing, traffic grooming	Priority beta
1	VoIP, VTC		Priority beta
2	Transaction data, highly interactive (Signaling)	Separate queue, drop priority	Assured alfa (Notes 1 and 2)
3	Transaction data, interactive		Assured beta (Note 2)
4	Low loss only (short transactions, bulk data, video streaming)	Long queue, drop priority	Assured beta (Note 2)
5	Traditional applications of default IP networks	Separate queue (lowest priority)	Default beta
NOTE 1 – Signalling or network management traffic may be prioritized within an Assured service class. Here signalling is assigned to a network management class. This should be taken as an example, rather than a suggestion.			
NOTE 2 – ITU-T Y.1541 classes 3-5 do not offer delay variation bounds and are characterized by different delay bounds. While it is optimistically unclear from Table 2 of [ITU-T Y.1541] whether class 4 is produced with another queue as classes 2 and 3, above it is assumed that classes 2, 3 and 4 are produced with the same queue and share the same properties.			

Mapping of ITU-T Y.1541 classes 2-4 to an Assured service is based mainly on the given usage examples and the queue description. These seem to indicate data transfer as the applications suggested for these classes. Here, the bounds for IP packet loss have been ignored. [ITU-T Y.1541] suggests two provisional QoS classes (class 6 and class 7). Both define an upper bound IP loss rate of 10^{-5} and are identical to class 0 and 1 definitions on mean IP transfer delay and IP delay variation otherwise. Two appendices of [ITU-T Y.1541] refer to these classes, one about digital television transmission, the other about TCP-based data transmission. [ITU-T Y.1541] does not point out example applications for these classes, nor does it offer node mechanisms. As digital television transmission may be expected to carry traffic benefitting from admission control and will not benefit from probabilistic dropping during congestion, TCP applications do not require admission control but benefit from probabilistic dropping.

If ITU-T Y.1541 classes 6 and 7 were used to carry digital television transmission traffic, the ITU-T Y.1566 class Bulk inelastic is a proposed match.

It is out of scope of this Recommendation to discuss the values proposed by [ITU-T Y.1541] or to suggest different ones.

Appendix III

Single class transport of multiclass traffic

(This appendix does not form an integral part of this Recommendation.)

A single class QoS transport of multiclass traffic is to some extent similar to a leased line. Single class transport protects all traffic against congestion. Should drops or queuing delay occur, any multiclass QoS properties will not be applicable. If realized by a tunnel, the inner header (e.g., IP) may carry different QoS marks, while the outer or tunnel header respectively (e.g., Ethernet or MPLS) only carries a single QoS mark.

Matching the highest QoS requirement of a customer packet is a possible but not a recommended strategy to decide on the single class transport (tunnel) service QoS. In some cases a combination of multiclass requirements like lowest loss, jitter and delay will result in multiple optimum single class tunnel matches. Hence a more pragmatic approach consists of negotiating tunnel service QoS to match the dominating QoS class requested by the customer.

Most often arbitrary traffic mixes apply and data or streaming traffic dominates. It is generally recommended to realize a single class transport service by using the classes Bulk inelastic or Assured class for the single tunnel QoS.

Bibliography

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