

MEF Standard

MEF 48.1

Ethernet Service Activation Testing

February 2020

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1 List of Contributing Members

The following members of the MEF participated in the development of this document and have requested to be included in this list.

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Bell Canada
Canoga Perkins
Ciena
Cisco
Iometrix
Telecom Italia
Spectrum Enterprise
Spirent Communications
Verizon

2 Abstract

This document specifies the requirements and test methodologies for Service Activation Testing (SAT) of MEF defined E-Line, Access E-Line and Transit E-Line services. SAT is a test process used to validate that a service behaves as per its Service Definition i.e. as specified in terms of values for all of the Service Attributes of the service, as per MEF 6.2 [7], MEF 10.3 [8] and MEF 45.1 [15] for E-Line and as per MEF 51.1 [17], MEF 26.2 [12] and MEF 45.1 [15] for Access E-Line and Transit E-Line.

It encompasses the verification of the service configuration, performance and the issuance of a SAT Record. Service Activation Testing is performed after service provisioning, before the service is delivered to the customer.

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3 Terminology and Abbreviations

This section defines the terms used in this document. In many cases, the normative definitions to terms are found in other documents. In these cases, the third column is used to provide the reference that is controlling, in other MEF or external documents.

In addition, terms defined in MEF 6.2 [7], MEF 10.3 [8], MEF 26.2 [12], MEF 45.1 [15] and MEF 51.1 [17], are included in this document by reference and are not repeated in the table below. If Table 1 contains a definition for a term that is also defined in one of the documents listed above, the definition in Table 1 applies within the context of this document.

Term	Definition	Reference
CTF	Collector Test Function	This document
Collector Test Function	A logical function for counting and discarding received Ethernet Frames, which can include test frames	This document
Down SAMP	A SAMP residing at an EI that receives test frames from, and transmits them towards, the direction of the Physical Layer	This document
EMIX	Ethernet Mix	ITU-T Y.1564 [6]
EPCF	ETH Provider Conditioning Function	MEF 12.2 [9]
ESCF	ETH Subscriber Conditioning Function	MEF 12.2 [9]
ETE	Ethernet Test Equipment	This document
ETE-A	Ethernet Test Equipment-Application	This document
ETE-I	Ethernet Test Equipment-Instrument	This document
ETE-TH	Ethernet Test Equipment-Test Head	This document
Ethernet Mix	Ethernet traffic pattern consisting of a preset mixture of Ethernet test frame sizes used to emulate real-world traffic scenarios in a testing environment.	ITU-T Y.1564 [6]
Ethernet Test Equipment	Ethernet Test Equipment utilized to perform Service Activation Testing which contains logical functions to generate, transmit, receive and collect the Ethernet test frames.	This document
Ethernet Test Equipment-Application	Functionality resident in a device, which may include a Generator Test Function, a Collector Test Function, and/or Latching Loopback Function that enables the Network Element to perform Service Activation Testing and activate/deactivate loopback devices.	MEF 46 [16]
Ethernet Test Equipment-Instrument	A portable, external Ethernet testing equipment not permanently installed in the network, which may include a Generator Test Function, a Collector Test Function, and/or Latching Loopback Function that enables the ETE to perform Service Activation Testing and activate/deactivate loopback devices.	MEF 46 [16]

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Term	Definition	Reference
Ethernet Test Equipment-Test Head	An external Ethernet testing equipment permanently installed in the network, which include a Generator Test Function and a Collector Test Function that enables the ETE to perform Service Activation Testing and activate/ deactivate loopback devices. It is not involved in the forwarding path of services.	MEF 46 [16]
FCS	Frame Check Sequence	IEEE Std 802.1Q – 2018 [1]
GTF	Generator Test Function	This document
Generator Test Function	A logical function for generating and transmitting Ethernet Frames, which can include test frames	This document
IR_{SC}	Information Rate Service Configuration	This document
Information Rate Service Configuration	Information Rate at which the test traffic is offered during the configuration tests	This document
IR_{SP}	Information Rate Service Performance	This document
Information Rate Service Performance	Information Rate at which the test traffic is offered during the performance test	This document
MP	Measurement Point	ITU-T Y.1564 [6]
SAC	Service Acceptance Criteria	ITU-T Y.1564 [6]
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.	ITU-T Y.1564 [6]
SAMP	Service Activation Measurement Point	This document
Service Activation Measurement Point	A Service Measurement Point that contains one GTF and one CTF	This document
SAT	Service Activation Testing	This document
Service Activation Testing	The process of executing a collection of test procedures to be applied to a given traffic entity (e.g., EVC, OVC, etc.) in order to collect behavioral information about the traffic and compare this with predefined expectations.	This document
Service Activation Test Record	A report of test results for an Ethernet service. The results show if the service met the applicable performance objectives or Service Acceptance Criteria.	This document
Service Definition	The definition of the service under test, in terms of values for all of the Service Attributes for the service, as per MEF 6.2 [7] and MEF 10.3 [8] and MEF 45.1 [15] for E-Line and as per MEF 51.1 [17] and MEF 26.2 [12] and MEF 45.1 [15] for Access E-Line and Transit E-Line.	This document
TAF	Transport Adaptation Function	MEF 12.2 [9]

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Term	Definition	Reference
TF	Tolerance Factor	This document
Tolerance Factor	The number of bytes that can be received in excess of the expected number of bytes, during a bandwidth profile test.	This document
THCP	Test Head Connection Point	This document
Test Head Connection Point	A reference point in the network where frames generated by an ETE-TH can be inserted into the service under test, and frames received within the service can be captured and redirected to the ETE-TH.	This document
T_{SC}	Test Duration Service Configuration	This document
Test Duration Service Configuration	Time interval over which the test traffic is offered during the configuration tests	This document
T_{SP}	Test Duration Service Performance	This document
Test Duration Service Performance	Time interval over which the test traffic is offered during the performance test	This document
Up SAMP	A SAMP residing at an EI that transmits test frames towards, and receives them from, the direction of the Service Provider or Operator network	This document

Table 1: Terminology and Abbreviations

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4 Compliance Levels

The key words "**MUST**", "**MUST NOT**", "**REQUIRED**", "**SHALL**", "**SHALL NOT**", "**SHOULD**", "**SHOULD NOT**", "**RECOMMENDED**", "**NOT RECOMMENDED**", "**MAY**", and "**OPTIONAL**" in this document are to be interpreted as described in BCP 14 (RFC 2119 [3], RFC 8174 [5]) when, and only when, they appear in all capitals, as shown here. All key words must be in bold text.

Items that are **REQUIRED** (contain the words **MUST** or **MUST NOT**) are labeled as **[Rx]** for required. Items that are **RECOMMENDED** (contain the words **SHOULD** or **SHOULD NOT**) are labeled as **[Dx]** for desirable. Items that are **OPTIONAL** (contain the words **MAY** or **OPTIONAL**) are labeled as **[Ox]** for optional**.**

A paragraph preceded by **[CRa]<** specifies a conditional mandatory requirement that **MUST** be followed if the condition(s) following the "<" have been met. For example, "**[CR1]<**[D38]" indicates that Conditional Mandatory Requirement 1 must be followed if Desirable Requirement 38 has been met. A paragraph preceded by **[CDb]<** specifies a Conditional Desirable Requirement that **SHOULD** be followed if the condition(s) following the "<" have been met. A paragraph preceded by **[COc]<** specifies a Conditional Optional Requirement that **MAY** be followed if the condition(s) following the "<" have been met.

5 Numerical Prefix Conventions

This document uses the prefix notation to indicate multiplier values as shown in Table 2.

Decimal		**Binary**	
Symbol	**Value**	**Symbol**	**Value**
k	10^3	Ki	2^{10}
M	10^6	Mi	2^{20}
G	10^9	Gi	2^{30}
T	10^{12}	Ti	2^{40}
P	10^{15}	Pi	2^{50}
E	10^{18}	Ei	2^{60}
Z	10^{21}	Zi	2^{70}
Y	10^{24}	Yi	2^{80}

Table 2: Numerical Prefix Conventions

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6 Scope

The SAT requirements and test methodologies specified in this document are applicable to E-Line, Access E-Line and Transit E-Line services defined in MEF 6.2 [7], and MEF 51.1 [17]. The following figures represent high level topologies of these three services together with their External Interfaces (UNIs and ENNIs) and the Virtual Connections (EVCs and OVCs). Figure 1 depicts an E-Line service deployed over a Service Provider network between UNI_1 to UNI_2.

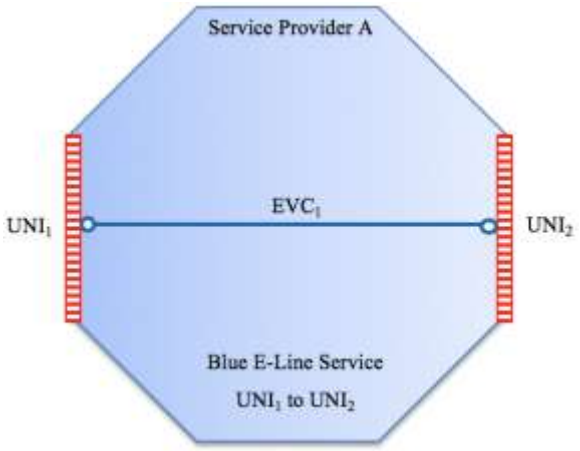


Figure 1 – E-Line Service Topology

Figure 2 exemplifies Access E-Line services interconnected at the ENNI to offer E-Line services over multiple Operator networks. The Green E-Line which interconnects UNI_1 in Operator B network to UNI_3 in Operator C network via $ENNI_1$, is composed of the Green Access E-Line which interconnects UNI_1 to $ENNI_1$ in Operator B network and the Green Access E-Line which interconnects UNI_3 to $ENNI_1$ in Operator C network. Similarly, the Pink E-Line which interconnects UNI_2 in Operator B network to UNI_4 in Operator C network via $ENNI_1$, is composed of the Pink Access E-Line which interconnects UNI_2 to $ENNI_1$ in Operator B network and the Pink Access E-Line which interconnects UNI_4 to $ENNI_1$ in Operator network C.

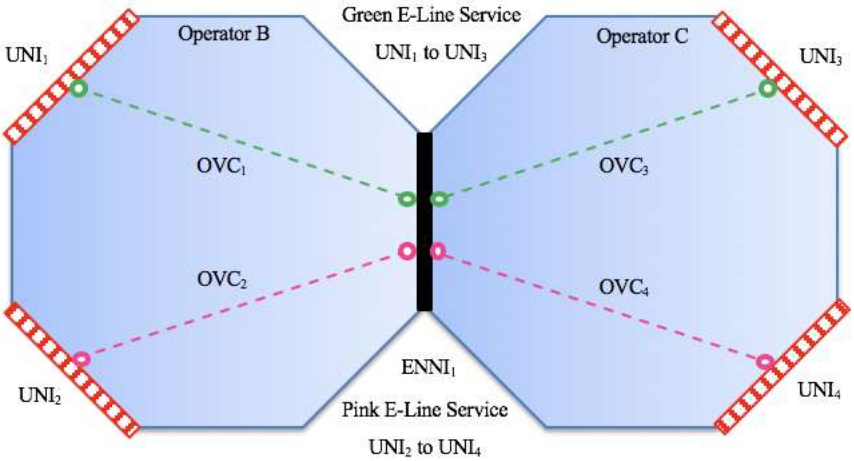


Figure 2 – E-Line and Access E-Line Service Topologies

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Figure 3 shows Access E-Line and Transit E-Line services interconnected at the ENNI to offer E-Line services over multiple Operator networks. Access E-Line and Transit E-Line services could also be used to support E-LAN and E-Tree services. In this example, the Red E-Line which interconnects UNI_1 in Operator A network to UNI_3 in Operator C network via $ENNI_1$ and $ENNI_2$, is composed of the Red Access E-Line which interconnects UNI_1 to $ENNI_1$ in Operator A network, the Red Transit E-Line which interconnects $ENNI_1$ to $ENNI_2$ in Operator B network and the Red Access E-Line which interconnects $ENNI_2$ to UNI_3 in Operator C network. Similarly, the Purple E-Line which interconnects UNI_2 in Operator A network to UNI_4 in Operator C network via $ENNI_1$ and $ENNI_2$, is composed of the Purple Access E-Line which interconnects UNI_2 to $ENNI_1$ in Operator A network, the Purple Transit E-Line which interconnects $ENNI_1$ to $ENNI_2$ in Operator B network and the Purple Access E-Line which interconnects $ENNI_2$ to UNI_4 in Operator C network.

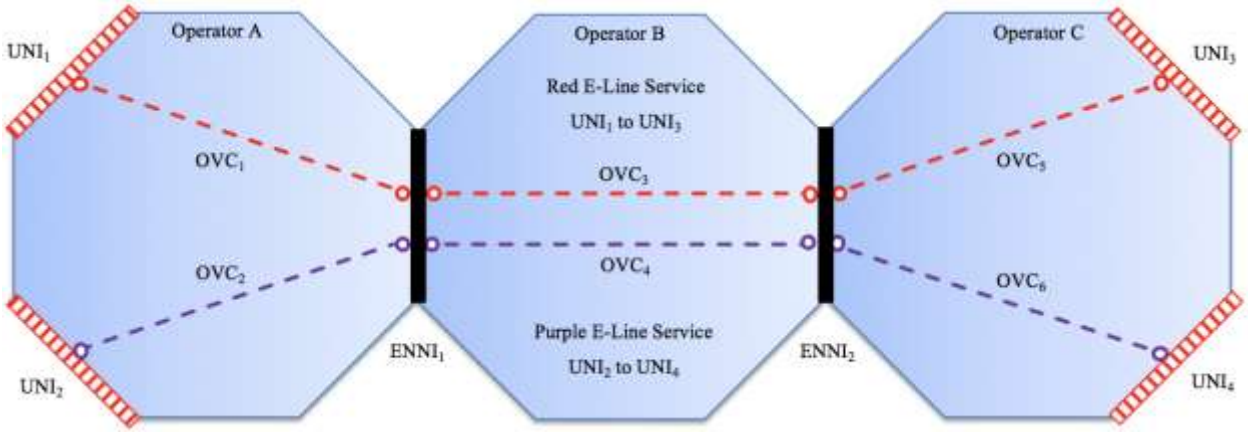


Figure 3 – E-Line, Access E-line and Transit E-Line Service Topologies

The SAT methodology defined in this document comprises service configuration tests to verify Maximum Frame Size, VLAN ID Preservation, VLAN PCP Preservation, VLAN DEI Preservation, Untagged and Priority Tagged Support, Broadcast, Unicast & Multicast Data Frame Delivery, Source MAC Address Limit, L2CP Handling, OVC Available MEG Level and Bandwidth Profile including bursts and token sharing. It also comprises a service performance test to verify One-way Frame Delay (FD), One-way Mean Frame Delay (MFD), One-way Inter-Frame Delay Variation (IFDV), One-way Frame Delay Range (FDR) and One-way Frame Loss Ratio (FLR). Service OAM PM peering, orchestration and specific protocols such as Latching Loopback are out of scope.

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7 Introduction

Service Activation Testing encompasses the verification of the service configuration, performance and the issuance of a SAT Record. Service Activation Testing is performed after service provisioning, before the service is delivered to the customer. Service Activation Testing is usually carried out while other services are active in the network.

The SAT configuration tests are of short duration, usually between 1 to 300 seconds and are ideal for validating Service Attributes such as the EVC MFS or the Bandwidth Profile parameters. Performance tests require a longer test duration generally set between 15 minutes to 24 hours. Performance verification focuses on the measurement and calculation of performance metrics such as One-way Frame Delay (FD), One-way Mean Frame Delay (MFD), One-way Inter-Frame Delay Variation (IFDV), One-way Frame Delay Range (FDR) and One-way Frame Loss Ratio (FLR).

Configuration and performance tests pass or fail on the basis of whether or not the service meets its Service Acceptance Criteria (SAC) during each test. The SAC is 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. Some differences can exist between the Service Acceptance Criteria and the Class of Service Performance Objectives defined in the SLS.

The SAT Record that is created as a result of Service Activation Testing can be used as the birth certificate for the service, as well as a reference document that can be consulted and used as a basis for troubleshooting, should the service experience issues after its delivery to the customer.

This document uses and extends test processes and procedures based on the Ethernet test methodology defined by ITU-T Y.1564 [6]. However, this document is specific to MEF services, service attributes and parameters.

7.1 Service Activation Testing Terminology

This section describes the different components and associated terms specific to Service Activation Testing. Ethernet Test Equipment (ETE) is the general term used to describe Ethernet Test Equipment-Instrument (ETE-I), Ethernet Test Equipment-Application (ETE-A) or Ethernet Test Equipment-Test Head (ETE-TH). An ETE contains a Generator Test Function (GTF) which is a logical function used for generating and transmitting Ethernet test frames. It also contains a Collector Test Function (CTF) which is a logical function used for receiving or collecting the Ethernet test frames.

An ETE-I is a portable testing device that can temporarily be installed in a network. The ETE-I can include a GTF and a CTF and/or a Latching Loopback function (LLF) as defined in MEF 46 [16]. The ETE-I contains the necessary logical and physical test functions to be remotely connected to a UNI-N and perform Service Activation Testing and/or activate/deactivate LLFs.

An ETE-A is an application which includes functionalities such as GTF, CTF and/or LLF. It can reside in a Network Element and perform Service Activation Testing and/or activate/deactivate LLFs. For example, the ETE-A can be operating at the ENNI-N or at the UNI-N.

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An ETE-TH is an Ethernet Test Equipment that can permanently be installed in the network to perform Service Activation Testing. The ETE-TH includes a GTF and a CTF and may have the ability to activate and deactivate LLFs in the network.

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8 Service Activation Measurement Points and Functions

This section defines the functions, architecture, requirements and use cases for the Service Activation Measurement Points in performing Service Activation Testing for MEF services.

A SAMP, which is a specialization of a Service Measurement Point, contains one GTF and one CTF. A SAMP enables SAT to perform measurements on the service under test.

The figures in the following sub-sections depict some of the different measurement point locations and test topologies used when Service Activation Testing is performed. The Service Activation Measurement Point (SAMP) location depends on the type of ETE used for testing. If the ETE is a Test Head or an Instrument, the SAMP is located at a physical point in the network. If the ETE is an Application, then the SAMP is located at a logical point inside a Network Element.

8.1 Service Activation Measurement Point Locations

As shown in Figure 4, Figure 5 and Figure 6 the locations of the SAMPs (up or down) is in relation to the ETH Layer Functional Elements as specified in MEF 12.2 [9] for an ETE-A. An up SAMP, generates and collects traffic that crosses the ETH Ethernet Virtual Connection (EVC) Adaptation and/or Termination Functions such as between the ESCF or EPCF and the TAF facing the ESCF or EPCF. A down SAMP, generates and collects traffic that crosses the ETH Adaptation and/or Termination Functions such as between the TAF and the ESCF or EPCF facing the TAF.

In an ETE-A, SAMPs can be located at the ENNI-N and at the UNI-N and their directions can be up or down in relation to the ETH Layer Functional Elements. In Figure 4 and Figure 5, the Up and Down SAMPs are located at the ENNI-Ns. In Figure 6 the SAMP is hosted in a Network Element at the UNI-N.

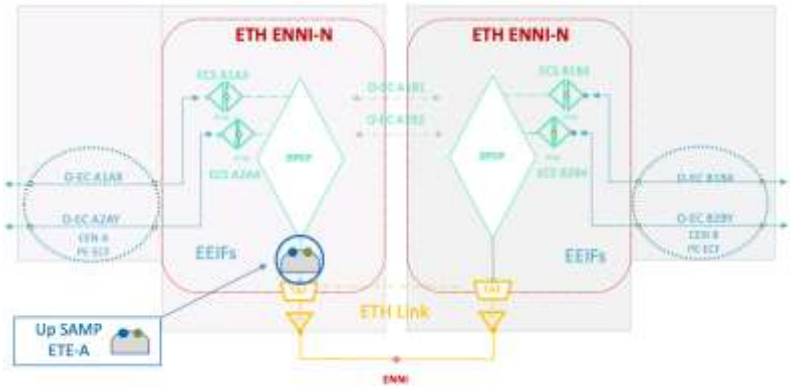


Figure 4 – Up SAMP at the ENNI-N

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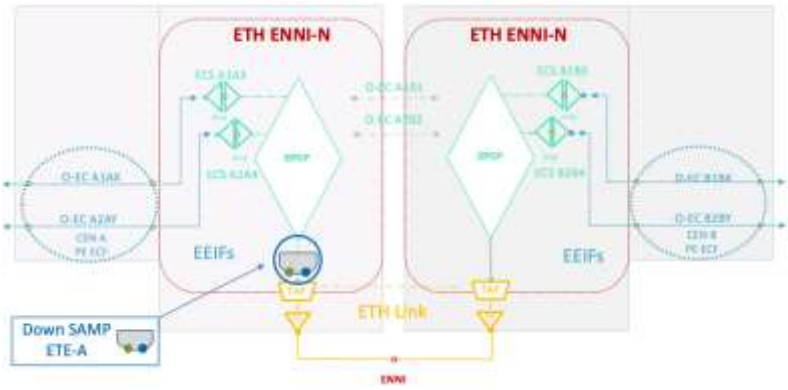


Figure 5 – Down SAMP at the ENNI-N

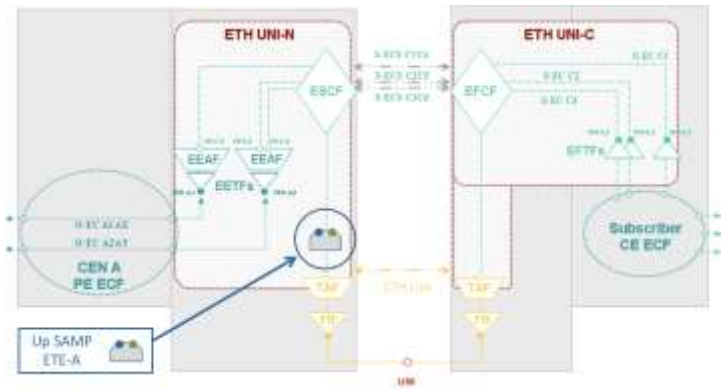


Figure 6 – Up SAMP at the UNI-N

An ETE-I emulates the UNI-C and in this case, the SAMP is contained in the ETE-I. ETE-As can support both up or down SAMPs whereas ETE-Is can only support down SAMPs, sending and receiving test traffic from the physical ports.

