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

Internet protocol aspects – Quality of service and network
performance

Ethernet service activation test methodology

Recommendation ITU-T Y.1564

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

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
Enhancements to NGN	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

CLOUD COMPUTING

INTERNET OF THINGS AND SMART CITIES AND COMMUNITIES

General	Y.4000–Y.4049
Definitions and terminologies	Y.4050–Y.4099
Requirements and use cases	Y.4100–Y.4249
Infrastructure, connectivity and networks	Y.4250–Y.4399
Frameworks, architectures and protocols	Y.4400–Y.4549
Services, applications, computation and data processing	Y.4550–Y.4699
Management, control and performance	Y.4700–Y.4799
Identification and security	Y.4800–Y.4899

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

Recommendation ITU-T Y.1564

Ethernet service activation test methodology

Summary

Recommendation ITU-T Y.1564 defines a test methodology that may be used in assessing the proper configuration and performance of an Ethernet network to deliver Ethernet-based services. This out-of-service test methodology was created so that service providers may have a standard way of measuring the performance of Ethernet-based services.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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Table of Contents

		Page
1	Scope.....	1
2	References.....	1
3	Definitions	2
	3.1 Terms defined elsewhere	2
	3.2 Terms defined in this Recommendation.....	2
4	Abbreviations and acronyms	3
5	Conventions	4
6	Background on Ethernet network architecture	4
	6.1 Ethernet network architecture.....	4
	6.2 Ethernet service attributes	5
7	Test architecture and considerations.....	7
	7.1 Measurement points and measurable sections.....	8
	7.2 Ethernet frame transfer reference events (FRE).....	9
	7.3 Test architecture considerations	10
	7.4 Required test equipment capabilities.....	11
8	Ethernet service activation test methodology	12
	8.1 Service configuration test	12
	8.2 Service performance test	17
	8.3 Test configuration.....	19
	8.4 Test connectivity considerations	20
	8.5 Availability considerations for testing.....	20
	8.6 Frame loss ratio and errored frame ratio	21
	Appendix I – CBS and EBS test methodology	22
	I.1 Introduction	22
	I.2 CBS test methodology	22
	I.3 EBS configuration test methodology.....	23
	Appendix II – Example of service activation test reports	27
	II.1 Introduction	27
	II.2 Service configuration test reporting format.....	27
	II.3 Service performance test report format	28
	Bibliography.....	30

Introduction

Ethernet services have evolved significantly with the deployment of Ethernet in service providers' networks. Not only is Ethernet found at the user network interface (UNI), it can be deployed anywhere in the network. With the capability to prioritize traffic, its built-in resiliency and high availability, service providers are now using this technology to deliver advanced services. Unfortunately, there are currently no standardized test methodologies that can deliver to the expectation of measuring performance parameters as specified in [ITU-T Y.1563].

Prior to this Recommendation, the only methodology widely used to assess performance of Ethernet-based network service was IETF's "Benchmarking Methodology for Network Interconnect Devices", also known as IETF RFC 2544. [b-IETF RFC 2544] was created to evaluate the performance characteristics of network devices in the lab. It was widely adapted to provide performance metrics of Ethernet-based network services as there was no other methodology available to measure the quantities defined in [b-IETF RFC 1242].

With its capability to measure throughput, latency, frame loss (FL), and burstability (back-to-back test), [b-IETF RFC 2544] could arguably be used to provide performance metrics. However, to do so [b-IETF RFC 2544] would have to be used beyond its intended scope.

