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SERIES Y: GLOBAL INFORMATION
INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS,
NEXT-GENERATION NETWORKS, INTERNET OF
THINGS AND SMART CITIES

Future networks

**Requirements and framework for latency
guarantee in large-scale networks including the
IMT-2020 network**

Recommendation ITU-T Y.3113

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Recommendation ITU-T Y.3113

Requirements and framework for latency guarantee in large-scale networks including the IMT-2020 network

Summary

Recommendation ITU-T Y.3113 specifies requirements and a framework for effective and efficient solutions for latency guarantee and cooperation among heterogeneous quality of service (QoS) domains.

For a latency guarantee in multi-domain large-scale networks, it is necessary to clarify how the numerous data-plane functional entities should be arranged and operate in conjunction with each other. In order for the solution to be both effective and efficient, selecting an appropriate traffic granularity for network treatment is essential. The variety of granularity of flow aggregates (FAs), between flow and class, should be taken into consideration.

On the Internet or the IMT-2020 network, there are inevitably multiple domains with possibly different QoS architectures. Even with multiple heterogeneous domains, there should be an underlying unified resource reservation and admission control functions, while the data plane functions should be based on FAs and appropriate regulations in the middle of an end-to-end path.

History

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Flow aggregate, IMT-2020, latency guarantee, large-scale network, quality of service.

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FOREWORD

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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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Recommendation ITU-T Y.3113

Requirements and framework for latency guarantee in large-scale networks including the IMT-2020 network

1 Scope

This Recommendation specifies requirements and a framework for latency guarantee in large-scale networks, including the IMT-2020 network, as follows:

- the requirements for achieving latency guarantee in large-scale networks including the IMT-2020 network;
- overall framework and functional entities, and their interworking to achieve latency guarantee, effectively and efficiently.

Routing and upper layer functions lie outside 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 Y.2111] Recommendation ITU-T Y.2111 (2011), *Resource and admission control functions in next generation networks*.
- [ITU-R M.1645] Recommendation ITU-R M.1645 (2003), *Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000*.
- [ITU-R M.2083] Recommendation ITU-R M.2083 (2015), *IMT vision – Framework and overall objectives of the future development of IMT for 2020 and beyond*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 customer premises equipment [b-ITU-T E.800]: Telecommunications equipment located at the customer installation on the customer side of the network interface.

3.1.2 service provider [b-ITU-T E.800]: An organization that provides services to users and customers.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 aggregation domain: A set of relay nodes in the path, for a flow, between the aggregation and segregation points.

3.2.2 domain: A set of relay nodes and end-hosts under a single administrative control or within a closed group of administrative control; these include campus wide networks, private wide area networks, and IMT-2020 networks.

NOTE – This definition references the description in the Introduction to [b-IETF RFC 8655].

3.2.3 IMT-2020: Systems, system components, and related technologies that provide far more enhanced capabilities than those described in [ITU-R M.1645].

NOTE 1 – [ITU-R M.1645] defines the framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000 for the radio access network.

NOTE 2 – Based on [ITU-R M.2083].

3.2.4 large-scale network: A network or a set of networks, whose longest end-to-end path includes 16 or more relay nodes.

3.2.5 relay node: A node supporting relay functionality that acts as an intermediary node, through which other nodes can pass their traffic (e.g., router, switch or gateway).

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

5G	fifth Generation
5QI	5G QoS Identifier
AN	Access Network
ATS	Asynchronous Traffic Shaping
CN	Core Network
CPE	Customer Premises Equipment
DiffServ	Differentiated Services
DL	Downlink
DN	Data Network
DRR	Deficit Round Robin
e2e	end to end
FA	Flow Aggregate
FIFO	First In, First Out
GBR	Guaranteed Bit Rate
GFBR	Guaranteed Flow Bit Rate
IntServ	Integrated Services
IP	Internet Protocol
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
IR	Interleaved Regulator
MDBV	Maximum Data Burst Value
MFBR	Maximum Flow Bit Rate
NGBR	Non-GBR
NG-RAN	Next Generation-Radio Access Network
PDB	Packet Delay Budget
PDU	Protocol Data Unit

PGPS	Packetized Generalized Processor Sharing
QFI	QoS Flow Identifier
QoS	Quality of Service
RAN	Radio Access Network
RSpec	Request Specification
SDF	Service Data Flow
SMF	Session Management Function
TDM	Time Division Multiplexing
TSpec	Traffic Specification
UE	User Equipment
UL	Uplink
UPF	User Plane Function
uRLLC	ultra-Reliable Low Latency Communication

5 Conventions

None.

6 Introduction

The IMT-2020 network is expected to be able to support a variety of different services and applications. Among them, the ultra-reliable and low-latency communication (uRLLC) service requires an end-to-end (e2e) network latency bound [ITU-R M.2083]. A network latency guarantee is also one of the most important requirements for the 6G network [b-ITU-T Y-Suppl.66]. For example, it is required to have a 5 ms latency upper bound for the tactile Internet. Remote industrial management control and remote robotic surgery are example applications of the tactile internet. On the Internet, when measured in 1998, 90% of hosts were within fewer than 18 hops from the University of California at Los Angeles [b-Fei]. The Internet in 2030 should not be smaller than this measurement. As such, a large-scale network is defined to include 16 or more e2e hops in this Recommendation.

Different networks on the Internet including the IMT-2020 network, which is further divided into access network (AN), core network (CN) and data network (DN), have different quality of service (QoS) models and components. A QoS model includes the mechanisms, functions, description of QoS parameters information, and how that information should be treated and interpreted on the network. An integrated approach is necessary, which makes the various domains in the Internet work together as a whole.

Legacy technologies, based on either microscopic flows or simple classes, are too complex to be implemented on a large-scale network, or ineffective in an arbitrary network topology. Time-synchronized approaches, which are similar to time division multiplexing (TDM), taken in IEEE Time Sensitive Network (TSN) task group (TG) are not scalable to IMT-2020 networks or the current Internet.

In order for the solution to be both effective and efficient, selecting appropriate traffic granularity for network treatment is essential. The various granularity levels of flow aggregates (FAs), between flow and class, should be taken into consideration, and used as a basis for QoS control.

Therefore, this Recommendation specifies requirements and a framework for a latency guarantee in large-scale networks.