In the case of an ETE-TH, the down SAMP is contained within the ETE-TH and sends and received traffic via the Test Head Connection Point (THCP) as depicted in Figure 7. This figure shows a Down THCP but an Up THCP is also possible.

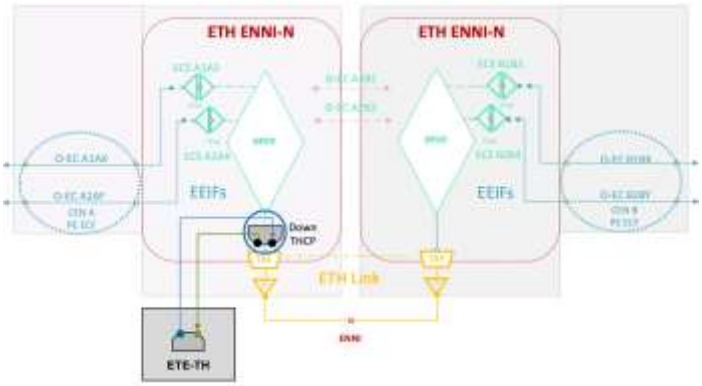


Figure 7 – SAMP in the ETE-TH

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[R1] When using an ETE-A at the ENNI-N, a down SAMP **MUST** behave as if located between the ETH Provider Conditioning Function (EPCF) and the Transport Adaptation Function (TAF) where the down SAMP is facing the TAF.

[R2] When using an ETE-A at the ENNI-N, an up SAMP **MUST** behave as if located between the EPCF and the TAF where the up SAMP is facing the EPCF.

[R3] When using an ETE-A at the UNI-N, an up SAMP **MUST** be located between the ETH Subscriber Conditioning Function (ESCF) and the TAF where the up SAMP is facing the ESCF of the service under test.

[R4] When using an ETE-TH, a down THCP at the ENNI-N **MUST** behave as if located between the EPCF and the TAF where the down THCP is facing the TAF.

[R5] When using an ETE-TH, an up THCP at the ENNI-N **MUST** behave as if located between the EPCF and the TAF where the up THCP is facing the EPCF.

[R6] When using an ETE-TH at the UNI-N, an up THCP **MUST** be located between the ETH Subscriber Conditioning Function (ESCF) and the TAF of the Service under test where the up THCP is facing the ESCF.

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8.2 Service Activation Measurement Point Use Cases

The first three use cases presented in this section are examples of E-Line, Access E-Line and Transit E-Line Service Activation Testing setups using ETEs at the External Interfaces. The fourth use case involves a combination of an ETE and a Latching Loopback Function. Note that these examples are not exhaustive; any combination of ETE-As, ETE-Is, ETE-THs and Latching Loopback Functions can be used.

Use Case A: Service Activation Testing of a Transit E-Line service using two ETE-As with up SAMPs located at the ENNI-Ns is illustrated in Figure 8.



Figure 8 – SAT Using ETE-As

Use Case B: Service Activation Testing of an Access E-Line service using an ETE-TH with a SAMP connected to a THCP at the ENNI-N and an ETE-A with an up SAMP located at the UNI-N is illustrated in Figure 9.

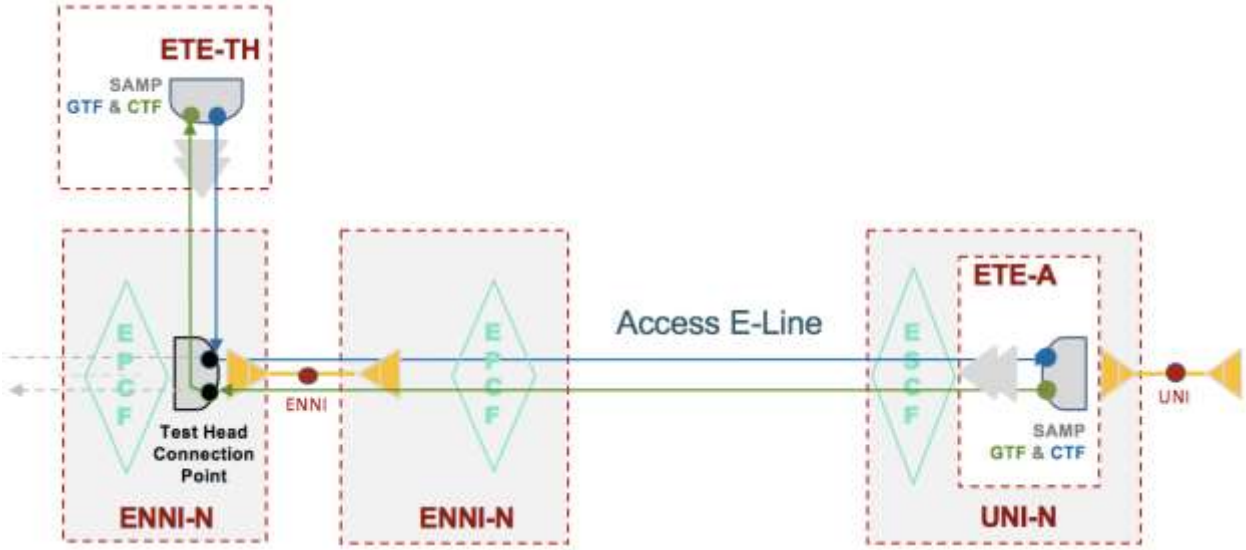


Figure 9 – SAT Using both ETE-TH and ETE-A

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Use Case C: Service Activation Testing of an E-Line service using an ETE-A with an up SAMP located at one UNI-N and an ETE-I located at the UNI-C and externally connected to the other UNI-N is illustrated in Figure 10. In this case the Service Activation Measurement Point in the ETE-I becomes the UNI-C itself, and the service is measured at that UNI exactly as it is delivered to the Subscriber. This choice of measurement point, however, temporarily takes that UNI and any services configured on it out-of-service for the Subscriber while the tests are executed.

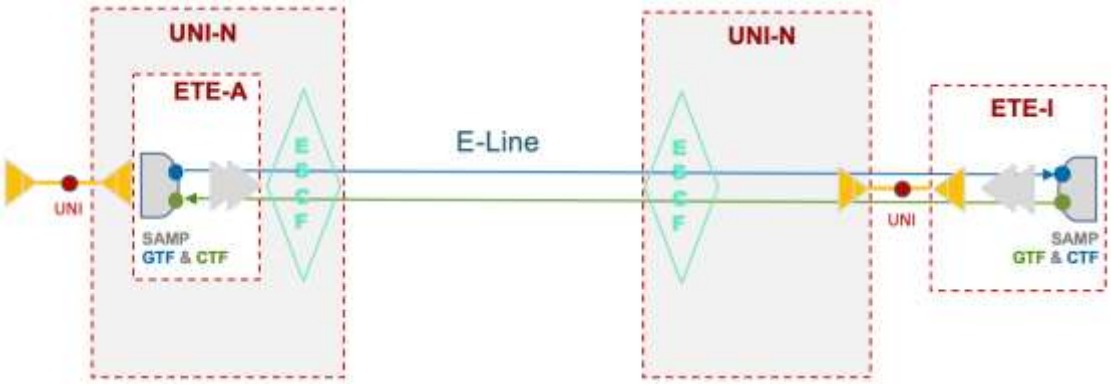


Figure 10 – SAT Using both ETE-A and ETE-I

Use Case D: Service Activation Testing of an Access E-Line service using an ETE-TH with a SAMP connected to a Test Head Connection Point at the ENNI-N and a Latching Loopback Function as defined in MEF 46 [16] at the UNI-N. In this case, the Generator Test Function of the ETE-TH transmits the test traffic and the Latching Loopback Function located at the UNI-N loops it back towards the Collector Test Function of the ETE-TH located at the ENNI-N as illustrated in Figure 11.

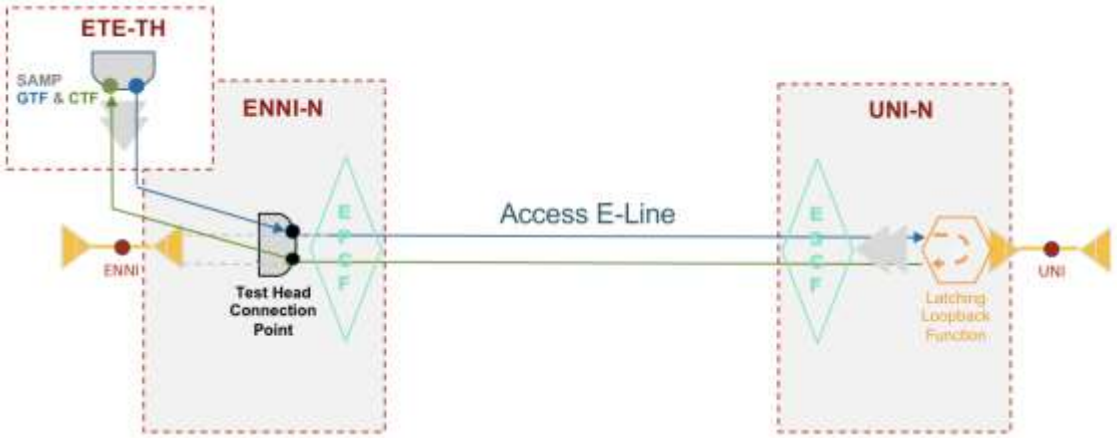


Figure 11 – SAT Using both ETE-TH and Latching Loopback Function

These are not an exhaustive list of use cases. Other combinations of ETEs are possible such as an ETE-TH placed at the ENNI-N facing an ETE-I placed at the UNI-C.

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8.3 Loopback Considerations

It is not recommended to use a Latching Loopback Function (LLF) as defined in MEF 46 [16] to run the complete suite of test methodologies defined in this document. Layer 2 Control Protocol Handling, Bandwidth Profile and One-way Frame Loss Ratio are a few examples for which the use of a Latching Loopback Function at one of the External Interfaces would lead to inaccurate test results.

More specifically, the use of a Latching Loopback Function is not appropriate when testing for configuration of ingress Bandwidth Profiles. One reason for this is that the application of the ingress Bandwidth Profile in one direction may limit the Information Rate of the test traffic in the other direction to a level below that needed to test for proper configuration.

Additionally, significant measurement degradation could take place due to frames transmitted at the CIR experiencing large IFDV. Burst test procedures are generally only meaningful at the ESCF or EPCF when directly connected to a GTF through a SAMP. See Appendix A for more information on this subject.

8.4 Frame Coloring Considerations

The objective of SAT is to validate that a Service behaves as per its Service Definition, which includes the differentiated treatment of Green and Yellow External Interface (EI) frames in the network. The External Interface frames are classified as Green or Yellow at the ingress.

Due to the positioning of the SAMPs, as described in this section, it is not possible for the Service Activation Tests to determine the color assigned to each frame at the Ingress EI. Therefore, it is possible for some of the tests described in this specification to pass even if the configuration of the service differs from the Service Definition. This can happen because frames declared Yellow on ingress might or might not be delivered, so it is not possible for the test to determine whether delivered frames were correctly declared Green, or incorrectly declared Yellow but delivered anyway. In the case of an incorrectly configured service, it is possible that the SAT tests might pass (if frames incorrectly declared Yellow were delivered during the test), but that the behavior observed by the Subscriber once the service is delivered does not match the Service Definition (if frames incorrectly declared Yellow are not delivered).

This situation can occur when Ingress Bandwidth Profile parameters such as *CIR*, CIR_{max}, *EIR*, EIR_{max} are misconfigured and the frames are marked as Yellow instead of Green.

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9 Service Attributes of Point-to-Point Services

This section specifies how the Service Attributes of point-to-point services are to be handled during Service Activation Testing.

Section 9.1 addresses the MEF 6.2 [7] E-Line Service Attributes, section 9.2 covers MEF 51.1 [17] Access E-Line Service Attributes and section 9.3 addresses the MEF 51.1 [17] Transit E-Line Service Attributes.

For each service type, information on how to handle and report each Service Attribute is provided:

- **Action:** Each Service Attribute can either be 1) Tested using one of the test methodologies defined in sections 0 and 12 of this document, and the value of the configured Service Attribute and the test result are to be reported in the SAT Record, or 2) Reported, meaning that the value of the configured Service Attribute is to be reported in the SAT Record or 3) Not applicable in the context of SAT meaning that the Service Attribute is not required to be tested nor its value reported in the SAT Record. Note that when testing of a Service Attribute is optional, it is still mandatory to report the configured value of the Service Attribute in the SAT Record.

- **Status:** When a Service Attribute has to be ***tested*** or ***reported***, the third column of the Service Attribute tables indicates if it is mandatory or optional to test and/or to report it in the SAT Record.

- **Methodology:** Provides a link to the SAT Methodology to be used for the verification of the Service Attribute.

- **Comments:** Useful comments and notes.

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9.1 E-Line Service Attributes

The Service Attribute tables of this section specify how UNI, EVC per UNI and EVC Service Attributes of E-Line services are to be handled.

9.1.1 E-Line - UNI Service Attributes

Table 3 provides the list of UNI Service Attributes as defined in MEF 6.2 [7] section 8.2 for E-Line services.

E-Line UNI Service Attributes	Action	Status	Methodology	Comments
UNI ID Specified in MEF 10.3 [8]	Reported	Mandatory	-	-
Physical Layer Specified in MEF 10.3 [8]	Reported	Mandatory	-	-
Synchronous Mode Specified in MEF 10.3 [8]	Reported	Mandatory	-	Report Enabled or Disabled for each physical link. See note 1.
Number of Links Specified in MEF 10.3 [8]	Reported	Mandatory	-	-
UNI Resiliency Specified in MEF 10.3 [8]	Reported	Mandatory	-	-
Service Frame Format Specified in MEF 10.3 [8]	N/A	N/A	-	See note 2.
UNI Maximum Service Frame Size Specified in MEF 10.3 [8]	Reported	Mandatory	-	-
Service Multiplexing Specified in MEF 10.3 [8]	N/A	N/A	-	-
CE-VLAN ID for Un-tagged and Priority Tagged Service Frames Specified in MEF 10.3 [8]	Tested	Mandatory	11.5	If the CE-VLAN ID for Untagged and Priority Tagged Service Frames is mapped to the service under test, testing is Mandatory. See note 4.
CE-VLAN ID/EVC Map Specified in MEF 10.3 [8]	Tested	Mandatory	11.2	The CE-VLAN ID/EVC map is only tested for CE-VLAN IDs that map to the service under test

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E-Line UNI Service Attributes	Action	Status	Methodology	Comments
Maximum number of EVCs Specified in MEF 10.3 [8]	N/A	N/A	-	-
Bundling Specified in MEF 10.3 [8]	N/A	N/A	-	See note 3.
All to One Bundling Specified in MEF 10.3 [8]	N/A	N/A	-	See note 3.
Token Share Specified in MEF 6.2 [7]	Reported	Mandatory	-	-
Envelopes Specified in MEF 10.3 [8]	Reported	Mandatory	-	-
Ingress Bandwidth Profile Per UNI Specified in MEF 10.3 [8]	N/A	N/A	-	-
Egress Bandwidth Profile Per UNI Specified in MEF 10.3 [8]	N/A	N/A	-	-
Link OAM Specified in MEF 10.3 [8]	N/A	N/A	-	-
UNI MEG Specified in MEF 10.3 [8]	N/A	N/A	-	-
E-LMI Specified in MEF 10.3 [8]	N/A	N/A	-	-
UNI L2CP Address Set Specified in MEF 45.1 [15]	Tested	Mandatory	11.8	The UNI L2CP Address set is tested for each service at the UNI
L2CP Peering Specified in MEF 45.1 [15]	Reported	Mandatory	-	-
Note 1: If enabled, accuracy is not to be reported.				
Note 2: Service Frames are generated and expected to be received by the ETE, untagged, priority tagged or tagged, as specified in MEF 10.3 [8].				
Note 3: Verified as part of the VLAN ID preservation test. See section 11.2.				
Note 4: When All to One Bundling is enabled, the value of the CE-VLAN ID for Untagged and Priority Tagged Service Frames does not affect the behavior of the EVC as seen by the Subscriber and thus can be considered to be not applicable.				

Table 3: E-Line UNI Service Attributes

[R7] For E-Line services, the SAT Record **MUST** contain all the reported values and test results of the mandatory UNI Service Attributes, as specified in Table 3.

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9.1.2 E-Line - EVC per UNI Service Attributes

Table 4 provides the list of EVC per UNI Service Attributes as defined in MEF 6.2 [7] section 8.3 for E-Line services.

E-Line EVC per UNI Service Attributes	Action	Status	Methodology	Comments
UNI EVC ID Specified in MEF 10.3 [8]	Reported	Mandatory	-	-
Class of Service Identifier for Data Service Frame Specified in MEF 10.3 [8]	Reported	Mandatory	-	See note 1.
Class of Service Identifier for L2CP Service Frame Specified in MEF 10.3 [8]	Reported	Mandatory	-	-
Class of Service Identifier for SOAM Service Frame Specified in MEF 10.3 [8]	N/A	N/A	-	-
Color Identifier for Service Frame Specified in MEF 10.3 [8]	Reported	Mandatory	-	See note 1.
Egress Equivalence Class Identifier for Data Service Frames Specified in MEF 10.3 [8]	N/A	N/A	-	See note 2.
Egress Equivalence Class Identifier for L2CP Service Frames Specified in MEF 10.3 [8]	N/A	N/A	-	See note 2.
Egress Equivalence Class Identifier for SOAM Service Frames Specified in MEF 10.3 [8]	N/A	N/A	-	See note 2.
Ingress Bandwidth Profile per EVC Specified in MEF 10.3 [8]	N/A	N/A	-	-
Egress Bandwidth Profile per EVC Specified in MEF 10.3 [8]	N/A	N/A	-	-
Ingress Bandwidth Profile per Class of Service Identifier Specified in MEF 10.3 [8]	Tested	Mandatory	11.10	See note 3.

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E-Line EVC per UNI Service Attributes	Action	Status	Methodology	Comments
Egress Bandwidth Profile per Egress Equivalence Class Specified in MEF 10.3 [8]	N/A	N/A	-	See note 2.
Source MAC Address Limit Specified in MEF 10.3 [8]	Tested	Optional	11.7	Report if enabled or disabled. If enabled testing is optional.
Test MEG Specified in MEF 6.2 [7]	N/A	N/A	-	-
Subscriber MEG MIP Specified in MEF 6.2 [7]	Reported	Mandatory	-	-
Note 1: Verified as part of the Ingress Bandwidth Profile per CoS ID test methodology.				
Note 2: Egress Bandwidth Profile and Egress Equivalence Class Identifier can be addressed in a future release of this document.				
Note 3: See section 9.4 for the Bandwidth Profile parameters to be tested using SAT methodologies.				

Table 4: E-Line EVC per UNI Service Attributes

[R8] For E-Line services, the SAT Record **MUST** contain all the reported values and test results of the mandatory EVC per UNI Service Attributes, as specified in Table 4.

[R9] For E-Line services, the SAT Record **MUST** contain all the reported values of the optional EVC per UNI Service Attributes, as specified in Table 4.

[O1] For E-Line services, the SAT Record **MAY** contain the test results of the optional EVC per UNI Service Attributes, as specified in Table 4.

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9.1.3 E-Line - EVC Service Attributes

Table 5 provides the list of EVC Service Attributes as defined in MEF 6.2 [7] section 8.4 for E-Line services.

E-Line EVC Service Attributes	Action	Status	Methodology	Comments
EVC Type Specified in MEF 10.3 [8]	Reported	Mandatory	-	-
EVC ID Specified in MEF 10.3 [8]	Reported	Mandatory	-	-
UNI List Specified in MEF 10.3 [8]	Reported	Mandatory	-	-
Maximum Number of UNIs Specified in MEF 10.3 [8]	N/A	N/A	-	-
Unicast Service Frame Delivery Specified in MEF 10.3 [8]	Tested	Mandatory	11.6	Report if delivery is conditional, unconditional or discard. If conditional, report condition (See note 1). If unconditional or discard testing is mandatory.
Multicast Service Frame Delivery Specified in MEF 10.3 [8]	Tested	Mandatory	11.6	Report if delivery is conditional, unconditional or discard. If conditional, report condition (See note 1). If unconditional or discard testing is mandatory.
Broadcast Service Frame Delivery Specified in MEF 10.3 [8]	Tested	Mandatory	11.6	Report if delivery is conditional, unconditional or discard. If conditional, report condition (See note 1). If unconditional or discard testing is mandatory.
CE-VLAN ID Preservation Specified in MEF 10.3 [8]	Reported	Mandatory	-	Report if enabled or disabled. See note 3.
CE-VLAN PCP Preservation Specified in MEF 10.3 [8]	Tested	Mandatory	11.3	Report if enabled or disabled. If enabled testing is mandatory.

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E-Line EVC Service Attributes	Action	Status	Methodology	Comments
EVC Performance Specified in MEF 10.3 [8]	Tested	Mandatory	12.1	See note 2.
EVC Maximum Service Frame Size Specified in MEF 10.3 [8]	Tested	Mandatory	11.1	-
Note 1: Conditional Delivery of Service Frames is not tested since an unlimited number of conditions can exist.				
Note 2: Performance metrics are verified according to the Service Acceptance Criteria. Refer to section 10.2 for SAC description.				
Note 3: CE-VLAN ID Preservation is verified as part of testing the CE-VLAN ID/EVC Map using test methodology in 11.2.				