This Recommendation fills the methodological gap for measurement of operational Ethernet network services. Also, Ethernet-based services have evolved to include more features and complexities than those covered by the [b-IETF RFC 2544] scope. The [b-IETF RFC 2544] benchmarking methodology is not applicable to Ethernet service activation because:

- [b-IETF RFC 2544] does not consider multiple time durations for tests, as are often performed in operational networks with time-varying impairments. Its procedures find the absolute performance limit of a network element in a laboratory environment rather than verify that a service is delivered to the agreed level.
- Latency is measured in a limited way, on only one frame every two minutes, and only at maximum transmitted load with no loss rate, which is very likely much higher than the agreed upon committed information rate (CIR).
- It does not provide for the verification of configuration and performance of CIR, committed burst size (CBS), excess information rate (EIR), excess burst size (EBS) and colour mode (CM), all important components of the bandwidth profile.
- Finally, important Ethernet service attributes, such as frame delay variation (FDV), are not part of the methodology.

Recommendation ITU-T Y.1564

Ethernet service activation test methodology

1 Scope

This Recommendation defines an out-of-service test methodology to assess the proper configuration and performance of an Ethernet service prior to customer notification and delivery. The test methodology applies to point-to-point and point-to-multipoint connectivity (using a pair-wise configuration) in the Ethernet layer, and to the network portions that provide or contribute to the provisioning of such services. This Recommendation does not define Ethernet network architectures or services, but defines a methodology to test Ethernet-based services at the service activation stage. In particular, it addresses testing outside of the scope of [b-IETF RFC 2544] methods, as listed in the introduction above.

This Recommendation assumes dedicated test equipment in the test methodology. It is understood that this test methodology may be implemented as a test function inside of a network element.

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 G.8010] Recommendation ITU-T G.8010/Y.1306 (2004), *Architecture of Ethernet layer networks*.
- [ITU-T G.8011] Recommendation ITU-T G.8011/Y.1307 (2015), *Ethernet service characteristics*.
- [ITU-T G.8011.1] Recommendation ITU-T G.8011.1/Y.1307.1 (2013), *Ethernet private line service*.
- [ITU-T G.8011.2] Recommendation ITU-T G.8011.2/Y.1307.2 (2013), *Ethernet virtual private line service*.
- [ITU-T G.8012] Recommendation ITU-T G.8012/Y.1308 (2004), *Ethernet UNI and Ethernet NNI*.
- [ITU-T M.2110] Recommendation ITU-T M.2110 (2002), *Bringing into service international multi-operator paths, sections and transmission systems*.
- [ITU-T Y.1543] Recommendation ITU-T Y.1543 (2007), *Measurements in IP networks for inter-domain performance assessment*.
- [ITU-T Y.1563] Recommendation ITU-T Y.1563 (2009), *Ethernet frame transfer and availability performance*.
- [ITU-T Y.1730] Recommendation ITU-T Y.1730 (2004), *Requirements for OAM functions in Ethernet-based networks and Ethernet services*.
- [ITU-T Y.1731] Recommendation ITU-T Y.1731 (2008), *OAM functions and mechanisms for Ethernet based networks*.

- [IEEE 802.1Q] IEEE 802.1Q-2003, *IEEE Standards for Local and Metropolitan Area Networks – Virtual Bridged Local Area Networks*.
- [MEF 10.2] Technical Specification MEF 10.2 (2009), *Ethernet Services Attributes, phase 2*.

3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 Ethernet virtual connection (EVC) (derived from [MEF 10.2]: An association of two or more user network interfaces (UNIs) that limits the exchange of service frames between these interfaces.

3.2.2 information rate: The average bit rate of Ethernet service frames at the measurement point (MP) starting with the first medium access control (MAC) address bit and ending with the last frame check sequence (FCS) bit.

NOTE – Refer to [MEF 10.2] for a clear discussion of Ethernet service frames and specific examples of information rate –the committed information rate (CIR) and the excess information rate (EIR). So, for instance, a 100 Mbit/s Ethernet port can handle a total information rate of about 77 Mbit/s to 99 Mbit/s depending on the average frame size of the transmitted Ethernet frames.

3.2.3 service activation: The step of bringing a network feature into operation for eventual use by a customer, prior to customer notification that the feature is ready to use.

3.2.4 service activation test methodology: The procedures performed after service activation in order to verify that a newly operational network feature to be used by a customer is working properly prior to customer notification that the feature is ready to be used.

3.2.5 service acceptance criteria: A set of criteria used to ensure that a service meets its functionality and quality requirement and that the service is ready to operate when it has been deployed.

3.2.6 test flow: A protocol-compliant frame-size pattern used to simulate a stream of service frames and provide the basis for measurements and test results. Each unique test flow shall be categorized by its source and destination address and other header information, such as quality of service (QoS)/class of service (CoS) at the Ethernet layer (all eight [IEEE 802.1Q] priorities) and optionally the IP layer. Protocol layer configurations above IP layer may be used as part of the flow configuration because the network under test might require these layers to transmit data between source (SRC) and destination (DST).

3.2.7 utilized line rate: The average bit rate of the Ethernet line at the measurement point, including the bits a) allocable to the minimum-duration period of each interframe gap (but not the number of bits allocable to the part of each interframe gap longer than the minimum duration), b) in the preamble, c) in the start of frame delimiter and d) in the Ethernet service frame starting with the first MAC address bit and ending with the last FCS bit.

NOTE – This rate is calculated before the expansion effect of using code substitution at the physical layer. So for instance, a 1 Gbit/s Ethernet port has a 1 Gbit/s maximum Utilized Line Rate even though the 8/10 bit code substitution runs the actual physical interface at 1.25 Gbit/s.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ATM	Asynchronous Transfer Mode
AVAIL	Availability
CBS	Committed Burst Size
CE	Customer Edge
CF	Coupling Flag
CIR	Committed Information Rate
CM	Colour Mode
CoS	Class of Service
DST	Destination CE
EBS	Excess Burst Size
EIR	Excess Information Rate
EL	Exchange Link
EMIX	Ethernet Mix
ETY	Ethernet physical layer network
EVC	Ethernet Virtual Connection
FCS	Frame Check Sequence
FDV	Frame Delay Variation
FL	Frame Loss
FLR	Frame Loss Ratio
FRE	Frame Reference Event
FTD	Frame Transfer Delay
GPS	Global Positioning System
IMIX	Internet Mix
IP	Internet Protocol
IR	Information Rate
LACP	Link Aggregation Control Protocol
LAN	Local Area Network
MAC	Medium Access Control
MP	Measurement Point
MPLS	Multi-Protocol Label Switching
MTU	Maximum Transmission Unit
NID	Network Interface Device
NS	Network Section
NSE	Network Section Ensemble
OAM	Operation, Administration and Maintenance



OTN	Optical Transport Network
PDH	Plesiochronous Digital Hierarchy
PE	Provider Edge
QoS	Quality of Service
SAC	Service Acceptance Criteria
SDH	Synchronous Digital Hierarchy
SLA	Service Level Agreement
SRC	Source CE
TCP	Transmission Control Protocol
ToD	Time of Day
UDP	User Datagram Protocol
ULR	Utilized Line Rate
UNI	User Network Interface
UNI-C	UNI – Customer
UNI-N	UNI – Network
VLAN	Virtual LAN

5 Conventions

This Recommendation uses the following terms to indicate requirement levels:

- **MUST, SHALL, or REQUIRED** means that the specification is a mandatory requirement for test functions that claim compliance with this Recommendation.
- **SHOULD** means that there may exist valid reasons to avoid this specification, but the reasons need to be fully understood otherwise this is a strong suggestion for test functions that claim compliance with this Recommendation.
- **MAY** means that the specification is truly optional and need not be implemented in test functions that claim compliance with this Recommendation.

6 Background on Ethernet network architecture and service attributes

This Recommendation does not define Ethernet network architectures or services, but defines a methodology to test Ethernet-based services at the service activation stage. To provide some background to the user, an overview of Ethernet network architecture and related service attributes will be covered in this clause.

As the methodology relates to the performance model defined in [ITU-T Y.1563], the network architecture it defines is used. From a service attributes perspective (i.e., CIR, EIR, etc.), there is no reference to any service attributes in [ITU-T Y.1563], therefore the ones presented in the ITU-T G.8011/Y.1307 family of Recommendations will be used.