Table 5: E-Line EVC Service Attributes

[R10] For E-Line services, the SAT Record **MUST** contain all the reported values and test results of the mandatory EVC Service Attributes, as specified in Table 5.

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9.2 Access E-Line Service Attributes

The Service Attribute tables of this section specify how the OVC, OVC End Point (OVC EP), ENNI and UNI Service Attributes of Access E-Line services defined in MEF 51.1 [17] are to be handled during SAT.

9.2.1 Access E-Line - OVC Service Attributes

Table 6 provides the list of OVC Service Attributes as defined in MEF 51.1 [17] section 9.1.1 for Access E-Line services.

Access E-Line OVC Service Attributes	Action	Status	Methodology	Comments
OVC ID Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC Type Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC End Point List Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
Maximum Number of UNI OVC End Points Specified in MEF 26.2 [12]	N/A	N/A	-	-
Maximum Number of ENNI OVC End Points Specified in MEF 26.2 [12]	N/A	N/A	-	-
OVC Maximum Frame Size Specified in MEF 26.2 [12]	Tested	Mandatory	11.1	-
OVC CE-VLAN ID Preservation Specified in MEF 26.2 [12]	Tested	Mandatory	11.2	-
OVC CE-VLAN PCP Preservation Specified in MEF 26.2 [12]	Tested	Mandatory	11.3	Report if enabled or disabled. If enabled testing is mandatory.
OVC CE-VLAN DEI Preservation Specified in MEF 26.2 [12]	Tested	Mandatory	11.4	Report if enabled or disabled. If enabled testing is mandatory.
OVC S-VLAN PCP Preservation Specified in MEF 26.2 [12]	N/A	N/A	-	-
OVC S-VLAN DEI Preservation Specified in MEF 26.2 [12]	N/A	N/A	-	-
OVC List of Class of Service Names Specified in MEF 26.2 [12]	Reported	Mandatory	-	-

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Access E-Line OVC Service Attributes	Action	Status	Methodology	Comments
OVC Service Level Specification Specified in MEF 26.2 [12]	Tested	Mandatory	12.1	See note 1
OVC Frame Delivery Specified in MEF 26.2 [12]	Tested	Mandatory	11.6	Report if delivery Unicast, Multicast and Broadcast External Interface Frames is conditional, unconditional or discard. If conditional, report condition (See note 2). If unconditional or discard testing is mandatory.
OVC Available MEG Level Specified in MEF 26.2 [12]	Tested	Mandatory	11.9	Testing is mandatory when the value is not 'None' and if there are no MEPs configured at or above the OVC Available MEG level.
OVC L2CP Address Set Specified in MEF 45.1 [15]	Tested	Mandatory	11.8	-
Note 1: Performance metrics are verified according to the Service Acceptance Criteria. Refer to section 10.2 for SAC description.				
Note 2: Conditional Delivery of External Interface Frames is not tested since an unlimited number of conditions can exist.				

Table 6: Access E-Line OVC Service Attributes

[R11] For Access E-Line services, the SAT Record **MUST** contain all the reported values and test results of the mandatory OVC Service Attributes, as specified in Table 6.

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9.2.2 Access E-Line - OVC EP Service Attributes when the OVC EP is at an ENNI

Table 7 provides the list of OVC EP Service Attributes when the OVC EP is at an ENNI as defined in MEF 51.1 [17] section 9.1.2 for Access E-Line services.

Access E-Line OVC EP Service Attributes when the OVC EP is at an ENNI	Action	Status	Methodology	Comments
OVC EP Identifier Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC EP External Interface Type Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC EP External Interface Identifier Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC EP Role Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC End Point Map Specified in MEF 26.2 [12]	Tested	Mandatory	11.2	-
OVC EP Class of Service Identifier Specified in MEF 26.2 [12]	Reported	Mandatory	-	See note 1.
OVC EP Color Identifier Specified in MEF 26.2 [12]	Reported	Mandatory	-	See note 1.
OVC EP Egress Map Specified in MEF 26.2 [12]	N/A	N/A	-	See note 3.
OVC EP Egress Equivalence Class Identifier Specified in MEF 26.2 [12]	N/A	N/A	-	See note 3.
Ingress Bandwidth Profile per OVC EP Specified in MEF 26.2 [12]	N/A	N/A	-	-
Egress Bandwidth Profile per OVC EP Specified in MEF 26.2 [12]	N/A	N/A	-	-
Ingress Bandwidth Profile per Class of Service Name Specified in MEF 26.2 [12]	Tested	Mandatory	11.10	See note 2.
Egress Bandwidth Profile per Class of Service Name Specified in MEF 26.2 [12]	N/A	N/A	-	See note 3.
OVC EP Aggregation Link Depth Specified in MEF 26.2 [12]	N/A	N/A	-	-

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Access E-Line OVC EP Service Attributes when the OVC EP is at an ENNI	Action	Status	Methodology	Comments
OVC EP Source MAC Limit Specified in MEF 26.2 [12]	Tested	Optional	11.7	Report if enabled or disabled. If enabled testing is optional.
OVC EP MIP Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC EP MEP List Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
Note 1: Verified as part of the Ingress Bandwidth Profile per CoS Name test methodology.				
Note 2: See section 9.4 for the Bandwidth Profile parameters to be tested using SAT methodologies.				
Note 3: Egress Bandwidth Profile, Egress Equivalence Class Identifier and Egress Map can be addressed in a future release of this document.				

Table 7: Access E-Line OVC EP Service Attributes when the OVC EP is at an ENNI

[R12] For Access E-Line services, the SAT Record **MUST** contain all the reported values and test results of the mandatory OVC End Point Service Attributes when the OVC EP is at an ENNI, as specified in Table 7.

[R13] For Access E-Line services, the SAT Record **MUST** contain all the reported values of the optional OVC End Point Service Attributes when the OVC EP is at an ENNI, as specified in Table 7.

[O2] For Access E-Line services, the SAT Record **MAY** contain the test results of the optional OVC End Point Service Attributes when the OVC EP is at an ENNI, as specified in Table 7.

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9.2.3 Access E-Line - OVC EP Service Attributes when the OVC EP is at a UNI

Table 8 provides the list of OVC EP Service Attributes when the OVC EP is at a UNI as defined in MEF 51.1 [17] section 9.1.3 for Access E-Line services.

Access E-Line OVC EP Service Attributes when the OVC EP is at a UNI	Action	Status	Methodology	Comments
OVC EP Identifier Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC EP External Interface Type Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC EP External Interface Identifier Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC EP Role Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC EP Map Specified in MEF 26.2 [12]	Tested	Mandatory	11.2	-
OVC EP Class of Service Identifiers Specified in MEF 26.2 [12]	Reported	Mandatory	-	See note 1.
OVC EP Color Identifier Specified in MEF 26.2 [12]	Reported	Mandatory	-	See note 1.
OVC EP Egress Map Specified in MEF 26.2 [12]	N/A	N/A	-	See note 3.
OVC EP Egress Equivalence Class Identifier Specified in MEF 26.2 [12]	N/A	N/A	-	See note 3.
Ingress Bandwidth Profile per OVC EP Specified in MEF 26.2 [12]	N/A	N/A	-	-
Egress Bandwidth Profile per OVC EP Specified in MEF 26.2 [12]	N/A	N/A	-	-
Ingress Bandwidth Profile per Class of Service Name Specified in MEF 26.2 [12]	Tested	Mandatory	11.10	See note 2.
Egress Bandwidth Profile per Egress Equivalence Class Name Specified in MEF 26.2 [12]	N/A	N/A	-	See note 3.

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Access E-Line OVC EP Service Attributes when the OVC EP is at a UNI	Action	Status	Methodology	Comments
OVC EP Aggregation Link Depth Specified in MEF 26.2 [12]	N/A	N/A	-	-
OVC EP Source MAC Address Limit Specified in MEF 26.2 [12]	Tested	Optional	11.7	Report if enabled or disabled. If enabled testing is optional.
OVC EP MIP Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC EP MEP List Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
Note 1: Verified as part of the Ingress Bandwidth Profile per CoS Name test methodology.				
Note 2: See section 9.4 for the Bandwidth Profile parameters to be tested using SAT methodologies.				
Note 3: Egress Bandwidth Profile, Egress Equivalence Class Identifier and Egress Map can be addressed in a future release of this document.				

Table 8: Access E-Line OVC EP Service Attributes when the OVC EP is at a UNI

[R14] For Access E-Line services, the SAT Record **MUST** contain all the reported values and test results of the mandatory OVC End Point Service Attributes when the OVC EP is at a UNI, as specified in Table 8.

[R15] For Access E-Line services, the SAT Record **MUST** contain all the reported values of the optional OVC End Point Service Attributes when the OVC EP is at a UNI, as specified in Table 8.

[O3] For Access E-Line services, the SAT Record **MAY** contain the test results of the optional OVC End Point Service Attributes when the OVC EP is at a UNI, as specified in Table 8.

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9.2.4 Access E-Line - ENNI Service Attributes

Table 9 provides the list of ENNI Service Attributes as defined in MEF 51.1 [17] section 7.5. The Common Attributes and Multilateral Attributes are not applicable as they might not be known by the Operator.

Access E-Line ENNI Service Attributes	Action	Status	Methodology	Comments
Operator ENNI Identifier Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
S-VLAN ID Control Specified in MEF 26.2 [12]	N/A	N/A	-	-
Maximum Number of OVCs Specified in MEF 26.2 [12]	N/A	N/A	-	-
Maximum Number of OVC EP per OVC Specified in MEF 26.2 [12]	N/A	N/A	-	-
ENNI Token Share Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
ENNI Envelopes Specified in MEF 26.2 [12]	Reported	Mandatory	-	-

Table 9: Access E-Line ENNI Service Attributes

[R16] For Access E-Line services, the SAT Record **MUST** contain all the reported values of the mandatory ENNI Service Attributes, as specified in Table 9.

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9.2.5 Access E-Line - UNI Service Attributes

Table 10 provides the list of UNI Service Attributes as defined in MEF 51.1 [17] section 7.6 for Access E-Line services.

Access E-Line UNI Service Attributes	Action	Status	Methodology	Comments
Operator UNI ID Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
Operator UNI Physical Layer Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
Operator UNI Synchronous Mode Specified in MEF 26.2 [12]	Reported	Mandatory	-	Report Enabled or Disabled for each physical link. See note 1.
Operator UNI Number of Links Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
Operator UNI Link Aggre-gation Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
Operator UNI Port Conver-sation ID to Aggregation Link Map Specified in MEF 26.2 [12]	N/A	N/A	-	-
Operator UNI Service Frame Format Specified in MEF 26.2 [12]	N/A	N/A	-	See note 2.
Operator UNI Maximum Service Frame Size Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
Operator UNI Default CE-VLAN ID Specified in MEF 26.2 [12]	Tested	Mandatory	11.5	If the UNI Default CE-VLAN ID is mapped to the service under test, testing is Mandatory. See note 3.
Operator UNI Maximum number of OVC EP Specified in MEF 26.2 [12]	N/A	N/A	-	-
Operator UNI Maximum number CE-VLAN IDs per OVC EP Specified in MEF 26.2 [12]	N/A	N/A	-	-

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Access E-Line UNI Service Attributes	Action	Status	Methodology	Comments
Operator UNI Ingress Bandwidth Profile Specified in MEF 26.2 [12]	N/A	N/A	-	-
Operator UNI Egress Bandwidth Profile Specified in MEF 26.2 [12]	N/A	N/A	-	-
Operator UNI Link OAM Specified in MEF 26.2 [12]	N/A	N/A	-	-
Operator UNI MEG Specified in MEF 26.2 [12]	N/A	N/A	-	-
Operator UNI LAG Link MEG Specified in MEF 26.2 [12]	N/A	N/A	-	-
Operator UNI E-LMI Specified in MEF 26.2 [12]	N/A	N/A	-	-
Operator UNI Token Share Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
Operator UNI Envelopes Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
Operator UNI L2CP Address Set Specified in MEF 45.1 [15]	Tested	Mandatory	11.8	-
Operator UNI L2CP Peering Specified in MEF 45.1 [15]	Reported	Mandatory	-	-
Note 1: If enabled, accuracy is not to be reported.				
Note 2: Service Frames are generated and expected to be received by the ETE, untagged, priority tagged or tagged, as specified in MEF 10.3 [8].				
Note 3: When the OVC End Point Map contains all CE-VLAN ID values, the value of the Operator UNI Default CE-VLAN ID Service Attribute does not affect the behavior of the mapping of Service Frames to OVC End Points at the UNI and thus can be considered to be not applicable.				

Table 10: Access E-Line UNI Service Attributes

[R17] For Access E-Line services, the SAT Record **MUST** contain all the reported values and test results of the mandatory UNI Service Attributes, as specified in Table 10.

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9.3 Transit E-Line Service Attributes

The Service Attribute tables of this section specify how the OVC, OVC End Point (OVC EP) and ENNI Service Attributes of Transit E-Line services defined in MEF 51.1 [17] are to be handled during SAT.

9.3.1 Transit E-Line - OVC Service Attributes

Table 11 provides the list of OVC Service Attributes as defined in MEF 51.1 [17] section 10.1.1 for Transit E-Line services.

Transit E-Line OVC Service Attributes	Action	Status	Methodology	Comments
OVC ID Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC Type Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC End Point List Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
Maximum Number of UNI OVC End Points Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
Maximum Number of ENNI OVC End Points Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC Maximum Frame Size Specified in MEF 26.2 [12]	Tested	Mandatory	11.1	-
OVC CE-VLAN ID Preservation Specified in MEF 26.2 [12]	Tested	Mandatory	11.2	See note 3.
OVC CE-VLAN PCP Preservation Specified in MEF 26.2 [12]	Tested	Mandatory	11.3	See note 3.
OVC CE-VLAN DEI Preservation Specified in MEF 26.2 [12]	Tested	Mandatory	11.4	See note 3.
OVC S-VLAN PCP Preservation Specified in MEF 26.2 [12]	Tested	Mandatory	11.3	Report if enabled or disabled. If enabled testing is mandatory.
OVC S-VLAN DEI Preservation Specified in MEF 26.2 [12]	Tested	Mandatory	11.4	Report if enabled or disabled. If enabled testing is mandatory.
OVC List of Class of Service Names Specified in MEF 26.2 [12]	Reported	Mandatory	-	-

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Transit E-Line OVC Service Attributes	Action	Status	Methodology	Comments
OVC Service Level Specification Specified in MEF 26.2 [12]	Tested	Mandatory	12.1	See note 1.
OVC Frame Delivery Specified in MEF 26.2 [12]	Tested	Mandatory	11.6	Report if delivery of Unicast, Multicast and Broadcast External Interface Frames is conditional, unconditional or discard. If conditional, report condition (See note 2). If unconditional or discard testing is mandatory.
OVC Available MEG Level Specified in MEF 26.2 [12]	Tested	Mandatory	11.9	Testing is mandatory when the value is not 'None' and if there are no MEPs configured at or above the OVC Available MEG level.
OVC L2CP Address Set Specified in MEF 45.1 [15]	Tested	Mandatory	11.8	-
Note 1: Performance metrics are verified according to the Service Acceptance Criteria. Refer to section 10.2 for SAC description.				
Note 2: Conditional Delivery of External Interface Frames is not tested since an unlimited number of conditions can exist.				
Note 3: The value of this attribute has no impact on the behavior of the service see MEF 51.1 [17] Table 18. SAT is used to verify that the C-Tag is not modified.				

Table 11: Transit E-Line OVC Service Attributes

[R18] For Transit E-Line services, the SAT Record **MUST** contain all the reported values and test results of the mandatory OVC Service Attributes, as specified in Table 11.

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9.3.2 Transit E-Line - OVC EP Service Attributes for an OVC EP at an ENNI

Table 12 provides the list of OVC EP Service Attributes for an OVC EP at an ENNI, as defined in MEF 51.1 [17] section 10.1.2 for Transit E-Line services.

Transit E-Line OVC EP Service Attributes for an OVC EP at an ENNI	Action	Status	Methodology	Comments
OVC EP Identifier Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC EP External Interface Type Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC EP External Interface Identifier Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC EP Role Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC End Point Map Specified in MEF 26.2 [12]	Tested	Mandatory	11.2	-
OVC EP Class of Service Identifier Specified in MEF 26.2 [12]	Reported	Mandatory	-	See note 1.
OVC EP Color Identifier Specified in MEF 26.2 [12]	Reported	Mandatory	-	See note 1.
OVC EP Egress Map Specified in MEF 26.2 [12]	N/A	N/A	-	See note 3.
OVC EP Egress Equivalence Class Identifier Specified in MEF 26.2 [12]	N/A	N/A	-	See note 3.
Ingress Bandwidth Profile per OVC EP Specified in MEF 26.2 [12]	N/A	N/A	-	-
Egress Bandwidth Profile per OVC EP Specified in MEF 26.2 [12]	N/A	N/A	-	-
Ingress Bandwidth Profile per Class of Service Name Specified in MEF 26.2 [12]	Tested	Mandatory	11.10	See note 2.
Egress Bandwidth Profile per Class of Service Name Specified in MEF 26.2 [12]	N/A	N/A	-	See note 3.
OVC EP Aggregation Link Depth Specified in MEF 26.2 [12]	N/A	N/A	-	-

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Transit E-Line OVC EP Service Attributes for an OVC EP at an ENNI	Action	Status	Methodology	Comments
OVC EP Source MAC Limit Specified in MEF 26.2 [12]	Tested	Optional	11.7	Report if enabled or disabled. If enabled testing is optional.
OVC EP MIP Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
OVC EP MEP List Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
Note 1: Verified as part of the Ingress Bandwidth Profile per CoS ID test methodology				
Note 2: See section 9.4 for the Bandwidth Profile parameters to be tested using SAT Methodologies				
Note 3: Egress Bandwidth Profile, Egress Equivalence Class Identifier and Egress Map can be addressed in a future release of this document				

Table 12: Transit E-Line OVC EP Service Attributes for an OVC EP at an ENNI

[R19] For Transit E-Line services, the SAT Record **MUST** contain all the reported values and test results of the mandatory OVC EP Service Attributes for an OVC EP at an ENNI, as specified in Table 12.

[R20] For Transit E-Line services, the SAT Record **MUST** contain all the reported values of the optional OVC End Point Service Attributes for an OVC EP at an ENNI, as specified in Table 12.

[O4] For Access E-Line services, the SAT Record **MAY** contain the test results of the optional OVC End Point Service Attributes for an OVC EP at an ENNI, as specified in Table 12.

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9.3.3 Transit E-Line - ENNI Service Attributes

Table 13 provides the list of ENNI Service Attributes as defined in MEF 51.1 [17] section 7.5. The Common Attributes and Multilateral Attributes are not applicable as they might not be known by the Operator.

Transit E-Line ENNI Service Attributes	Action	Status	Methodology	Comments
Operator ENNI Identifier Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
S-VLAN ID Control Specified in MEF 26.2 [12]	N/A	N/A	-	-
Maximum Number of OVCs Specified in MEF 26.2 [12]	N/A	N/A	-	-
Maximum Number of OVC EP per OVC Specified in MEF 26.2 [12]	N/A	N/A	-	-
ENNI Token Share Specified in MEF 26.2 [12]	Reported	Mandatory	-	-
ENNI Envelopes Specified in MEF 26.2 [12]	Reported	Mandatory	-	-

Table 13: Transit E-Line ENNI Service Attributes

[R21] For Transit E-Line services, the SAT Record **MUST** contain all the reported values of the mandatory ENNI Service Attributes, as specified in Table 13.

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9.4 E-Line, Access E-Line and Transit E-Line Bandwidth Profile

This section describes the Ingress Bandwidth Profile (BWP) Flow Parameters applicable to E-Line, Access E-Line and Transit E-Line services that can be tested and reported in the SAT Record. When a parameter is tested, its configured value is also to be reported in the SAT Record. The Ingress BWP Flow Parameters are defined and described in MEF 10.3 [8] section 12.1 and MEF 26.2 [12] section 17.1.2.

Ingress BWP Flow Parameters	Action	Status	Methodology	Comments
CIR	Tested	Mandatory	11.10.4	If the BWP conforms to the C-G-D model specified in MEF 23.2.1 [11], testing is mandatory.
CBS	Tested	Mandatory	11.10.2	If CBS > 0 testing is mandatory.
CIR_{max}	Tested	Mandatory	11.10.1	If CIR_{max} > 0 testing is mandatory.
EIR	Reported	Mandatory	-	-
EBS	Tested	Mandatory	11.10.2	If EBS > 0 testing is mandatory.
EIR_{max}	Tested	Mandatory	11.10.1	If EIR_{max} > 0 testing is mandatory.
ER	Reported	Mandatory	-	-
CM	Tested	Mandatory	11.10.3	If Color Mode is Aware testing is mandatory.
CF	Reported	Mandatory	-	The configured value of CF is taken into account when testing the other BWP Flow parameters.
F	Reported	Mandatory	-	The configured value of F is taken into account when testing the other BWP Flow parameters. This parameter only applies to Access E-Line and Transit E-Line services.

Table 14: Ingress BWP Flow Parameters

[R22] For E-Line, Access E-Line and Transit E-Line services, the SAT Record **MUST** contain all the reported values and test results of the mandatory Ingress BWP Flow Parameters, as specified in Table 14.

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9.5 E-Line, Access E-Line and Transit E-Line Performance Metrics

This section describes the Performance Metrics applicable to E-Line, Access E-Line and Transit E-Line services and that can be tested and reported in the SAT Record.