6.1 Ethernet network architecture

As illustrated in Figure 1, based on Figure 2 of [ITU-T Y.1563], Ethernet services are delivered through a layered architecture. User information will be transported over a higher layer (usually IP), that will then be encapsulated in an Ethernet layer to be finally transmitted across a network to a destination. To provide an end-to-end transfer of user information, the higher layer at the source

customer edge (CE) will use the Ethernet layer to access the network. The Ethernet layer has end-to-end significance only for a pair of source and destination MAC addresses.

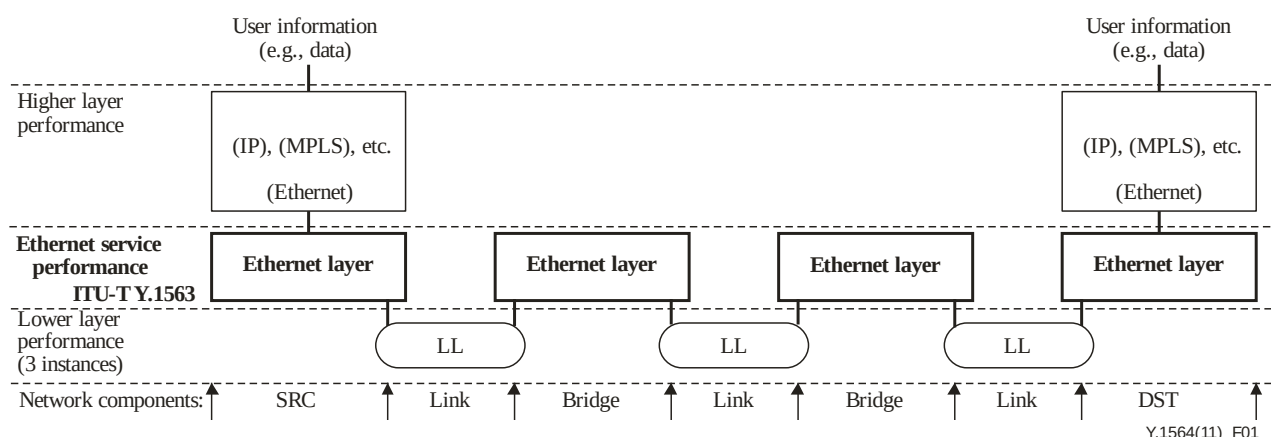


Figure 1 – Layered model of performance for Ethernet service – Example

This network is comprised of connection-oriented or connectionless links that are connected to bridges that will process the Ethernet layer inside the network. Each time an Ethernet frame goes through an Ethernet layer, it will be processed for integrity and sent to the next bridge through a lower layer connection. Lower layers are based on multiple technologies, for example, synchronous digital hierarchy (SDH), optical transport network (OTN), plesiochronous digital hierarchy (PDH), multi-protocol label switching (MPLS), asynchronous transfer mode (ATM) and Ethernet physical layer network (ETY). The performance of all Ethernet layers and lower layers will impact the end-to-end performance of the network used to deliver services.

Higher layers may be used to enable end-to-end communications. Higher layers may include protocols like internet protocol (IP) that allow a greater scalability for network deployment. Other protocols, like transmission control protocol TCP, provide the capability to retransmit frames should a frame loss occur. Unfortunately, two of the drawbacks of TCP are (1) added delay in the transmission of user information and (2) the possible limitation of throughput due to the interactions of maximum advertised window size, bandwidth-delay product, frame loss and frame transfer delay. As this Recommendation covers a test methodology to be used in the activation of Ethernet-based services, the performance and interoperation details with other protocols, such as link aggregation control protocol (LACP), IP, TCP and user datagram protocol (UDP) are out of scope for this Recommendation.

6.2 Ethernet service attributes

As mentioned in the introduction, Ethernet services attributes are not defined in [ITU-T Y.1563]. Therefore, this clause summarizes the important concepts found in the ITU-T G.8011/Y.1307 family of Recommendations.

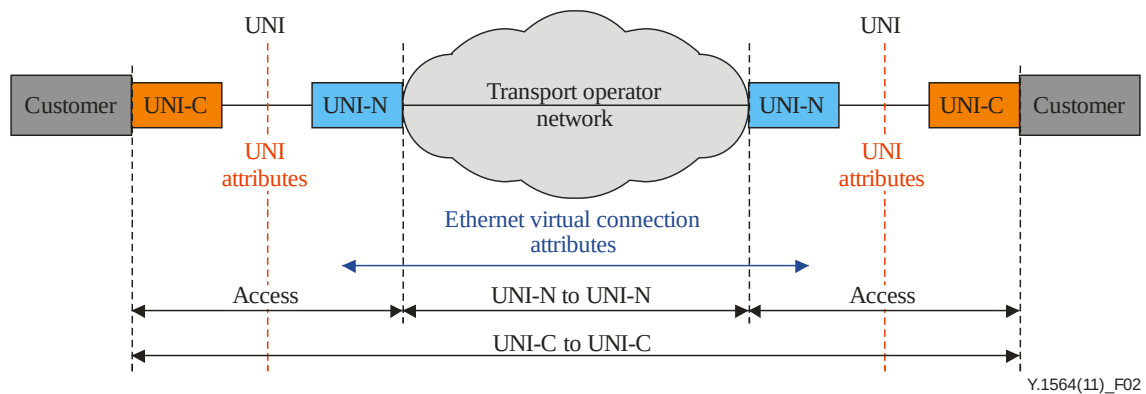


Figure 2 – Single provider view of Ethernet service areas

A simple example of Ethernet service areas is presented in Figure 2. This network, partly reproduced from [ITU-T G.8011], shows the different portions of a network that support an Ethernet service instance.

It is further shown that the user network interface (UNI) demarcation point occurs in the middle of the access link, or more precisely that the UNI is a reference point which splits the UNI-related functionalities into customer (UNI-C) and network (UNI-N) components. Additional UNI details are defined in [ITU-T G.8012]. From a service provider's perspective, they need to deliver services from UNI-C to UNI-C and it is from this perspective that the test methodology was created.

The customer's Ethernet network contains the last piece of equipment that connects to the operator's network. This last piece of equipment is called the customer edge). The port on the CE that connects to the operator's network across the UNI is called the UNI-C. Likewise, the operator's port that is presented to the customer at the UNI is called the UNI-N. The CE and the operator's network exchange service frames across the UNI, between the UNI-C and UNI-N. A service frame is an Ethernet frame transmitted across the UNI toward the service provider (called ingress service frame) or an Ethernet frame transmitted across the UNI towards the CE (called an egress service frame). Many services run on each UNI that are qualified by their attributes, which include, among others (e.g., see [MEF 10.2]):

- connection type;
- QoS (including virtual local area network (VLAN) information), traffic type (data vs management), etc.;
- bandwidth profile: CIR, CBS, EIR, EBS, CF and CM;
- performance criteria: FTD, FDV, FLR, AVAIL, etc.

6.2.1 Bandwidth profile

As per clause 7.10 of [ITU-T G.8011], bandwidth profile is applicable per service instance and is applicable at the ingress and egress UNI. It defines an upper bound on the volume of the expected service frames belonging to a particular service instance.

Bandwidth profile defines the following four traffic parameters: committed information rate (CIR), committed burst size (CBS, excess information rate (EIR) and excess burst size (EBS). CIR and CBS are related in such a way that CBS must be defined when CIR is set at a value that is greater than zero. EIR and EBS are related in the same way as CIR and CBS.

The CIR can be interpreted as the maximum sustained information rate (IR) the network is committed to transfer while meeting the performance level guaranteed in the service level agreement (SLA). Performance metrics in terms of FTD, FDV and FLR are applicable only to those frames that are transmitted at or below the CIR.