Performance Metrics	Action	Status	Methodology	Comments
One-way Frame Delay Performance (FD)	Tested	Mandatory	12.1	Mandatory if SAC have been agreed
One-way Mean Frame Delay Performance (MFD)	Tested	Mandatory	12.1	Mandatory if SAC have been agreed
One-way Frame Delay Range Performance (FDR)	Tested	Mandatory	12.1	Mandatory if SAC have been agreed
One-way Inter-Frame Delay Variation Performance (IFDV)	Tested	Mandatory	12.1	Mandatory if SAC have been agreed
One-way Frame Loss Ratio Performance (FLR)	Tested	Mandatory	12.1	Mandatory if SAC have been agreed

Table 15: Service Performance Metrics

[R23] For E-Line, Access E-Line and Transit E-Line services, the SAT Record **MUST** contain all the test results of the Service Performance Metrics, as specified in Table 15, for which Service Acceptance Criteria have been agreed per [R42].

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10 Service Activation Testing Methodology

The Service Activation Testing methodology specified in this document can be used to validate the Configuration and Performance attributes of E-Line, Access E-Line and Transit E-Line services. It is performed by transmitting, receiving and processing test traffic.

The goal of Service Activation Testing is to validate the Service Configuration (UNI, EVC, OVC, and/or ENNI) and to verify the Service Performance. The validation is performed by sending predefined test traffic and verifying that the behavior is according to the Service Definition. The following sections provide the methodology to perform this validation. To remove complexity from this document, the test methodology presented in these sections is for testing between two ETEs. Although testing from an ETE to an LLF is valid, it is a subset of this methodology.

Figure 12 below provides a summary view of the SAT methodology. The figure does not provide the description of the methodology in case of test failures and errors. The detailed methodology involving test failures and errors is addressed in later figures, when appropriate.

The methodology described in Figure 12 comprises processes that apply to both Service Providers and Operators.

The first step of the process is to set up the test architecture by ensuring connectivity between the two ETEs. Use cases for Service Activation Testing are provided in section 8.2 of this document.

The next steps of the process are the Service Configuration Tests specified in section 11 and the Service Performance Tests specified section 12 of this document. Each test identified in these sections, is run in sequence.

The last steps of the process are used to return the service to the pre-test state and to complete the SAT Record.

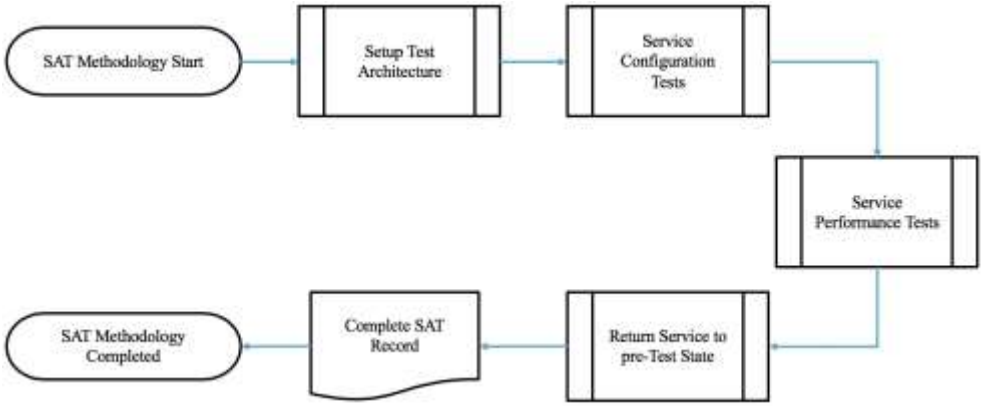


Figure 12 – Service Activation Test Methodology

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10.1 Test Traffic Requirements

This section captures the common testing parameters and requirements applicable to Service Configuration tests and Service Performance tests. Section 10.1.1 provides the common ETE requirements related to the attributes that need to be tested and the different parameters that are configured.

Section 10.1.2 provides the requirements related to the Ethernet frames used in SAT. Finally, section 10.1.3 offers a description of one-way versus two-way performance measurement in the context of SAT.

10.1.1 Common Ethernet Test Equipment Requirements

This section provides the common Ethernet Test Equipment requirements to perform SAT. The following requirements relate to the measurement and calculation of performance service attributes.

The performance of E-Line services is specified using one or more Service Frame Performance Metrics, which are specified in MEF 10.3 [8] section 8.8. In the context of SAT, the performance measurement of E-Line services is specified for the following metrics: One-way Frame Delay Performance (FD), One-way Mean Frame Delay Performance (MFD), One-way Frame Delay Range Performance (FDR), One-way Inter-Frame Delay Variation Performance (IFDV) and One-way Frame Loss Ratio Performance (FLR).

The performance of Access E-Line and Transit E-Line services is specified using one or more Performance Metrics, which are specified in MEF 26.2 [12] section 12.13. In the context of SAT, the performance measurement of Access E-Line and Transit E-Line services is specified for the following metrics: One-way Frame Delay Performance (FD), One-way Mean Frame Delay Performance (MFD), One-way Frame Delay Range Performance (FDR), One-way Inter-Frame Delay Variation Performance (IFDV) and One-way Frame Loss Ratio Performance (FLR).

In the context of SAT, the performance metrics are calculated over a time interval T_{SP} and for a single ordered pair in the set *S*.

[R24] An ETE implementation **MUST** measure the frame delay and the frame loss.

[R25] An ETE implementation **MUST** calculate the One-way FD, One-way MFD, One-way FDR, One-way IFDV and One-way FLR.

[R26] An ETE implementation **MUST** be capable of generating frames on multiple BWP Flows at the same time in a single envelope. See Appendix C example.

The methodology to measure and calculate the performance service attributes is beyond the scope of this specification.

The goal for SAT is to reproduce Service and ENNI Frame behavior to ensure that the service performs as per the Service Acceptance Criteria (SAC). SAT is performed on a single pair of

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External Interfaces at a time and the test traffic is sent in both directions (ETE_1 to ETE_2 and ETE_2 to ETE_1).

[R27] For MEF 6.2 [7] E-Line services, SAT **MUST** be performed between the pair of UNIs in both directions concurrently.

[R28] For MEF 51.1 [17] Access E-Line and Transit E-Line services, SAT **MUST** be performed between the pair of EIs in both directions concurrently.

For the purposes of this document, [R27] and [R28] are met if ETE_2 starts or stops sending frames within two seconds of ETE_1.

10.1.2 Test Frame Format and Size Requirements

The test frame format and size are important parts of SAT as test frames need to reproduce the behavior of Service and ENNI Frames. This section lists the test frames format and size requirements.

[R29] An ETE implementation **MUST** use IEEE Std 802.3-2015 [2] framing to perform SAT.

[R30] An ETE implementation **MUST** generate and process the C-VLAN ID, C-VLAN PCP, C-VLAN DEI, S-VLAN ID, S-VLAN PCP and S-VLAN DEI fields as specified for C-tag and S-tag in IEEE Std 802.1Q-2018 [1] sections 9.5 and 9.6.1.

[R31] An ETE implementation **MUST** generate or process frames such that ENNI Frames can have any valid PCP and DEI values when C-Tagged or S-Tagged.

[R32] An ETE Implementation **MUST** be capable of generating and processing untagged, C-Tagged, S-Tagged, and S/C-Tagged frames.

The frame size used for Service Configuration and Service Performance tests can be constant or a distribution of multiple frame sizes.

[R33] An ETE Implementation **MUST** support the capability to send a single constant test frame size.

[R34] An ETE Implementation **MUST** support the capability to configure the test frame size.

The test frame size refers to the total size in octets from the MAC Destination Address through the FCS of an untagged Service Frame at the UNI and excludes the preamble and IPG. A tagged Service Frame at the UNI has four more bytes than an untagged Service Frame at the UNI. An ENNI Frame has zero or four more bytes than a tagged Service Frame at the UNI and has four or eight more bytes than an untagged Service Frame at UNI.

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A predefined distribution of multiple frames sizes is referred to as Ethernet Mix (EMIX). This name is similar to the name applied to the variable size patterns assigned in IP-layer testing, Internet Mix (IMIX). The EMIX definition found in this technical specification draws upon ITU-T Y.1564 [6] and section 4 of RFC 6985 [4]. EMIX is used to emulate real-world traffic scenarios in a testing environment.

The EMIX pattern is specified in the following format:

EMIX – 123456… x

where each number is replaced by the letter corresponding to the size of the test frame at that position in the sequence. Table 16 gives the letter encoding for standard frame size (64, 128, 256, 512, 1024, 1280, and 1518 bytes), EVC or OVC MFS and user defined test frame sizes.

a	b	c	d	e	f	g	h	u
64	128	256	512	1024	1280	1518	EVC or OVC MFS	User de-fined

Table 16: Ethernet Test Frame Sizes and Size Designations

EMIX patterns are to be specified by the size designator for each frame in the repeating pattern from Table 16. For example, an eight-frame repeating pattern can be specified as follows:

EMIX – abcdefgh = 64, 128, 256, 512, 1024, 1280, 1518, EVC or OVC MFS

[D1] EMIX variable test frame size pattern **SHOULD** be used as part of the Service Configuration and Service Performance tests.

[CR1]<[D1] If an EMIX variable test frame size pattern is used, the ETE implementation **MUST** support a repeating sequence of at least eight elements containing at least two different frame sizes.

[CR2]<[D1] The variable test frame size pattern **MUST** be repeated as long as necessary during the test procedure from the first to last frame size starting at the beginning of each test procedure.

[CD1]<[D1] The EMIX default pattern **SHOULD** be the sequence of sizes: EMIX – abcdefgh where the letter encoding is as per Table 16.

[R35] The test frame size pattern used in the EMIX **MUST** be reported as a part of the SAT Record.

10.1.3 One-Way vs Two-Way Performance Measurement

The SAT definitions of one-way and two-way performance measurement are based on the MEF 35.1 [14] definitions, with adjustments for SAT to include SAMP reference points.

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One-way performance measurement, in the context of SAT, is defined as a measurement in a single direction, from one ETE to another ETE. From the perspective of a given ETE, a one-way measurement can be in the forward direction or the backward direction. For example, in Figure 13 from the perspective of the ETE at the ENNI-N, the forward direction is from the SAMP placed at the ENNI-N to the SAMP placed at the UNI-N. From the same figure, from the perspective of the ETE at the ENNI-N, the backward direction is from the SAMP placed at the UNI-N to the SAMP placed at the ENNI-N.

In the forward direction, the test frames are transmitted by the GTF placed at the ENNI-N and received by the CTF placed at the UNI-N and in the backward direction, the test frames are transmitted by the GTF placed at the UNI-N and received by the CTF placed at the ENNI-N.



Figure 13 – One-Way Performance Measurement

Two-way measurement, in the context of SAT, is defined as a measurement performed from one ETE to another ETE and back. For example, in Figure 14 the test frames are transmitted by the GTF placed at the ENNI-N towards the UNI-N where they are looped back to the ENNI-N, where they are received by the CTF. A two-way measurement is a round-trip measurement.



Figure 14 – Two-Way Performance Measurement

MEF 10.3 [8] and MEF 26.2 [12] define performance as one-way metrics for EVC and OVC services however, one-way delay is difficult to measure as it requires clock synchronization. Therefore, in some cases, one-way delay can be approximated using two-way delay measurement.

[R36] If one-way metrics are approximated from two-way measurements, it **MUST** be mentioned in the SAT Record.

[R37] If SAT is performed between two ETEs with clock synchronization, then One-way measurements of frame loss and frame delay **MUST** be taken to calculate

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the One-way FD, One-way MFD, One-way IFDV, One-way FDR and One-way FLR performance metrics.

When there is no clock synchronization between the two ETEs, One-way measurements can still be used to calculate One-way IFDV and One-way FDR performance metrics because the metrics are calculated based on the difference between delay measurements.

[R38] If SAT is performed between two ETEs without clock synchronization, then One-way measurements of frame loss and frame delay **MUST** be taken to calculate the One-way IFDV, One-way FDR and One-way FLR performance metrics.

[R39] If SAT is performed between two ETEs without clock synchronization, then Two-way measurements of frame delay **MUST** be taken to approximate the One-way FD and One-way MFD performance metrics.

[R40] If SAT is performed between one ETE and an LLF then Two-way measurements of frame loss and frame delay **MUST** be taken to approximate the One-way FD, One-way MFD, One-way IFDV, One-way FDR and One-way FLR performance metrics.

10.2 Service Acceptance Criteria

As described in section 7, the Service Acceptance Criteria (SAC) apply to the Service Configuration and Service Performance tests and provide pass or fail criteria on the basis of whether or not the service meets its SAC during each test, and this per Service Attribute and per direction. These criteria are allowable limits for each of the measured Service Attributes in the test and are carefully selected to give the Service Provider and the Subscriber or the Operator and the Service Provider confidence that a service that passes its Service Activation Testing, according to the established SAC, will be a satisfactory service that will meet its Class of Service Performance Objectives (CPOs). SAC for a given measurement (e.g. FLR) may be different for each test methodology and for each CoS Name.

SAT Service Acceptance Criteria are not equivalent to CPOs. CPOs are based on performance of in-service EVCs and OVCs over a relatively long time period; while SAC values are based on measuring test frames transmitted for a limited time period, e.g., normally less than 24 hours, before an EVC or an OVC is placed in-service. Due to this difference, the values contained in MEF 23.2 [10]75 for CPOs are not directly applicable to SAC for an EVC or an OVC.

[R41] SAC **MUST** be defined for each Service Attribute that is tested.

[R42] The Service Acceptance Criteria (SAC) **MUST** be agreed upon by the Service Provider and the Subscriber or by the Operator and the Service Provider.

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10.3 Service Configuration Test Process

The Service Configuration Test Process is composed of ten tests used to verify that a service is configured as per its Service Definition. Figure 15 illustrates the Service Configuration Test Process.

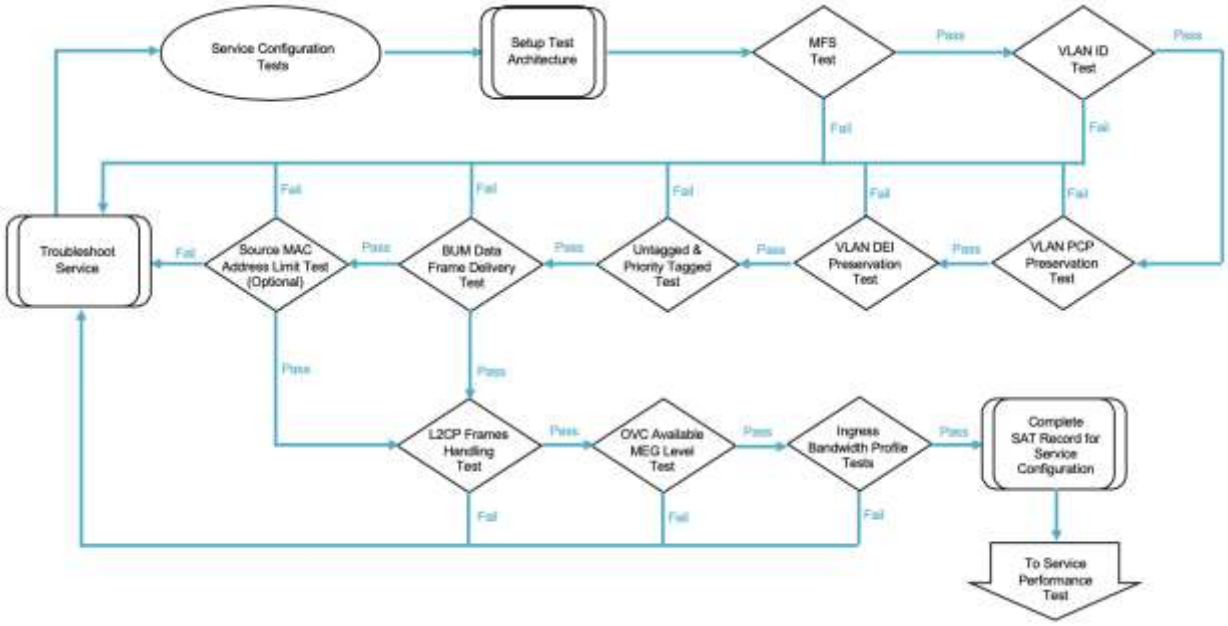


Figure 15 – Service Configuration Test Process

Note: Upon a configuration test failure, the ETE test logs/results should contain key information such as the observed FLR, the direction(s) in which the test failed and any other relevant information to help troubleshooting.

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10.4 Service Performance Test Process

The Service Performance Test Process is composed of one test, from which multiple metrics are measured and calculated, and is used to verify that the service meets the SAC agreed upon by the Service Provider and the Subscriber or by the Operator and the Service Provider for the purposes of Service Activation Testing. Figure 16 depicts the Service Performance Test Process.

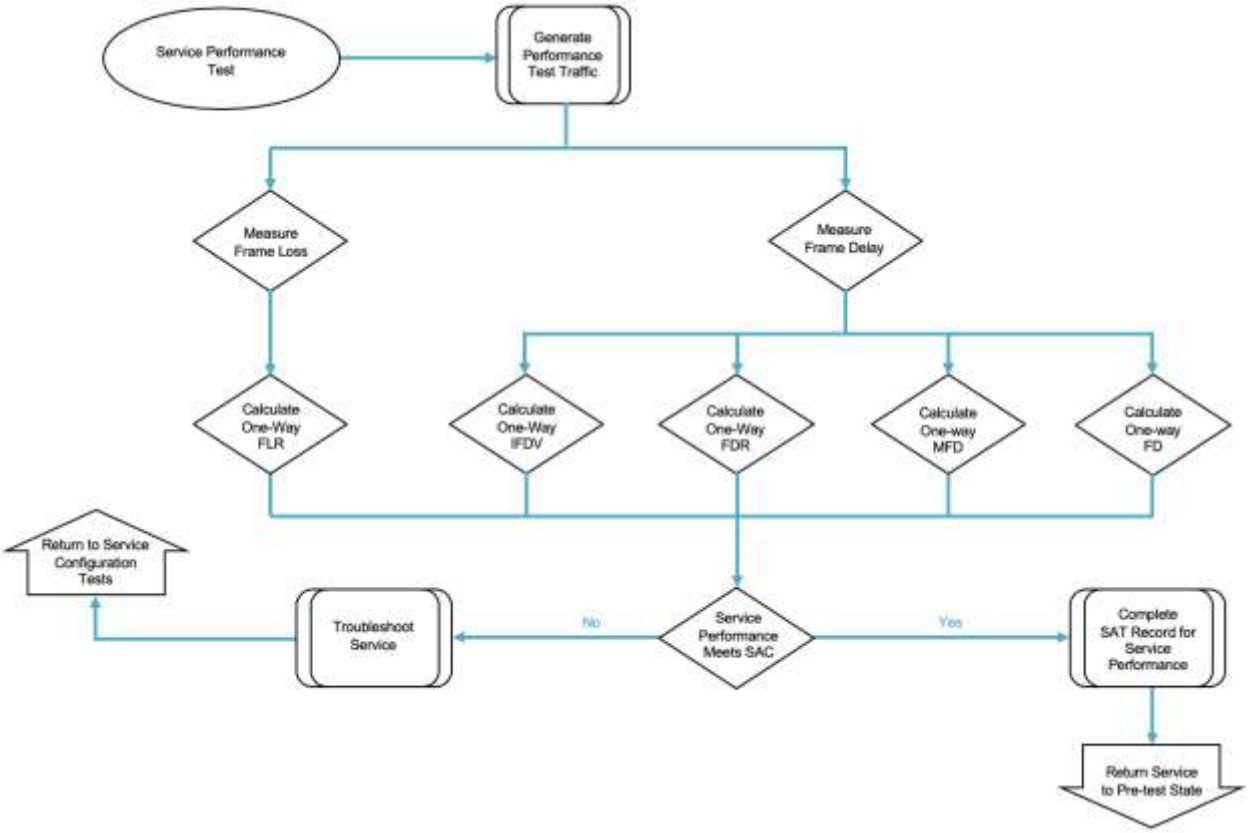


Figure 16 – Service Performance Test Process

Note: Upon a performance test failure, the ETE test logs/results should contain key information such as the observed FLR, the direction(s) in which the test failed and any other relevant information to help troubleshooting.

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11 Service Configuration Test Methodology

For all Service Configuration Tests defined in this section, a test duration is specified as T_{SC} and the test traffic is offered at an Information Rate equal to IR_{SC}. The '*SC*' in T_{SC} and IR_{SC} stands for Service Configuration.

[R43] T_{SC} **MUST** be configurable to a value between 1 and 300 seconds.

[R44] T_{SC} **MUST** be configurable to a different value for each individual test.

[R45] IR_{SC} **MUST** be configurable to a different value for each individual test.

[R46] Unless stated otherwise in the Test Methodology, IR_{SC} **MUST** be less than the rate at which offered test traffic could be declared Red by the ingress or the egress bandwidth profiles.

[D2] IR_{SC} **SHOULD** be the same in both directions (forward direction and backward direction) except for bandwidth profile tests.

Note 1: For the OVC Available MEG Level Test, a specific number of test frames is offered at the ingress External Interface and the same number of test frames is expected to be received at the egress External Interface.

Note 2: For all Service Configuration Tests defined in this section that are applicable to Access E-Line, the Ethernet Test Equipment number one (ETE_1) is to be located at the UNI and the Ethernet Test Equipment number two (ETE_2) is to be located at the ENNI.

Note 3: For all bandwidth profile tests, if the value of the Token Request Offset (F) is different than 0, the Information Rate IR_{SC} and the amount of traffic delivered at the egress EI (in bytes) need to be adjusted accordingly.

Note 4: The following test methodologies assume that the receiving ETE is not aware of the color of the frames as determined by the ingress bandwidth profile.

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11.1 Maximum Frame Size Test

The Maximum Frame Size (MFS) test enables the verification of the EVC MFS for E-Line and of the OVC MFS for Access E-Line and Transit E-Line services.

[R47] The Maximum Frame Size **MUST** be tested as per the methodology defined in Table 17.

Service Activation Test Methodology	
Test Name	Maximum Frame Size Test
Test Type	Service Activation
Service Type	E-Line, Access E-Line, Transit E-Line
Test Status	Testing is mandatory for E-Line, Access E-Line and Transit E-Line services
Test Objective	For E-Line, Access E-Line and Transit E-Line services, verify that an ingress frame, mapped to an EVC or to an OVC End Point, whose size is equal to the value of the EVC or OVC MFS Service Attribute adjusted to account for the frame format (untagged, single tagged or double tagged), is received at the egress EI
Test Procedure	1. ETE_1 offers frames that are mapped to the service under test per the Service Definition with frame size equal to the EVC MFS or OVC MFS adjusted to account for the frame format (See note 2), at an Information Rate IR_{SC}, for a time interval T_{SC}, at EI_1 2. ETE_2 verifies that the frames offered at the EI_1 are received as specified in the Service Definition at EI_2. Frame loss is acceptable up to FLR_{SAC}, where FLR_{SAC} is the SAC for One-Way Frame Loss Ratio. 3. Concurrently, ETE_2 offers frames that are mapped to the service under test per the Service Definition with frame size equal to the EVC MFS or OVC MFS adjusted to account for the frame format (See note 2), at an Information Rate IR_{SC}, for a time interval T_{SC}, at EI_2 4. ETE_1 verifies that the frames offered at the EI_2 are received as specified in the Service Definition at EI_1. Frame loss is acceptable up to FLR_{SAC}. 5. If EI Frames with different numbers of tags can be mapped to the EVC or OVC under test at the EI per the Service Definition, then the test methodology is to be repeated for each different number of tags. (See note 3).
Variables	IR_{SC}, T_{SC} and FLR_{SAC}
Results	PASS or FAIL
Remarks	Note 1: The EVC or OVC MFS is a value that is agreed between the Subscriber and the Service Provider or between the Service Provider and the Operator. Note 2: See MEF 10.3 [8] section 8.9 and/or MEF 26.2 [12] section 12.6 for the details on adjustments to account for the frame format. Note 3: For both Access E-Line and Transit E-Line, the Service Definition does not specify whether single-tagged or double-tagged frames are expected at the ENNI, so both cases always need to be tested.

Table 17: Maximum Frame Size Test

[R48] The SAT Record for the Maximum Frame Size Test **MUST** include the values of the following test variables: T_{SC} and IR_{SC} (as specified in section 11) and FLR_{SAC} (as specified in section 10.2).

[R49] The Maximum Frame Size Test result **MUST** include one of the following test result assertion codes: PASS or FAIL.

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11.2 VLAN ID Test

The VLAN ID test enables the verification of the End Point Map and VLAN ID preservation for E-Line, Access E-Line and Transit E-Line services.

[R50] The End Point Map and VLAN ID Preservation **MUST** be tested as per the methodology defined in Table 18.

Service Activation Test Methodology	
Test Name	VLAN ID Test
Test Type	Service Activation
Service Type	E-Line, Access E-Line, Transit E-Line
Test Status	Testing is mandatory for E-Line, Access E-Line and Transit E-Line services
Test Objective	For E-Line, Access E-Line and Transit E-Line services, verify that the VLAN IDs of the frames that are mapped to the service under test are preserved or not preserved, stripped or translated to different VLAN IDs, based on the End Point Maps and VLAN ID preservation attributes in the Service Definition
Test Procedure	1. The frame size to be used for testing can be a single frame size or an EMIX as per section 10.1.2. 2. ETE_1 offers frames that are mapped to the service under test per the Service Definition, at an Information Rate IR_{SC}, for a time interval T_{SC}, at EI_1 (See note 1). 3. ETE_2 verifies that the frames offered at EI_1 are delivered with VLAN IDs as per the End Point Map and the VLAN ID preservation attribute value in the Service Definition at EI_2. Frame loss is acceptable up to FLR_{SAC}, where FLR_{SAC} is the SAC for One-Way Frame Loss Ratio. 4. Concurrently, ETE_2 offers frames that are mapped to the service under test per the Service Definition, at an Information Rate IR_{SC}, for a time interval T_{SC}, at EI_2 (See note 1). 5. ETE_1 verifies that the frames offered at EI_2 are delivered with VLAN IDs as per the End Point Map and the preservation attribute value in the Service Definition at EI_1. Frame loss is acceptable up to FLR_{SAC}. 6. If EI Frames with different numbers of tags can be mapped to the EVC or OVC under test at the EI per the Service Definition, then the test methodology is to be repeated for each different number of tags. (See note 2).
Variables	The number and the values of tested VLAN IDs, Service and ENNI frame sizes, IR_{SC}, T_{SC} and FLR_{SAC}
Results	PASS or FAIL
Remarks	Note 1: The number and the values of tested VLAN IDs are to be agreed between the Subscriber and the Service Provider or between the Service Provider and the Operator. Note 2: For both Access E-Line and Transit E-Line, the Service Definition does not specify whether single-tagged or double-tagged frames are expected at the ENNI, so both cases always need to be tested.

Table 18: VLAN ID Test

[R51] The SAT Record for the VLAN ID Test **MUST** include the values of the following test variables: The number and the values of tested VLAN IDs, Test Frame Size (as specified in section 10.1.2), T_{SC} and IR_{SC} (as specified in section 11) and FLR_{SAC} (as specified in section 10.2).

[R52] The VLAN ID Test result **MUST** include one of the following test result assertion codes: PASS or FAIL.

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11.3 VLAN PCP Preservation Test

The VLAN PCP Preservation test enables the verification of Customer VLAN PCP Preservation for E-Line, Access E-Line and Transit E-Line services and Service VLAN PCP Preservation for Transit E-Line services.

[R53] For E-Line and Access E-Line services, when CE-VLAN PCP Preservation is enabled, it **MUST** be tested as per the methodology defined in Table 19.

[R54] For Transit E-Line services, CE-VLAN PCP Preservation **MUST** be tested as per the methodology defined in Table 19.

[R55] For Transit E-Line services, if S-VLAN PCP Preservation is enabled, it **MUST** be tested as per the methodology defined in Table 19.

Service Activation Test Methodology	
Test Name	VLAN PCP Preservation Test
Test Type	Service Activation
Service Type	E-Line, Access E-Line, Transit E-Line
Test Status	For Transit E-Line, CE-VLAN PCP preservation testing is Mandatory. For Transit E-Line, if Enabled, S-VLAN PCP preservation testing is Mandatory. For E-Line and Access E-Line, if Enabled, CE-VLAN PCP preservation testing is Mandatory.
Test Objective	For Transit E-Line, for E-Line if CE-VLAN PCP preservation is Enabled and for Access E-Line if CE-VLAN PCP preservation is Enabled, verify that ingress frames with all C-Tag PCP values not mapped to a Class of Service Name that calls for discard are received at the egress interface with identical C-Tag PCP values. For Transit E-Line, if S-VLAN PCP preservation is Enabled, verify that ingress frames with all S-Tag PCP values not mapped to a Class of Service Name that calls for discard are received at the egress interface with identical S-Tag PCP values
Test Procedure	1. The frame size to be used for testing can be a single frame size or an EMIX as per section 10.1.2. 2. ETE_1 offers tagged Service Frames that are mapped to the service under test per the Service Definition with one of the CE-VLAN PCP values not mapped to a Class of Service Name that calls for discard at the UNI or double tagged ENNI Frames that are mapped to the service under test per the Service Definition with one of the S-VLAN PCP values not mapped to a Class of Service Name that calls for discard at the ENNI and with one of the CE-VLAN PCP values not mapped to a Class of Service Name that calls for discard at the UNI, at an Information Rate IR_{SC} for a time interval T_{SC}, at EI_1. 3. ETE_2 verifies that the CE-VLAN PCP value of the frames received at EI_2 is identical to the CE-VLAN PCP value of the frames offered at EI_1. Frame loss is acceptable up to FLR_{SAC}, where FLR_{SAC} is the SAC for One-Way Frame Loss Ratio. For Transit E-Line, if S-VLAN PCP Preservation is enabled, ETE_2 also verifies that the S-VLAN PCP value of the frames received at EI_2 is identical to the S-VLAN PCP value of the frames offered at EI_1. Frame loss is acceptable up to FLR_{SAC}. 4. Concurrently, ETE_2 offers tagged Service Frames that are mapped to the service under test per the Service Definition with one of the CE-VLAN PCP values not mapped to a Class of Service Name that calls for discard at the UNI or double tagged ENNI Frames that are mapped to the service under test per the Service Definition with one of the S-VLAN PCP values not mapped to a Class of Service Name that calls for discard at the ENNI and with one of the CE-VLAN PCP values not mapped to a Class of Service Name that calls for discard at the UNI, at an Information Rate IR_{SC} for a time interval T_{SC}, at EI_2. 5. ETE_1 verifies that the CE-VLAN PCP value of the frames received at EI_1 is identical to the CE-VLAN PCP value of the frames offered at EI_2. Frame loss is acceptable up to FLR_{SAC}. For Transit E-Line, if S-VLAN PCP Preservation is enabled, ETE_1 also verifies that the S-VLAN PCP value of the frames received at EI_2 is identical to the S-VLAN PCP value of the frames offered at EI_2. Frame loss is acceptable up to FLR_{SAC}. 6. At the UNI, the test methodology is to be repeated for each CE-VLAN PCP value that does not map to a Class of Service Name that calls for discard. 7. For Transit E-Line, the test methodology is to be repeated for each CE-VLAN PCP value, and for each S-VLAN PCP value that does not map to a Class of Service Name that calls for discard.
Variables	Service and ENNI frame sizes, IR_{SC}, T_{SC} and FLR_{SAC}
Results	PASS, FAIL or NOT APPLICABLE
Remarks	

Table 19: VLAN PCP Preservation Test

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[R56] The SAT Record for the VLAN PCP Preservation Test **MUST** include the values of the following test variables: Test Frame Size (as specified in section 10.1.2), T_{SC} and IR_{SC} (as specified in section 11) and FLR_{SAC} (as specified in section 10.2).

[R57] If the VLAN PCP Preservation Test is run, the test result **MUST** include one of the following test result assertion codes: PASS or FAIL.

[R58] If the VLAN PCP Preservation Test is not run, the test result assertion code **MUST** be NOT APPLICABLE.

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11.4 VLAN DEI Preservation Test

The VLAN DEI Preservation test enables the verification of Customer VLAN DEI Preservation for Access E-Line and Transit E-Line services and Service VLAN DEI Preservation for Transit E-Line services.

[R59] For Access E-Line services, when CE-VLAN DEI Preservation is enabled, it **MUST** be tested as per the methodology defined in Table 20.

[R60] For Transit E-Line services, CE-VLAN DEI Preservation **MUST** be tested as per the methodology defined in Table 20.

[R61] For Transit E-Line services, if S-VLAN DEI Preservation is enabled, it **MUST** be tested as per the methodology defined in Table 20.

Service Activation Test Methodology	
Test Name	VLAN DEI Preservation Test
Test Type	Service Activation
Service Type	Access E-Line, Transit E-Line
Test Status	For Transit E-Line, CE-VLAN DEI preservation testing is Mandatory. For Transit E-Line, if Enabled, S-VLAN DEI preservation testing is Mandatory. For Access E-Line, if Enabled, CE-VLAN DEI preservation testing is Mandatory.
Test Objective	For Transit E-Line, and for Access E-Line if CE-VLAN DEI preservation is Enabled, verify that ingress frames with C-Tag DEI value 0 are received at the egress interface with C-Tag DEI value 0 and that ingress frames with C-Tag DEI value 1 are received at the egress interface with C-Tag DEI value 1. For Transit E-Line, if S-VLAN DEI preservation is Enabled, verify that ingress frames with S-Tag DEI value 0 are received at the egress interface with S-Tag DEI value 0 and ingress frames with S-Tag DEI value 1 are received at the egress interface with S-Tag DEI value 1.
Test Procedure	1. The frame size to be used for testing can be a single frame size or an EMIX as per section 10.1.2. 2. ETE_1 offers tagged Service Frames that are mapped to the service under test per the Service Definition with CE-VLAN DEI value 0 at the UNI or double tagged ENNI Frames that are mapped to the service under test per the Service Definition with S-VLAN DEI value 0 and with CE-VLAN DEI value 0 at the ENNI, at an Information Rate IR_{SC}, for a time interval T_{SC}, at EI_1. 3. ETE_2 verifies that the CE-VLAN DEI value of the frames received at EI_2 is identical to the CE-VLAN DEI value of the frames offered at EI_1. Frame loss is acceptable up to FLR_{SAC}, where FLR_{SAC} is the SAC for One-Way Frame Loss Ratio. For Transit E-Line, if S-VLAN DEI Preservation is enabled, ETE_2 also verifies that the S-VLAN DEI value of the frames received at EI_2 is identical to the S-VLAN DEI value of the frames offered at EI_1. Frame loss is acceptable up to FLR_{SAC}. 4. Concurrently, ETE_2 offers double tagged ENNI Frames that are mapped to the service under test per the Service Definition with S-VLAN DEI value 0 and with CE-VLAN DEI value 0 at the ENNI, at an Information Rate IR_{SC}, for a time interval T_{SC}, at EI_2. 5. ETE_1 verifies that the CE-VLAN DEI value of the frames received at EI_1 is identical to the CE-VLAN DEI value of the frames offered at EI_2. Frame loss is acceptable up to FLR_{SAC}, where FLR_{SAC} is the SAC for One-Way Frame Loss Ratio. For Transit E-Line, if S-VLAN DEI Preservation is enabled, ETE_1 also verifies that the S-VLAN DEI value of the frames received at EI_1 is identical to the S-VLAN DEI value of the frames offered at EI_2. Frame loss is acceptable up to FLR_{SAC}. 6. At the UNI, the test methodology is to be repeated for CE-VLAN DEI value 1. 7. For Transit E-Line, the test methodology is to be repeated for CE-VLAN DEI value 1, and for S-VLAN DEI value 1.
Variables	Service and ENNI frame sizes, IR_{SC}, T_{SC} and FLR_{SAC}
Results	PASS, FAIL or NOT APPLICABLE
Remarks	

Table 20: VLAN DEI Preservation Test

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[R62] The SAT Record for the VLAN DEI Preservation Test **MUST** include the values of the following test variables: Test Frame Size (as specified in section 10.1.2), T_{SC} and IR_{SC} (as specified in section 11) and FLR_{SAC} (as specified in section 10.2).

[R63] If the VLAN DEI Preservation Test is run, the test result **MUST** include one of the following test result assertion codes: PASS or FAIL.

[R64] If the VLAN DEI Preservation Test is not run, the test result assertion code **MUST** be NOT APPLICABLE.

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11.5 Untagged and Priority Tagged Test

When Untagged and Priority Tagged frames are mapped to a service at a UNI, the untagged and priority tagged frames have to have the same CE-VLAN ID in the range 1, 2, …,4094.

[R65] When Untagged and Priority Tagged frames are mapped to a service at a UNI, they **MUST** be tested as specified in Table 21.

Service Activation Test Methodology	
Test Name	Untagged and Priority Tagged Test
Test Type	Service Activation
Service Type	E-Line, Access E-Line
Test Status	Testing is mandatory for E-Line and Access E-Line services if Untagged and Priority Tagged frames are mapped at the UNI
Test Objective	Verify that when Untagged and Priority Tagged frames are mapped to an E-Line or to an Access E-Line, they are processed as per the Service Definition
Test Procedure	1. The frame size to be used for testing can be a single frame size or an EMIX as per section 10.1.2. 2. ETE_1 offers Untagged frames that are mapped to the service under test per the Service Definition (See note 1) at the UNI, at an Information Rate IR_{SC}, for a time interval T_{SC}, at EI_1. 3. ETE_2 verifies that the frames offered at EI_1 are delivered as per the End Point Map and the preservation attribute value in the Service Definition at EI_2. Frame loss is acceptable up to FLR_{SAC}, where FLR_{SAC} is the SAC for One-Way Frame Loss Ratio. 4. Concurrently for E-Line and if Untagged and Priority Tagged frames are also mapped to the service under test per the Service Definition at the EI_2, ETE_2 offers Untagged frames at an Information Rate IR_{SC}, for a time interval $T_{SC.}$ Otherwise, if Untagged and Priority Tagged frames are not mapped at the EI_2, ETE_2 offers Tagged Service Frames that are mapped to the service under test per the Service Definition, at an Information Rate IR_{SC}, for a time interval T_{SC}. For Access E-Line ETE_2 offers single-tagged ENNI Frames that are mapped to the service under test per the Service Definition at the ENNI, at an Information Rate IR_{SC}, for a time interval T_{SC}, at EI_2. 5. ETE_1 verifies that the frames offered at EI_2 are delivered as per the End Point Map and the preservation attribute value in the Service Definition at EI_1. Frame loss is acceptable up to FLR_{SAC}. 6. At the UNI, the test methodology is to be repeated with Priority Tagged service frames. 7. At the ENNI, the test methodology is to be repeated with double-tagged ENNI frames.
Variables	Service and ENNI frame sizes, IR_{SC}, T_{SC} and FLR_{SAC}
Results	PASS, FAIL or NOT APPLICABLE
Remarks	Note 1: The External Interface 1 (EI_1) is a UNI where Untagged and Priority Tagged frames are mapped to the service under test.

Table 21: Untagged and Priority Tagged Test

[R66] The SAT Record for the Untagged and Priority Tagged Test **MUST** include the values of the following test variables: Test Frame Size (as specified in section 10.1.2), T_{SC} and IR_{SC} (as specified in section 11) and FLR_{SAC} (as specified in section 10.2).

[R67] If the Untagged and Priority Tagged Test is run, the test result **MUST** include one of the following test result assertion codes: PASS or FAIL.

[R68] If the Untagged and Priority Tagged Test is not run, the test result assertion code **MUST** be NOT APPLICABLE.

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11.6 Broadcast, Unicast & Multicast Data Frame Delivery Test

This test validates Broadcast, Unicast and Multicast Data Frame delivery from one External Interface to the other.

[R69] When the Broadcast, Unicast or Multicast Data Frame delivery is Unconditional or Discard, it **MUST** be tested as per the methodology defined in Table 22.

Service Activation Test Methodology	
Test Name	Broadcast, Unicast and Multicast Data Frame Delivery Test
Test Type	Service Activation
Service Type	E-Line, Access E-Line, Transit E-Line
Test Status	Testing is mandatory for E-Line, Access E-Line and Transit E-Line services if the Broadcast, Unicast or Multicast Data Frame delivery is Unconditional or Discard
Test Objective	Verify that when the Broadcast, Unicast or Multicast Data Frame delivery is Unconditional or Discard, the Broadcast, Unicast or Multicast Data Frames are delivered as per the Service Definition
Test Procedure	1. The frame size to be used for testing can be a single frame size or an EMIX as per section 10.1.2. 2. If Broadcast Data Frame delivery is Unconditional or Discard, ETE_1 offers Broadcast Data Frames that are mapped to the service under test per the Service Definition, at an Information Rate IR_{SC}, for a time interval T_{SC}, at EI_1. 3. If the delivery is Unconditional, ETE_2 verifies that the Broadcast Data Frames offered at EI_1 are received as specified in the Service Definition at EI_2. Frame loss is acceptable up to FLR_{SAC}, where FLR_{SAC} is the SAC for One-Way Frame Loss Ratio. If the delivery is Discard, ETE_2 verifies that none of the Broadcast Data Frames offered at EI_1 are delivered at EI_2. 4. Concurrently, ETE_2 offers Broadcast Data Frames that are mapped to the service under test per the Service Definition, at an Information Rate IR_{SC}, for a time interval T_{SC}, at EI_2. 5. If the delivery is Unconditional, ETE_1 verifies that the Broadcast Data Frames offered at EI_2 are received as specified in the Service Definition at EI_1. Frame loss is acceptable up to FLR_{SAC}. If the delivery is Discard, ETE_1 verifies that none of the Broadcast Data Frames offered at EI_2 are delivered at EI_1. 6. The test methodology is to be repeated for Unicast Data Frames and for Multicast Data Frames. 7. If EI Frames with different numbers of tags can be mapped to the EVC or OVC under test at the EI per the Service Definition, then the test methodology is to be repeated for each different number of tags. (See note 1).
Variables	Service and ENNI frame sizes, IR_{SC}, T_{SC} and FLR_{SAC}
Results	PASS, FAIL or NOT APPLICABLE
Remarks	Note 1: For both Access E-Line and Transit E-Line, the Service Definition does not specify whether single-tagged or double-tagged frames are expected at the ENNI, so both cases always need to be tested.

Table 22: Broadcast, Unicast and Multicast Data Frame Delivery Test

[R70] The SAT Record for the Broadcast, Unicast and Multicast Data Frame Delivery Test **MUST** include the values of the following test variables: Test Frame Size (as specified in section 10.1.2), T_{SC} and IR_{SC} (as specified in section 11) and FLR_{SAC} (as specified in section 10.2).

[R71] If the Broadcast, Unicast and Multicast Data Frame Delivery Test is run for Broadcast Data Frames, the test result for Broadcast Data Frames **MUST** include one of the following test result assertion codes: PASS or FAIL.

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[R72] If the Broadcast, Unicast and Multicast Data Frame Delivery Test is not run for Broadcast Data Frames, the test result for Broadcast Data Frames assertion code **MUST** be NOT APPLICABLE.

[R73] If the Broadcast, Unicast and Multicast Data Frame Delivery Test is run for Unicast Data Frames, the test result for Unicast Data Frames **MUST** include one of the following test result assertion codes: PASS or FAIL.

[R74] If the Broadcast, Unicast and Multicast Data Frame Delivery Test is not run for Unicast Data Frames, the test result for Unicast Data Frames assertion code **MUST** be NOT APPLICABLE.

[R75] If the Broadcast, Unicast and Multicast Data Frame Delivery Test is run for Multicast Data Frames, the test result for Multicast Data Frames **MUST** include one of the following test result assertion codes: PASS or FAIL.

[R76] If the Broadcast, Unicast and Multicast Data Frame Delivery Test is not run for Multicast Data Frames, the test result for Multicast Data Frames assertion code **MUST** be NOT APPLICABLE.

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11.7 Source MAC Address Limit Test

This test verifies that the number of Source MAC Addresses that can be used in ingress frames, over a time interval τ, can be limited.

[O5] When the Source MAC Address Limit is not Disabled at one or more of the end points, it **MAY** be tested as per the methodology defined in Table 23.

Service Activation Test Methodology	
Test Name	Source MAC Address Limit Test
Test Type	Service Activation
Service Type	E-Line, Access E-Line, Transit E-Line
Test Status	Testing is optional for E-Line, Access E-Line and Transit E-Line services if the Source MAC Address Limit is not Disabled at one or more of the end points
Test Objective	Verify that if the Source MAC Address Limit is not Disabled, the number of source MAC Addresses that can be used in ingress frames over a time duration τ is at least N, where N is the Source MAC Address limit
Test Procedure	1. Precondition: Start this procedure with an empty list of Source MAC Addresses, this can be achieved by waiting longer than τ without sending any frames or by clearing the list of Source MAC Addresses. 2. The frame size to be used for testing can be a single frame size or an EMIX as per section 10.1.2. 3. ETE_1 offers frames that are mapped to the service under test per the Service Definition, using X_1 unique Source MAC Addresses where X_1 is greater than N_1, at an Information Rate IR_{SC}, for a time interval T_{SC} (See Note 1) smaller than or equal to τ_1, where N_1 and τ_1 are the attribute pair $\langle N, \tau \rangle$ at EI_1. (See Note 3). 4. ETE_2 verifies that at least N_1 unique Source MAC Addresses are delivered as per the Service Definition at EI_2. 5. If the Source MAC Address Limit is not Disabled at EI_2 and if the list of Source MAC Addresses is empty, proceed to the next steps. 6. ETE_2 offers frames that are mapped to the service under test per the Service Definition, using X_2 unique Source MAC Addresses where X_2 is greater than N_1, at an Information Rate IR_{SC}, for a time interval T_{SC} (See Note 1) smaller than or equal to τ_2, where N_2 and τ_2 are the attribute pair $\langle N, \tau \rangle$ at EI_2. 7. ETE_1 verifies that at least N_2 unique Source MAC Addresses are delivered as per the Service Definition at EI_1.
Variables	Service and ENNI frame sizes, IR_{SC}, T_{SC}, Number of Unique Source MAC Addresses transmitted X.
Results	PASS, FAIL or NOT APPLICABLE
Remarks	Note 1: The values of T_{SC} and IR_{SC} have to be chosen such that the number X of unique MAC addresses generated is greater than N. Note 2: The verification of τ can be addressed in a future release of this document. Note 3: Each Source MAC Address comprises an equal percentage of the total test traffic.

Table 23: Source MAC Address Limit Test

[R77] The SAT Record for the Source MAC Address Limit Test **MUST** include the values of the following test variables: Test Frame Size (as specified in section 10.1.2), T_{SC} and IR_{SC} (as specified in section 11) and Number of Unique Source MAC Address transmitted and received.

[R78] If the Source MAC Address Limit Test is run, the test result **MUST** include one of the following test result assertion codes: PASS or FAIL.

[R79] If the Source MAC Address Limit Test is not run, the test result assertion code **MUST** be NOT APPLICABLE.

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11.8 L2CP Frames Handling Test

Based on the applicable Address Set and the L2CP Peering attribute, this test verifies that L2CP Frames using each one of the 32 Destination MAC Addresses reserved for control protocols by IEEE Std 802.1Q-2018 [1] are either filtered (L2CP Frames with these Destination MAC Addresses are peered or discarded but not passed) or not filtered and passed to the EVC or OVC. L2CP peering verification is outside the scope of this document.

[R80] L2CP Frames handling **MUST** be tested as per the methodology defined in Table 24.

Service Activation Test Methodology	
Test Name	L2CP Frames Handling Test
Test Type	Service Activation
Service Type	E-Line, Access E-Line, Transit E-Line
Test Status	Testing is mandatory for E-Line, Access E-Line and Transit E-Line services
Test Objective	Verify that the L2CP Frames that are not to be filtered are passed to the EVC or to the OVC and received at the egress EI and that the L2CP Frames that are to be filtered (discarded or peered) are not received at the egress EI.
Test Procedure	1. ETE_1 offers L2CP Frames with one of the 32 Destination MAC Addresses reserved for control protocols by IEEE Std 802.1Q [1], that are mapped to the service under test and have an L2CP protocol identifier that is not peered for that MAC address per the Service Definition, at an Information Rate IR_{SC}, for a time interval T_{SC}, at EI_1. 2. ETE_2 verifies that if the L2CP Frames are not to be filtered as per the Service Definition, they are passed to the EVC or to the OVC and they are received as per the Service Definition at EI_2. Frame loss for the L2CP Frames that are not to be filtered is acceptable up to FLR_{SAC}, where FLR_{SAC} is the SAC for One-Way Frame Loss Ratio. If the L2CP Frames are to be filtered as per the Service Definition, ETE_2 verifies that they are not received at the EI_2. (See Note 2). 3. Steps 1 and 2 of the test methodology are to be repeated for each one of the 32 Destination MAC Addresses reserved for control protocols by IEEE Std 802.1Q [1]. 4. ETE_1 offers L2CP Frames with one of the 32 Destination MAC Addresses reserved for control protocols by IEEE Std 802.1Q [1], that are mapped to the service under test and that have an L2CP protocol identifier that is peered for that MAC address per the Service Definition, at an Information Rate IR_{SC}, for a time interval T_{SC}, at EI_1. 5. ETE_2 verifies that the L2CP Frames that have an L2CP protocol identifier that is peered for that MAC address as per the Service Definition are not received at the EI_2. (See Note 2 and Note 3). 6. Steps 4 and 5 of the test methodology are to be repeated for each one of the 32 Destination MAC Addresses reserved for control protocols by IEEE Std 802.1Q [1]. 7. Concurrently, ETE_2 offers L2CP Frames with one of the 32 Destination MAC Addresses reserved for control protocols by IEEE Std 802.1Q [1], that are mapped to the service under test and have an L2CP protocol identifier that is not peered for that MAC address per the Service Definition, at an Information Rate IR_{SC}, for a time interval T_{SC}, at EI_2. 8. ETE_1 verifies that if the L2CP Frames are not to be filtered as per the Service Definition, they are passed to the EVC or to the OVC and they are received as per the Service Definition at EI_1. Frame loss for the L2CP Frames that are not to be filtered is acceptable up to FLR_{SAC}, where FLR_{SAC} is the SAC for One-Way Frame Loss Ratio. If the L2CP Frames are to be filtered as per the Service Definition, ETE_1 verifies that they are not received at the EI_1. (See Note 2). 9. Steps 7 and 8 of the test methodology are to be repeated for each one of the 32 Destination MAC Addresses reserved for control protocols by IEEE Std 802.1Q [1]. 10. ETE_2 offers L2CP Frames with one of the 32 Destination MAC Addresses reserved for control protocols by IEEE Std 802.1Q [1], that are mapped to the service under test and that have an L2CP protocol identifier that is peered for that MAC address per the Service Definition, at an Information Rate IR_{SC}, for a time interval T_{SC}, at EI_2. 11. ETE_1 verifies that the L2CP Frames that have an L2CP protocol identifier that is peered for that MAC address as per the Service Definition are not received at the EI_1. (See Note 2 and Note 3). 12. Steps 10 and 11 of the test methodology are to be repeated for each one of the 32 Destination MAC Addresses reserved for control protocols by IEEE Std 802.1Q [1].
Variables	IR_{SC}, T_{SC} and FLR_{SAC}
Results	PASS or FAIL
Remarks	Note 1: L2CP Frames are specified in MEF 45.1 [15] . Note 2: L2CP Frames can be filtered (peered or discarded) at the ingress or at the egress EI. Note 3: When an L2CP Frame is peered, the peering entity may generate different L2CP frames that may be received at the egress EI.

Table 24: L2CP Frames Handling Test

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[R81] The SAT Record for the L2CP Frames Handling Test **MUST** include the values of the following test variables: T_{SC} and IR_{SC} (as specified in section 11) and FLR_{SAC} (as specified in section 10.2).

[R82] For each L2CP Frame that is not to be filtered, the L2CP Frames Handling Test result **MUST** include one of the following test result assertion codes: PASS or FAIL.

[R83] For each L2CP Frame that is to be filtered, the L2CP Frames Handling Test result **MUST** include one of the following test result assertion codes: PASS or FAIL.

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11.9 OVC Available MEG Level Test

Based on the OVC Available MEG Level, this test verifies that SOAM frames at or above that MEG Level are transported across the OVC. SOAM peering is outside the scope of this document.

[R84] When the OVC Available MEG Level value is not 'None' and if there are no MEPs configured at or above the OVC Available MEG level, the OVC Available MEG level **MUST** be tested as per the methodology defined in Table 25.

Service Activation Test Methodology	
Test Name	OVC Available MEG Level Test
Test Type	Service Activation
Service Type	Access E-Line, Transit E-Line
Test Status	Testing is mandatory for Access E-Line and Transit E-Line services if the value of the Available MEG Level is not 'None' and if there are no MEPs configured at or above the OVC Available MEG level.
Test Objective	Verify that when the OVC Available MEG Level value is not 'None' and that there are no MEPs configured at or above the OVC Available MEG level, SOAM frames at or above the OVC Available MEG Level are passed over the OVC and received at the egress EI. (See Note 1).
Test Procedure	1. ETE_1 offers 3 frames at the OVC Available MEG Level of each of the following protocol types: CCM, LBM Multicast, LBM Unicast, LBR, LTR, DMM, DMR, SLM and SLR, that are mapped to the service under test per the Service Definition, at EI_1. 2. ETE_2 verifies that all three CCM, LBM Multicast, LBM Unicast, LBR, LTR, DMM, DMR, SLM and SLR frames offered at EI_1 are delivered with VLAN IDs as per the End Point Map and the preservation attribute value in the Service Definition at EI_2. 3. Concurrently, ETE_2 offers 3 frames at the OVC Available MEG Level of each of the following protocol types: CCM, LBM Multicast, LBM Unicast, LBR, LTR, DMM, DMR, SLM and SLR, that are mapped to the service under test per the Service Definition, at EI_2. 4. ETE_1 verifies that all three CCM, LBM Multicast, LBM Unicast, LBR, LTR, DMM, DMR, SLM and SLR frames offered at EI_2 are delivered with VLAN IDs as per the End Point Map and the preservation attribute value in the Service Definition at EI_1. 5. If EI Frames with different numbers of tags can be mapped to the OVC under test at the EI per the Service Definition, then the test methodology is to be repeated for each different number of tags. (See note 7).
Variables	None
Results	PASS, FAIL or NOT APPLICABLE
Remarks	Note 1: SOAM frames at or above the OVC Available MEG Level of a type that is passed transparently by a Service Provider MEG MIP are considered to be Data frames and consequently the frame delivery and the frame transparency requirements part of the Service Definition apply to them. Note 2: The SOAM FM protocol types (CCM, LBM, LBR, and LTR) used in this test are mandatory protocols specified in MEF 30.1 [13]. Note 3: The SOAM PM protocol types (DMM, DMR, SLM and SLR) used in this test are the mandatory protocols specified in MEF 35.1 [14]. Note 4: DMM Version 1 and DMR Version 1 frames are recommended to be used for this test. Note 5: LTM PDUs are not tested as they could be affected by a MIP at an EI. Note 6: The MAC Destination Address of the Unicast PDUs offered by one ETE is to be the MAC Source Address of the other ETE. Note 7: For both Access E-Line and Transit E-Line, the Service Definition does not specify whether single-tagged or double-tagged frames are expected at the ENNI, so both cases always need to be tested.

Table 25: OVC Available MEG Level Test

[R85] If the OVC Available MEG Level Test is run, for each one of the tested protocol types, the test result **MUST** include one of the following test result assertion codes: PASS or FAIL.

[R86] If the OVC Available MEG Level Test is not run, the test result assertion code **MUST** be NOT APPLICABLE.

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11.10 Bandwidth Profile Test Process

The Bandwidth Profile (BWP) Test methodology specified in this document applies to Services configured with Ingress BWPs. The verification of Ingress BWP comprises up to four tests depending on the configuration of the BWP parameters. The first three tests are to be executed for each BWP Flow within the Envelope. Then, if applicable, the fourth test involving all BWP Flows within the Envelope is to be executed. Figure 17 depicts the Ingress BWP test process.

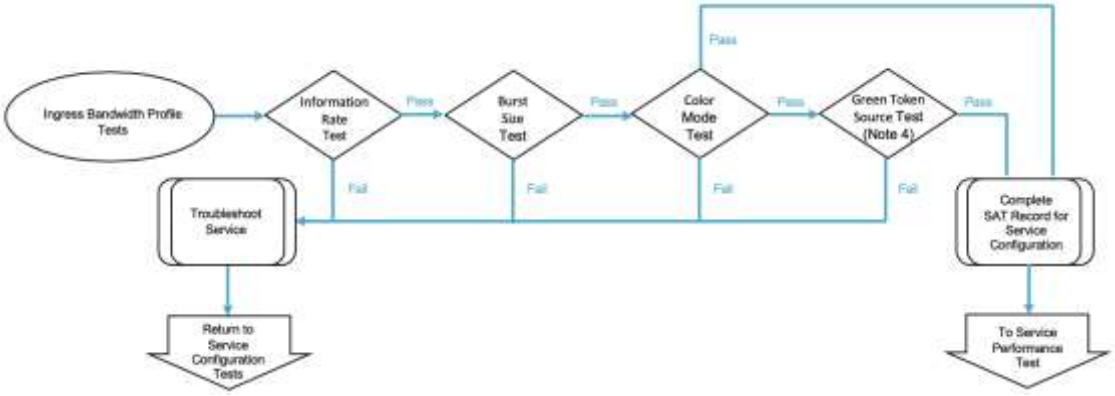


Figure 17 – Ingress Bandwidth Profile Test Process

Note 1: The BWP parameters are measured in terms of Service or ENNI Frames where the Service or ENNI Frame consists of the first bit of the Destination MAC Address to the last bit of the Frame Check Sequence.

Note 2: Testing of BWPs assumes the correct configuration of a number of other attributes that are not explicitly tested; in particular, the Ingress CoS Map and the Ingress Color Map. However, it does not assume that the CoS or color that was assigned to a frame on ingress can be determined on egress. See section 8.4 for additional considerations.

Note 3: While the verification of some performance metrics during the Service Configuration tests such as the Information Rate Test could provide preliminary indications of the service behavior, the Service Performance verification is to be executed as specified in section 12 of this document, after the Service Configuration tests.

Note 4: The Green Token Source Test only applies to Ingress BWPs with more than one BWP Flow in an Envelope that use Model C-G-D normatively defined in MEF 23.2.1 [11].

Note 5: It is not possible to test an Ingress BWP independently of an Egress BWP; only the combined effect of both can be tested. Addressing such cases is out of scope of this document.

Note 6: If the service under test has BWP Flows in an Envelope that also contains BWP Flows for other services, the BWP tests cannot be run without impacting the other services.

Note 7: If the ingress color map is such that only Green frames can be offered, the color mode test cannot be run; if only Yellow frames can be offered, then only the color mode test can be run. See Color Mode Test section 11.10.3.

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11.10.1 Ingress Bandwidth Profile - Information Rate Test

This test applies to all BWP Flows, whether they are part of an Envelope that contains a single or multiple BWP Flows. It applies to BWP Flows in color-blind or color-aware mode. It supports all CoS IDs and Color IDs defined in MEF 23.2 [10].

[R87] The CIR_{max} + EIR_{max} configuration of a BWP Flow **MUST** be tested as per the methodology defined in Table 26.

Service Activation Test Methodology	
Test Name	Ingress Bandwidth Profile – Information Rate Test
Test Type	Service Activation
Service Type	E-Line, Access E-Line, Transit E-Line
Test Status	Testing is mandatory for E-Line, Access E-Line and Transit E-Line services
Test Objective	When a BWP Flow is configured at an EI, verify that the BWP is applied to all ingress Service or ENNI Frames and the amount of traffic delivered at the egress EI is within the limits specified by the Service Acceptance Criteria (SAC).
Test Procedure	1. The frame size to be used for testing can be a single frame size or an EMIX as per section 10.1.2. 2. ETE_1 offers Green frames that are mapped to the service under test per the Service Definition and CoS IDs that are mapped to the CoS Name for the BWP Flow, at an Information Rate IR_{SC} greater than the CIR_{max} + EIR_{max} of the BWP Flow, for a time interval T_{SC}, (See Note 1) at EI_1. 3. ETE_2 measures the number of bytes (frames) delivered at EI_2. 4. Concurrently, ETE_2 offers Green frames that are mapped to the service under test per the Service Definition and CoS IDs that are mapped to the CoS Name for the BWP Flow, at an Information Rate IR_{SC} greater than the CIR_{max} + EIR_{max} of the BWP Flow, for a time interval T_{SC}, (See Note 1) at EI_2. 5. ETE_1 measures the number of bytes (frames) delivered at EI_1. 6. If the amount of traffic delivered at the egress EI is comprised between (the number of bytes corresponding to the calculated number of frames declared Green at the ingress EI minus FLR_{SAC}) and ((the number of bytes corresponding to the calculated number of frames declared Green at the ingress EI) + (the number of bytes corresponding to the calculated number of frames declared Yellow at the ingress EI) + *TF*), the test result is PASS, otherwise it is FAIL. (See Note 2 and Note 3). 7. For E-Line, the test methodology is to be repeated for each CoS Name listed in the Ingress Bandwidth Profile per Class of Service Identifier Service Attribute. For Access E-Line and Transit E-Line, the test methodology is to be repeated for each CoS Name listed in the Ingress Bandwidth Profile per Class of Service Name Service Attribute.
Variables	Service and ENNI frame sizes, T_{SC}, IR_{SC}, FLR_{SAC} and *TF*
Results	PASS, FAIL or NOT APPLICABLE
Remarks	Note 1: T_{SC} is to be such that the number of bytes in CBS + EBS is negligible compared to the total amount of traffic received over the total duration of the test. Note 2: *TF* is the tolerance factor, in number of bytes, specified by the Service Provider or the Operator. Note 3: Information on the calculated number of frames declared Green is provided in Appendix D.

Table 26: Ingress Bandwidth Profile – Information Rate Test

[R88] The SAT Record for the Ingress Bandwidth Profile - Information Rate Test **MUST** include the values of the following test variables: Test Frame Size (as specified in section 10.1.2), T_{SC} and IR_{SC} (as specified in section 11), FLR_{SAC} (as specified in section 10.2) and *TF*.

[R89] If the Ingress Bandwidth Profile - Information Rate Test is run for E-Line, it is to be run for each CoS Name listed in the Ingress Bandwidth Profile per Class

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of Service Identifier Service Attribute and the test result for each CoS Name **MUST** include one of the following test result assertion codes: PASS or FAIL.

[R90] If the Ingress Bandwidth Profile - Information Rate Test is run for Access E-Line or Transit E-Line, it is to be run for each CoS Name listed in the Ingress Bandwidth Profile per Class of Service Name Service Attribute and the test result for each CoS Name **MUST** include one of the following test result assertion codes: PASS or FAIL.

[R91] If the Ingress Bandwidth Profile - Information Rate Test is not run, the test result assertion code **MUST** be NOT APPLICABLE.

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11.10.2 Ingress Bandwidth Profile - Burst Size Test

This test applies to all BWP Flows, whether they are part of an Envelope that contains a single or multiple BWP Flows. It applies to BWP Flows in color-blind or color-aware mode. It supports all CoS IDs and Color IDs defined in MEF 23.2 [10].

[R92] The CBS + EBS configuration of a BWP Flow **MUST** be tested as per the methodology defined in Table 27.

Service Activation Test Methodology	
Test Name	Ingress Bandwidth Profile - Burst Size Test
Test Type	Service Activation
Service Type	E-Line, Access E-Line, Transit E-Line
Test Status	Testing is mandatory for E-Line, Access E-Line and Transit E-Line services
Test Objective	When a BWP Flow is configured at an EI, verify that the BWP is applied to all ingress Service or ENNI Frames and the amount of traffic delivered at the egress EI is within the limits specified by the Service Acceptance Criteria (SAC).
Test Procedure	1. Prerequisite: Before starting the test, there is to be an idle period (See Note 1), longer than necessary to refill the Green and Yellow token buckets. 2. The frame size to be used for testing can be a single frame size or an EMIX as per section 10.1.2. 3. ETE_1 offers Green frames that are mapped to the service under test per the Service Definition and CoS IDs that are mapped to the CoS Name for the BWP Flow, using an input traffic pattern of repeated bursts and idle periods (See Note 2), where each burst is longer than necessary to empty the Green and the Yellow token buckets of the BWP Flow and each idle period is longer than necessary to refill the Green and the Yellow token buckets of the BWP Flow, at EI_1. 4. ETE_2 measures the number of bytes (frames) delivered at EI_2. 5. Concurrently, ETE_2 offers Green frames that are mapped to the service under test per the Service Definition and CoS IDs that are mapped to the CoS Name for the BWP Flow, using an input traffic pattern of repeated bursts and idle periods (See Note 2) where each burst is longer than necessary to empty the Green and the Yellow token buckets of the BWP Flow and each idle period is longer than necessary to refill the Green and the Yellow token buckets of the BWP Flow, at EI_2. 6. ETE_1 measures the number of bytes (frames) delivered at EI_1. 7. If the amount of traffic delivered at the egress EI is comprised between (the number of bytes corresponding to the calculated number of frames declared Green at the ingress EI minus FLR_{SAC}) and ((the number of bytes corresponding to the calculated number of frames declared Green at the ingress EI) + (the number of bytes corresponding to the calculated number of frames declared Yellow at the ingress EI) + *TF*), the test result is PASS, otherwise it is FAIL. (See Note 3 and Note 4). 8. For E-Line, the test methodology is to be repeated for each CoS Name listed in the Ingress Bandwidth Profile per Class of Service Identifier Service Attribute. For Access E-Line and Transit E-Line, the test methodology is to be repeated for each CoS Name listed in the Ingress Bandwidth Profile per Class of Service Name Service Attribute.
Variables	Service and ENNI frame sizes, number of bursts, FLR_{SAC} and *TF*
Results	PASS, FAIL or NOT APPLICABLE
Remarks	Note 1: An idle period is a period of time during which no test frames are sent. Note 2: The number of bursts and Idle periods has to be ≥ 1, and an example of how to calculate burst and idle periods is presented in Appendix BB.1. Note 3: *TF* is the tolerance factor, in number of bytes, specified by the Service Provider or the Operator. Note 4: Information on the calculated number of frames declared Green is provided in Appendix D.

Table 27: Ingress Bandwidth Profile – Burst Size Test

[R93] The SAT Record for the Ingress Bandwidth Profile - Burst Size Test **MUST** include the values of the following test variables: Test Frame Size (as specified in section 10.1.2), number of bursts, FLR_{SAC} (as specified in section 10.2) and *TF*.

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[R94] If the Ingress Bandwidth Profile - Burst Size Test is run for E-Line, it is to be run for each CoS Name listed in the Ingress Bandwidth Profile per Class of Service Identifier Service Attribute and the test result for each CoS Name **MUST** include one of the following test result assertion codes: PASS or FAIL.

[R95] If the Ingress Bandwidth Profile - Burst Size Test is run for Access E-Line or Transit E-Line, it is to be run for each CoS Name listed in the Ingress Bandwidth Profile per Class of Service Name Service Attribute and the test result for each CoS Name **MUST** include one of the following test result assertion codes: PASS or FAIL.

[R96] If the Ingress Bandwidth Profile - Burst Size Test is not run, the test result assertion code **MUST** be NOT APPLICABLE.

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11.10.3 Ingress Bandwidth Profile - Color Mode Test

This test applies to all BWP Flows, whether they are part of an Envelope that contains a single or multiple BWP Flows. It applies to BWP Flows in color-blind or color-aware mode. It supports all CoS IDs and Color IDs defined in MEF 23.2 [10].

[R97] The Color Mode of a BWP Flow **MUST** be tested as per the methodology defined in Table 28.

Service Activation Test Methodology	
Test Name	Ingress Bandwidth Profile - Color Mode Test
Test Type	Service Activation
Service Type	E-Line, Access E-Line, Transit E-Line
Test Status	Testing is mandatory for E-Line, Access E-Line and Transit E-Line services
Test Objective	When a BWP Flow is configured at an EI, verify that the BWP is applied to all ingress Service or ENNI Frames and the amount of traffic delivered at the egress EI is within the limits specified by the Service Acceptance Criteria (SAC).
Test Procedure	1. The frame size to be used for testing can be a single frame size or an EMIX as per section 10.1.2. 2. ETE_1 offers Yellow frames that are mapped to the service under test per the Service Definition and CoS IDs that are mapped to the CoS Name for the BWP Flow, at an Information Rate IR_{SC} equal to the CIR_{max} + EIR_{max} of the BWP Flow, for a time interval T_{SC}, (See note 1) at EI_1. 3. ETE_2 measures the number of bytes (frames) delivered at EI_2. 4. Concurrently, ETE_2 offers Yellow frames that are mapped to the service under test per the Service Definition and CoS IDs that are mapped to the CoS Name for the BWP Flow, at an Information Rate IR_{SC} equal to the CIR_{max} + EIR_{max} of the BWP Flow, for a time interval T_{SC}, (See note 1) at EI_2. 5. ETE_1 measures the number of bytes (frames) delivered at EI_1. 6. If CM is set to Color Aware in the Service Definition, and the amount of traffic delivered at the egress EI is less than or equal to the number of bytes corresponding to the calculated number of frames declared Yellow at the ingress EI, the test result is PASS, otherwise it is FAIL. 7. If CM is set to Color Blind in the Service Definition, and the amount of traffic delivered at the egress EI is comprised between (the number of bytes corresponding to the calculated number of frames declared Green at the ingress EI minus FLR_{SAC}) and ((the number of bytes corresponding to the calculated number of frames declared Green at the ingress EI) + (the number of bytes corresponding to the calculated number of frames declared Yellow at the ingress EI) +TF), the test result is PASS, otherwise it is FAIL. (See Note 2 and Note 3). 8. For E-Line, the test methodology is to be repeated for each CoS Name listed in the Ingress Bandwidth Profile per Class of Service Identifier Service Attribute. For Access E-Line and Transit E-Line, the test methodology is to be repeated for each CoS Name listed in the Ingress Bandwidth Profile per Class of Service Name Service Attribute.
Variables	Service and ENNI frame sizes, T_{SC}, $IR_{SC,}$ FLR_{SAC} and TF
Results	PASS, FAIL or NOT APPLICABLE
Remarks	Note 1: T_{SC} is to be such that the number of bytes in CBS + EBS is negligible compared to the total amount of traffic received over the total duration of the test. Note 2: TF is the tolerance factor, in number of bytes, specified by the Service Provider or the Operator. Note 3: Information on the calculated number of frames declared Green is provided in Appendix D.

Table 28: Ingress Bandwidth Profile – Color Mode Test

[R98] The SAT Record for the Ingress Bandwidth Profile - Color Mode Test **MUST** include the values of the following test variables: Test Frame Size (as specified in section 10.1.2), T_{SC} and IR_{SC} (as specified in section 11), FLR_{SAC} (as specified in section 10.2) and TF.

[R99] If the Ingress Bandwidth Profile - Color Mode Test is run for E-Line, it is to be run for each CoS Name listed in the Ingress Bandwidth Profile per Class of

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Service Identifier Service Attribute and the test result for each CoS Name **MUST** include one of the following test result assertion codes: PASS or FAIL.

[R100] If the Ingress Bandwidth Profile - Color Mode Test is run for Access E-Line or Transit E-Line, it is to be run for each CoS Name listed in the Ingress Bandwidth Profile per Class of Service Name Service Attribute and the test result for each CoS Name **MUST** include one of the following test result assertion codes: PASS or FAIL.

[R101] If the Ingress Bandwidth Profile - Color Mode Test is not run, the test result assertion code **MUST** be NOT APPLICABLE.

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11.10.4 Ingress Bandwidth Profile - Green Token Source Test

This test applies to Ingress BWPs with more than one Bandwidth Profile Flow in an Envelope, that use Model C-G-D normatively defined in MEF 23.2.1 [11]. It applies to BWPs in color-blind or color-aware mode. It supports all CoS IDs and Color IDs defined in MEF 23.2 [10].

[R102] A BWP Flow in an Envelope that contains more than one BWP Flow, and that uses Model C-G-D normatively defined in MEF 23.2.1 [11], **MUS**T be tested as per the methodology defined in Table 29.

Service Activation Test Methodology	
Test Name	Ingress Bandwidth Profile - Green Token Source Test
Test Type	Service Activation
Service Type	E-Line, Access E-Line, Transit E-Line
Test Status	Testing is mandatory for E-Line, Access E-Line and Transit E-Line services
Test Objective	For a specific BWP Flow, verify that when an Ingress BWP with at least one BWP Flow with $CIR^i > 0$ as defined in the Service Definition, is in force at an EI, the BWP is applied to all ingress Service or ENNI Frames and the amount of traffic delivered at the egress EI is within the limits specified by the Service Acceptance Criteria (SAC).
Test Procedure	1. The frame size to be used for testing can be a single frame size or an EMIX as per section 10.1.2. If an EMIX is used, the same EMIX pattern must be used for all BWP Flows in the test. 2. ETE_1 offers a traffic mix (See Note 1) composed of Green frames that are mapped to the service under test per the Service Definition where the CoS ID of each frame is mapped to the BWP Flow of rank i or mapped to a higher-ranked BWP Flow configured in the Envelope. For the BWP Flow of rank i (the BWP Flow under test), traffic is sent at an Information Rate greater than the maximum rate at which frames in that BWP Flow could be declared Green, if all higher-ranked BWP Flows are using all Green tokens available to them to declare frames Green. For each BWP Flow of rank j, $i < j \leq n$, (where i is the rank of the BWP Flow under test and n is the number of BWP Flows in the Envelope), traffic is sent at an Information Rate equal to the maximum rate at which frames in that BWP Flow could be declared Green, if all BWP flows in ranks higher than j are using all Green tokens available to them to declare frames Green. Traffic is sent simultaneously for all BWP Flows, from rank i to rank n for a time interval T_{SC} at EI_1. 3. ETE_2 measures the number of bytes (frames) delivered at EI_2. 4. Concurrently, ETE_2 offers a traffic mix composed of Green frames that are mapped to the service under test per the Service Definition where the CoS ID of each frame is mapped to the BWP Flow of rank i or mapped to a higher-ranked BWP Flow configured in the Envelope. For the BWP Flow of rank i (the BWP Flow under test), traffic is sent at an Information Rate greater than the maximum rate at which frames in that BWP Flow could be declared Green, if all higher-ranked BWP Flows are using all Green tokens available to them to declare frames Green. For each BWP Flow of rank j, $i < j \leq n$, (where i is the rank of the BWP Flow under test and n is the number of BWP Flows in the Envelope), traffic is sent at an Information Rate equal to the maximum rate at which frames in that BWP Flow could be declared Green, if all BWP flows in ranks higher than j are using all Green tokens available to them to declare frames Green. Traffic is sent simultaneously for all BWP Flows, from rank i to rank n for a time interval T_{SC} at EI_2. 5. ETE_1 measures the number of bytes (frames) delivered at EI_1. 6. If the amount of traffic delivered at the egress EI is comprised between (the sum of the number of bytes corresponding to the calculated number of frames declared Green by each BWP Flow, from rank i to rank n, at the ingress EI minus FLR_{SAC}) and ((the sum of the number of bytes corresponding to the calculated number of frames declared Green by each BWP Flow, from rank i to rank n, at the ingress EI) + *TF*), the test result is PASS, otherwise it is FAIL. (See Note 2 and Note 3). 7. This test is to be run for each Envelope using Model C-G-D that has more than one BWP Flow including at least one BWP Flow for the service under test; and for each such Envelope, the test is to be run for each BWP Flow in the Envelope. 8. This test methodology allows verification of the CIR configuration of each BWP Flow within the Envelope in an iterative manner. First, the methodology is used to verify the CIR of the highest ranked BWP Flow (CIR^n), then in descending order, the CIR of each of the other BWP Flows in the envelope is verified. (See Note 4).
Variables	Service and ENNI frame sizes, T_{SC}, FLR_{SAC} and *TF*
Results	PASS, FAIL or NOT APPLICABLE
Remarks	Note 1: An example of traffic mix and the determination of traffic rates is presented in Appendix C. Note 2: *TF* is the tolerance factor, in number of bytes, specified by the Service Provider or the Operator. Note 3: Information on the calculated number of frames declared Green is provided in Appendix D. Note 4: Due to potential leaks of tokens from higher to lower ranks caused implementation approximations or rounding, it is recommended to use a *TF* value greater than zero in this test.

Table 29: Ingress Bandwidth profile – Green Token Source Test

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[R103] The SAT Record for the Ingress Bandwidth Profile - Green Token Source Test **MUST** include the values of the following test variables: Test Frame Size (as specified in section 10.1.2), T_{SC} (as specified in section 11), FLR_{SAC} (as specified in section 10.2) and *TF*.

[R104] The SAT Record for the Ingress Bandwidth Profile - Green Token Source Test **MUST** also include the Information Rate at which test frames are offered for each BWP Flow.

[R105] If the Ingress Bandwidth Profile - Green Token Source Test is run, it is to be run for each Envelope using Model C-G-D that has more than one BWP Flow including at least one BWP Flow for the service under test; and for each such Envelope, the test is to be run for each BWP Flow in the Envelope. The test result for each BWP Flow in each Envelope **MUST** include one of the following test result assertion codes: PASS or FAIL.

[R106] If the Ingress Bandwidth Profile - Green Token Source Test is not run, the test result assertion code **MUST** be NOT APPLICABLE.

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12 Service Performance Test Methodology

For the Service Performance Test defined in this section, the test duration is specified as T_{SP} and the test traffic is offered at an Information Rate equal to IR_{SP}, where IR_{SP} can be different for each CoS Name and each direction. The '*SP*' in T_{SP} and IR_{SP} stands for Service Performance.

[R107] T_{SP} **MUST** be agreed between the Subscriber and the Service Provider or between the Service Provider and the Operator before SAT is performed.

[R108] T_{SP} **MUST** be reported in the SAT Record.

[R109] The ETE **MUST** support T_{SP} of 15 minutes, 2 hours and 24 hours.

12.1 Service Performance Test

This test applies to all CoS Names that are not associated with a BWP Flow and to all CoS Names with BWP Flows configured with CBS > 0. The Service Performance Test uses frame delay and frame loss measurements to calculate delay-related and loss-related performance metrics: One-way Frame Delay (FD), one-way Mean Frame Delay (MFD), one-way Inter-Frame Delay Variation (IFDV), one-way Frame Delay Range (FDR) and one-way Frame Loss Ratio (FLR).

[R110] The service performance **MUST** be tested as per the methodology defined in Table 30.

Service Activation Test Methodology	
Test Name	Service Performance Test
Test Type	Service Activation
Service Type	E-Line, Access E-Line, Transit E-Line
Test Status	Testing is mandatory for E-Line, Access E-Line and Transit E-Line services with CoS Names that are not associated with a BWP Flow and with CoS Names with BWP Flows configured with CBS > 0
Test Objective	Based on frame delay and frame loss measurements, calculate the delay-related and loss-related performance metrics specified in the Service Acceptance Criteria (SAC) and verify that the calculated metrics are within the limits specified by the SAC, during a time interval T_{SP}

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Test Procedure	1. The frame size to be used for testing can be a single frame size or an EMIX as per section 10.1.2. 2. If the SAC includes performance metrics limits for the direction EI_1 to EI_2, ETE_1 offers Green frames that are mapped to the service under test per the Service Definition and CoS IDs that are mapped to the CoS Name, at an Information Rate IR_{SP}, for a time interval T_{SP}, at EI_1. 3. ETE_2 or ETE_1 measures frame delay (See Note 1 and Note 2). And, the applicable delay-related performance metrics are calculated: • One-way Frame Delay Performance is calculated for the time interval T_{SP}, as the P_d (percentile) of the Frame Delay for all frames successfully delivered between the EIs. • One-way Mean Frame Delay is calculated for the time interval T_{SP}, as the arithmetic mean of Frame Delays for all frames successfully delivered between the EIs. • One-way Inter-Frame Delay Variation is calculated for the time interval T_{SP} as the P_v (percentile) of the absolute value of the difference between the Frame Delays of all pairs of consecutive measurement frames successfully delivered between the EIs. • One-way Frame Delay Range is calculated for the time interval T_{SP}, as the difference between the delay value at percentile P_r and the minimum measured delay value, for all frames successfully delivered between the EIs. 4. Concurrently ETE_2 or ETE_1 measures frame loss. And, if applicable one-way Frame Loss Ratio is calculated: • One-way Frame Loss Ratio Performance is calculated for the time interval T_{SP}, as the ratio, expressed as a percentage, of the number of ingress frames not delivered at the egress EI divided by the total number of ingress frames that should have been delivered. 5. For all applicable performance metrics, if the calculated values are within the limits specified by the Service Acceptance Criteria (FD_{SAC}, MFD_{SAC}, $IFDV_{SAC}$, FDR_{SAC} and FLR_{SAC}) the test result is PASS, otherwise it is FAIL. 6. If the SAC includes performance metrics limits for the direction EI_2 to EI_1, ETE_2 offers Green frames that are mapped to the service under test per the Service Definition and CoS IDs that are mapped to the CoS Name, at an Information Rate IR_{SP}, for a time interval T_{SP}, at EI_2. 7. ETE_1 or ETE_2 measures frame delay (See Note 1 and Note 2). And, the applicable delay-related performance metrics are calculated: • One-way Frame Delay Performance is calculated for the time interval T_{SP}, as the P_d (percentile) of the Frame Delay for all frames successfully delivered between the EIs. • One-way Mean Frame Delay is calculated for the time interval T_{SP}, as the arithmetic mean of Frame Delays for all frames successfully delivered between the EIs. • One-way Inter-Frame Delay Variation is calculated for the time interval T_{SP} as the P_v (percentile) of the absolute value of the difference between the Frame Delays of all pairs of consecutive measurement frames successfully delivered between the EIs. • One-way Frame Delay Range is calculated for the time interval T_{SP}, as the difference between the delay value at percentile P_r and the minimum measured delay value, for all frames successfully delivered between the EIs. 8. Concurrently ETE_1 or ETE_2 measures frame loss (See Note 1 and Note 2). And, if applicable one-way Frame Loss Ratio is calculated: • One-way Frame Loss Ratio Performance is calculated for the time interval T_{SP}, as the ratio, expressed as a percentage, of the number of ingress frames not delivered at the egress EI divided by the total number of ingress frames that should have been delivered. 9. For all applicable performance metrics, if the calculated values are within the limits specified by the Service Acceptance Criteria (FD_{SAC}, MFD_{SAC}, $IFDV_{SAC}$, FDR_{SAC} and FLR_{SAC}) the test result is PASS, otherwise it is FAIL. 10. For E-Line, Access E-Line and Transit E-Line services, the test methodology is to be repeated for each CoS Name that is not associated with a BWP Flow and for each CoS Name with BWP Flows configured with CBS > 0.
Variables	Service and ENNI frame sizes, T_{SP}, IR_{SP}, FD_{SAC} and Percentile P_d, MFD_{SAC}, $IFDV_{SAC}$ and Percentile P_v, FDR_{SAC} and Percentile P_r and FLR_{SAC}
Results	PASS, FAIL or NOT APPLICABLE
Remarks	Note 1: Refer to section 10.1.3 for more information on one-way and two-way performance measurements and requirements. Note 2: Measurement techniques are beyond the scope of this document. Note 3: Each COS Name and each direction can have different values for IR_{SP} and for each Service Acceptance Criteria.

Table 30: Service Performance Test

[R111] The SAT Record for the Service performance Test **MUST** include the values of the following test variables: Test Frame Size (as specified in section 10.1.2), T_{SP} (as specified in section 12).

[R112] The SAT Record for the Service performance Test **MUST** include the values of the following test variables: IR_{SP} (as specified in section 12), FD_{SAC} and Percentile P_d, MFD_{SAC}, $IFDV_{SAC}$ and Percentile P_v, FDR_{SAC} and Percentile P_r and

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FLR_{SAC} (as specified in section 10.2), for each CoS Name and for each direction.

[R113] The SAT Record for the Service performance Test **MUST** include the metric measurement method i.e., one-way or two-way (as specified in section 10.1.3).

[R114] For each CoS Name and for each direction, for which the Service performance Test is run, the test result **MUST** include one of the following test result assertion codes: PASS or FAIL and the calculated values of FD, MFD, IFDV, FDR and FLR.

[R115] For each CoS Name and for each direction, for which the Service performance Test is not run, the test result **MUST** be NOT APPLICABLE.

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13 Test Results and SAT Record

This section provides guidelines and requirements to create the SAT Record.

[R116] The SAT Record **MUST** report all the Service Attributes and parameters with an action of 'tested' or 'reported' as specified in section 9 of this document.

[R117] The SAT Record **MUST** include the test results associated to all the Service Attributes and parameters with an action of 'tested' as specified in section 9 of this document.

[R118] The SAT Record for each test **MUST** mention the CoS Name over which the Service Configuration or the Service Performance test has been performed.

[R119] The SAT Record for the Maximum Frame Size Test specified in section 11.1, the VLAN ID Test in section 11.2, the VLAN PCP Preservation Test in section 11.3, the VLAN DEI Preservation Test in section 11.4, the Untagged and Priority Tagged Test in section 11.5, the Broadcast Unicast and Multicast Data Frame Delivery Test in section 11.6, the Source MAC Address Limit Test in section 11.7, the L2CP Frames Handling Test in section 11.8 and the OVC Available MEG Level Test in section 11.9 results **MUST** include the total number of transmitted frames, the total number of expected valid received frames and the total number of valid received frames.

[R120] If the number of expected valid received frames is a range for the Maximum Frame Size Test specified in section 11.1, the VLAN ID Test in section 11.2, the VLAN PCP Preservation Test in section 11.3, the VLAN DEI Preservation Test in section 11.4, the Untagged and Priority Tagged Test in section 11.5, the Broadcast Unicast and Multicast Data Frame Delivery Test in section 11.6, the Source MAC Address Limit Test in section 11.7, the L2CP Frames Handling Test in section 11.8, then the SAT Record **MUST** also include the minimum and the maximum number of expected valid received frames.

[R121] The SAT Record for the Ingress Bandwidth Profile Information Rate Test specified in section 11.10.1, the Burst Size Test in section 11.10.2, the Color Mode Test in section 11.10.3 and the Green Token Source Test in section 11.10.4 result **MUST** also include, the total number of bytes corresponding to the total number of transmitted frames, the total number of bytes corresponding to the total number of expected valid received frames and the total number of bytes corresponding to the total number of valid received frames.

[R122] If the number of expected valid received frames is a range for the Ingress Bandwidth Profile Information Rate Test specified in section 11.10.1, the Burst Size Test in section 11.10.2, the Color Mode Test in section 11.10.3 and the Green Token Source Test in section 11.10.4, then the SAT Record **MUST** also include number of bytes corresponding to the minimum and the maximum number of expected valid received frames.

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13.1 Orchestration and Automation Considerations

Service Activation Testing and the generation of the SAT Test Record can be executed with or without orchestration and automation systems. Orchestration and automation requirements and processes are out of scope of this document.

13.2 Test State Monitoring Considerations

Monitoring Test State can be possible when SAT is actively running or scheduled to run at a future time. For example, a Service Provider can query the ETE or its management system to get the state of a test.

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14 References

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[2] IEEE Std 802.3 – 2015, *IEEE Standard for Ethernet*, September 2015.

[3] Internet Engineering Task Force RFC 2119, *Key words for use in RFCs to Indicate Requirement Levels*, March 1997.

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[6] International Telecommunication Union, Recommendation Y.1564, *Ethernet Service Activation Test Methodology*, February 2016.

[7] MEF 6.2, *EVC Ethernet Services Definitions Phase 3*, August 2014

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[13] MEF 30.1, S*ervice OAM Fault Management Implementation Agreement: Phase 2*, April 2013.

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[15] MEF 45.1, *Layer 2 Control Protocols in Ethernet Services*, August 2018.

[16] MEF 46, *Latching Loopback Protocol and Functionality*, July 2014.

[17] MEF 51.1, *Operator Ethernet Service Definitions*, November 2018.

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Appendix A Service Activation Testing with an existing EVC or OVC (Informative)

Service Activation Testing of a new service at an External Interface where there are existing EVCs or OVCs might need to be performed differently in order to avoid adverse impacts on the existing services.

For example, if an ETE-I is used to perform SAT at a UNI where there is an existing EVC with Subscriber traffic, and that ETE-I is connected to the UNI-N, it will likely break the connection between the UNI-N and the UNI-C and adversely affect the Subscriber traffic. To avoid the impacts created by the use of an ETE-I, different methods such as the use of a Latching Loopback (LL) or the use of an ETE-A can be chosen. However, even the use of a Latching Loopback or the use of an ETE-A can adversely affect the existing Subscriber traffic. This is due to the fact that both test frames (either generated by the ETE-A or looped back) and Service Frames are transmitted at the same time. Since the Subscriber's equipment is not aware of the test frames, it might continue to transmit frames up to the CBS of the existing services while SAT is underway. If SAT is concurrently sending bursts of frames, the Subscriber might experience additional delay or frame loss on the existing service and additional delay can occur during SAT and cause it to fail.

Figure 18 exemplifies an OVC being activated at a UNI where an EVC is already in-service, using a Latching Loopback. In this example, both the EVC and the OVC have a CIR of 40 Mb/s and a CBS of 40,000 bytes and all physical interfaces are 100 Mb/s. In this example, a burst size test run while a Subscriber is sending Service Frames at line rate would cause congestion since the egress port can support only 100 Mb/s.

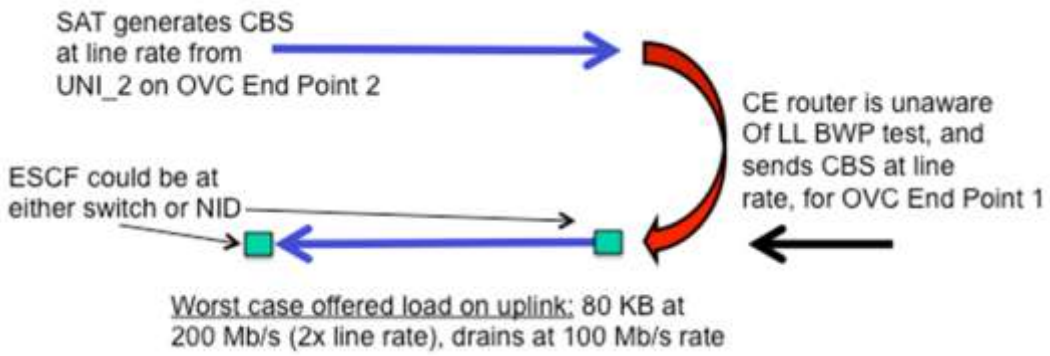


Figure 18 – Congestion Due to SAT Using a Latching Loopback Function

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A similar issue might exist with the use of an ETE-A, as illustrated in Figure 19. In this example, Service Frames and test frames contend for the same upstream bandwidth and additional Frame Delay or Inter-Frame Delay Variation can be experienced.

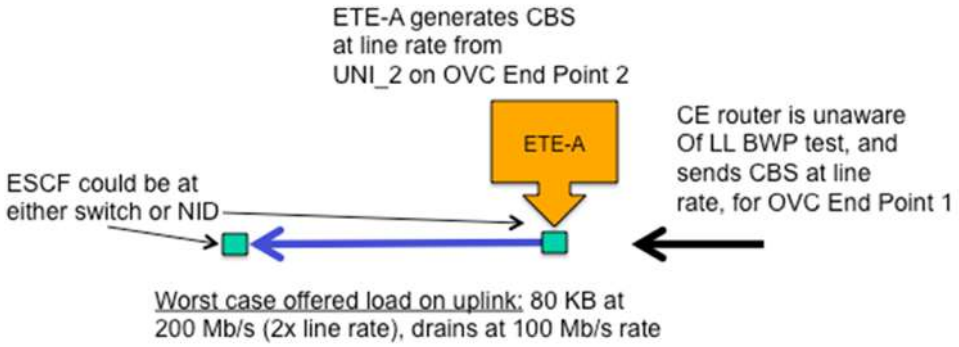


Figure 19 – Congestion Due to SAT Using an ETE-A

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Appendix B Bursts and Idle Periods Calculations (Informative)

This appendix provides guidance on calculating the burst and idle periods for the Burst Size Test described in section 11.10.2.

B.1 Burst Information Rate

A burst can be at any rate greater than CIR but is typically at line rate. The Burst Information Rate (BIR) is adjusted to not include the frame overhead which is not considered "information".

B.2 Burst Period Calculation Example

The Burst Period (B) is the minimum time it takes to be sure that the Green token bucket is empty. It can be calculated as follows: $B \geq CBS*8 / (BIR - CIR)$.

B.3 Idle Period Calculation Example

The Idle Period (I) is the minimum time it takes to be sure that the Green token bucket is full. It can be calculated as follow: $I \geq CBS*8 / CIR$.

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Appendix C Example of Test Traffic to Verify Green Token Sources Configuration (Informative)

In this example, and as depicted in Figure 20, a Token Sharing Bandwidth Profile Model C-G-D is used. The BWP has three BWP Flows, two Green token sources (CIR^3 = 100 Mb/s and CIR^1 = 80 Mb/s), and the token flow is down. Unused Green tokens at the bottom rank are discarded. For CoS H, CIR^3_{max} is equal to 100 Mb/s, for CoS M, CIR^2_{max} is also equal to 100 Mb/s, and for CoS L, CIR^1_{max} is equal to 180 Mb/s.

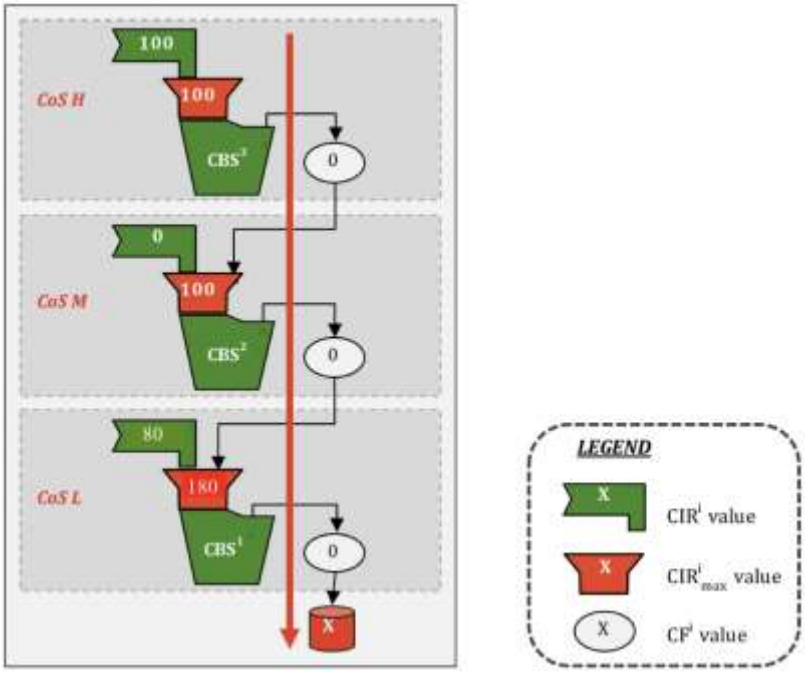


Figure 20 – Token Sharing Bandwidth Profile Model C-G-D

C.1 CIR^i Verification

The test traffic required to verify the configuration of a Green Token Source (CIR^i) is a mix of Green frames that are mapped to the service under test per the Service Definition where the CoS ID of each frame is mapped to the BWP Flow of rank i or mapped to a higher-ranked BWP Flow configured in the Envelope.

For the BWP Flow of rank i (the BWP Flow under test), the traffic is sent at an Information Rate greater than the maximum rate at which frames in that BWP Flow could be declared Green, if all higher-ranked BWP Flows are using all Green tokens available to them to declare frames Green.

For each BWP Flow of rank j, $i < j \leq n$, traffic is sent at an Information Rate equal to the maximum rate at which frames in that BWP Flow could be declared Green, if all higher-ranked BWP Flows are using all Green tokens available to them to declare frames Green. Test Traffic is sent simultaneously for all BWP Flows, from i to n for a time interval T_{SC}.

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The maximum rate R^k at which frames in a BWP Flow of rank k could be declared Green, if all higher-ranked BWP Flows are using all Green tokens available to them to declare frames Green, is given as follows:

$$R^k = \begin{cases} \min(CIR^k_{max}, CIR^k) & if\ k = n \\ \min\left(CIR^k_{max}, \sum_{x=k}^{n} CIR^x - \sum_{x=k+1}^{n} R^x\right) & if\ k < n \end{cases}$$

C.2 CIR^3 Verification - CoS H

The test traffic required to verify the configuration of the Green Token Source (CIR^3) is composed of frames with CoS IDs belonging to the BWP Flow of rank 3 only and it is sent at an Information Rate R where (R = R$^{3'}$).

The rate R$^{3'}$ has to be greater than the rate R^3 that is the maximum rate at which frames with CoS IDs belonging to the BWP Flow of rank 3 can be declared Green.

R^3 = min (CIR$^3_{max}$, CIR^3) = min (100 Mb/s, 100 Mb/s) = 100 Mb/s

R$^{3'}$ = R^3 + Extra* = 100 Mb/s + 5 Mb/s = 105 Mb/s

* In this example, an extra 5 Mb/s is added to R^3

R = R$^{3'}$

The test traffic to verify the configuration of the Green Token Source (CIR^3) is to be composed of 105 Mb/s of frames with CoS ID H.

C.3 CIR^2 Verification - CoS M

The test traffic required to verify the configuration of the Green Token Source (CIR^2) is a mix of frames with CoS IDs belonging to the BWP Flow of rank 2 and frames with CoS IDs belonging to all higher rank BWP Flows configured in the Envelope. It has to be sent at an Information Rate R where (R = R$^{2'}$ + R^3).

R$^{2'}$ is the first component of the rate R which is composed of frames with CoS IDs belonging to the BWP Flow of rank 2. The rate R$^{2'}$ has to be greater than R^2 that is the maximum rate at which frames with CoS IDs belonging to the BWP Flow of rank 2 can be declared Green, if all higher-priority BWP Flows of rank j where (i < j ≤ n), are using all Green tokens available to them to declare frames Green.

R^2 = min (CIR$^2_{max}$, ((CIR^2 + CIR^3) – (R^3))) = min (100 Mb/s, ((0 Mb/s + 100 Mb/s) – (100 Mb/s))) = 0 Mb/s

R$^{2'}$ = R^2 + Extra* = 0 Mb/s + 5 Mb/s = 5 Mb/s

* In this example, an extra 5 Mb/s is added to R^2

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R^3 = 100 Mb/s

$R = R^{2'} + R^3$

The test traffic mix to verify the configuration of the Green Token Source (CIR^2) is to be composed of 5 Mb/s of frames with CoS ID M and 100 Mb/s of frames with CoS ID H.

C.4 CIR^1 Verification - CoS L

The test traffic required to verify the configuration of the Green Token Source (CIR^1) is a mix of frames with CoS IDs belonging to the BWP Flow of rank 1 and frames with CoS IDs belonging to all higher rank BWP Flows configured in the Envelope. It has to be sent at a constant rate R where ($R = R^{1'} + R^2 + R^3$)

$R^{1'}$ is the first component of the rate R which is composed of frames with CoS IDs belonging to the BWP Flow of rank 1. The rate $R^{1'}$ has to be greater than R^1 that is the maximum rate at which frames with CoS IDs belonging to the BWP Flow of rank 1 can be declared Green, if all higher-priority BWP Flows of rank j where ($i < j \leq n$), are using all Green tokens available to them to declare frames Green.

$R^1 = \min (CIR^1_{max}, ((CIR^1 + CIR^2 + CIR^3) – (R^2 + R^3))) = \min$ (180 Mb/s, ((80 Mb/s + 0 Mb/s + 100 Mb/s) – (0 Mb/s + 100 Mb/s))) = 80 Mb/s

$R^{1'} = R^1$ + Extra* = 80 Mb/s + 5 Mb/s = 85 Mb/s

* In this example, an extra 5 Mb/s is added to R^1

R^2 = 0 Mb/s

R^3 = 100 Mb/s

$R = R^{1'} + R^2 + R^3$

The test traffic mix to verify the configuration of the Green Token Source (CIR^1) is to be composed of 85 Mb/s of frames with CoS ID L and 100 Mb/s of frames with CoS ID H.

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Appendix D Calculated number of frames declared "Green" (Informative)

The bandwidth profile tests described in section 11.10 have pass/fail criteria that depend on the bytes corresponding to the calculated number of frames declared Green. This appendix describes how such calculations can be performed.

Note that the tests in section 11.10 are applicable to the Token Sharing models described in MEF 23.2.1 [11], and the calculations described in this appendix are also applicable to these models. In particular, the calculations and equations assume that CF is 0 for every BWP Flow in an Envelope, which is a property of all three token sharing models in MEF 23.2.1 [11] (C-G-D, CX-G-R, and CX-GY-R). Similarly, the calculations described in this appendix assume that F (the Token Offset parameter) is 0 for every BWP Flow in an Envelope – if that is not the case, the calculations need to be adjusted accordingly.

In tests where traffic is offered at a constant rate for a single BWP Flow at any time, calculation of the bytes corresponding to the number of frames declared Green is relatively straightforward, and is given by the following equation, for a BWP Flow of rank *i* in an Envelope containing *n* BWP Flows, where CF = 0 for each BWP Flow:

$$\frac{\min\left(CIR_{max}^{i}, \sum_{j=i}^{n} CIR^{j}\right) * T_{SC}}{8}$$

where T_{SC} is the duration of the test as described in section 11.

Note that this calculation is not completely accurate but is a close enough approximation for most practical purposes; in particular, recall that it is assumed in section 11 that T_{SC} is long enough that the effect of draining CBS at the start of the test is insignificant. The calculation above makes the same assumption, i.e. it does not adjust the expected number of bytes to account for a burst at the start of the test.

If, conversely, a burst at the start of the test completely drains the committed bucket, then the calculation of the bytes corresponding to the number of frames declared Green is given by the following equation:

$$\frac{\left(\min\left(CIR_{max}^{i}, \sum_{j=i}^{n} CIR^{j}\right) * T_{SC}\right) + CBS^{i}}{8}$$

The rate at which the committed bucket is drained depends on by how much the rate of frames offered according to the test methodology exceeds the average rate of frames declared Green. If the frames are offered at the same rate as traffic is declared Green – in other words, if all of the offered frames for a given flow are declared Green – then the bucket will not be drained, and the first equation above should be used.

For the Green Token Source Test described in section 11.10.4, frames are offered in multiple BWP Flows simultaneously, and the calculation is consequently more complex. In an Envelope containing *n* BWP Flows, when a BWP Flow of rank *i* is under test, the calculation of the bytes corresponding to the number of frames declared Green can be determined recursively. Let IR_S^i be defined as follows:

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$$IR_S^i = \begin{cases} \min\left(CIR_{max}^i, CIR^i\right) & if\ i = n \\ \min\left(CIR_{max}^i, \sum_{j=i}^{n} CIR^j - \sum_{j=i+1}^{n} IR_S^j\right) & if\ i < n \end{cases}$$

Then the total bytes corresponding to the number of frames declared Green, where CF = 0 for each BWP Flow, is given by the following equation:

$$\frac{\left(\sum_{j=i}^{n} IR_S^j\right) * T_{SC}}{8}$$

Again, this calculation does not account for any initial burst, which is assumed to be insignificant. Note that for all flows at a higher rank than the flow under test, frames are offered at the same rate as they are expected to be declared Green, and thus the committed buckets for these flows will not be drained. However, for the flow under test, frames are offered at a higher rate, and thus, provided the test duration (T_{SC}) is sufficiently long, the committed bucket for that flow will be drained. This can be accounted for by using the following equation:

$$\frac{\left(\left(\sum_{j=i}^{n} IR_S^j\right) * T_{SC}\right) + CBS^i}{8}$$

By way of an example, consider the Bandwidth Profile configuration shown in Table 31, for an Envelope containing four BWP Flows, with $CF^0 = 0$. In this example, we do not adjust for CBS.

BWP Flow Parameter	BWP Flow Rank 4	BWP Flow Rank 3	BWP Flow Rank 2	BWP Flow Rank 1
CIR	**200Mb/s**	**0**	**100Mb/s**	**0**
CIRmax	**40Mb/s**	**100Mb/s**	**300Mb/s**	**300Mb/s**
CBS	36528	36528	36528	36528
EIR	0	0	0	0
EIRmax	0	0	0	0
EBS	0	0	0	0
CF	0	0	0	0
CM	Color-Blind	Color-Blind	Color-Blind	Color-Blind
ER	<ID, 4>	<ID, 3>	<ID, 2>	<ID, 1>
F	0	0	0	0

Table 31: Example Bandwidth Profile

In a test of duration 600 seconds, where traffic is only offered for a single Bandwidth Profile Flow at a time, the expected number of bytes corresponding to the calculated number of Frames declared Green for each flow is shown in Table 32. The numbers in bold indicate values taken directly from Table 31.

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Flow under Test	Expected number of bytes
4	$\frac{\min\left(CIR_{max}^{4}, \sum_{j=4}^{4} CIR^{j}\right) * 600}{8}$ = min(**40**, **200**) * 600 / 8 = 40 * 600 / 8 = 3000 MB
3	$\frac{\min\left(CIR_{max}^{3}, \sum_{j=3}^{4} CIR^{j}\right) * 600}{8}$ = min(**100**, **200** + **0**) * 600 / 8 = 100 * 600 / 8 = 7500 MB
2	$\frac{\min\left(CIR_{max}^{2}, \sum_{j=2}^{4} CIR^{j}\right) * 600}{8}$ = min(**300**, **200** + **0** + **100**) * 600 / 8 = 300 * 600 / 8 =22500 MB
1	$\frac{\min\left(CIR_{max}^{1}, \sum_{j=1}^{4} CIR^{j}\right) * 600}{8}$ = min(**300**, **200** + **0** + **100** + **0**) * 600 / 8 = 300 * 600 / 8 = 22500 MB

Table 32: Green Frame Calculation for a Single BWP Flow

For a Green Token Source Test of duration 600 seconds, where traffic is offered in multiple Bandwidth Profile Flows simultaneously, the expected number of bytes corresponding to the calculated number of Frames declared Green, for each flow under test, is shown in Table 33. The numbers in bold indicate values taken directly from Table 31, while the colored numbers indicate where the result of one calculation is used in another calculation.

Flow under Test	IR_S^4	IR_S^3	IR_S^2	IR_S^1	Expected number of bytes
4	$\min(CIR_{max}^{4}, CIR^{4})$ = min(**40**, **200**) = 40				$\frac{\left(\sum_{j=4}^{4} IR_S^j\right) * T_{SC}}{8}$ = 40 * 600 / 8 = 3000 MB
3	$\min(CIR_{max}^{4}, CIR^{4})$ = min(**40**, **200**) = 40	$\min\left(CIR_{max}^{3}, \sum_{j=3}^{4} CIR^{j} - \sum_{j=3+1}^{4} IR_S^j\right)$ = min(**100**, (**200** + **0**) – (40)) = min(100, 160) = 100			$\frac{\left(\sum_{j=3}^{4} IR_S^j\right) * T_{SC}}{8}$ = (40 + 100) * 600 / 8 = 10500 MB
2	$\min(CIR_{max}^{4}, CIR^{4})$ = min(**40**, **200**) = 40	$\min\left(CIR_{max}^{3}, \sum_{j=3}^{4} CIR^{j} - \sum_{j=3+1}^{4} IR_S^j\right)$ = min(**100**, (**200** + **0**) – (40)) = min(100, 160) = 100	$\min\left(CIR_{max}^{2}, \sum_{j=2}^{4} CIR^{j} - \sum_{j=2+1}^{4} IR_S^j\right)$ = min(**300**, (**200** + **0** + **100**) – (40 + 100)) = min(300, 160) = 160		$\frac{\left(\sum_{j=2}^{4} IR_S^j\right) * T_{SC}}{8}$ = (40 + 100 + 160) * 600 / 8 = 22500 MB

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Flow under Test	IR_S^4	IR_S^3	IR_S^2	IR_S^1	Expected number of bytes
1	$\min(CIR_{max}^4, CIR^4)$ = min(**40**, **200**) = 40	$\min\left(CIR_{max}^3, \sum_{j=3}^{4} CIR^j - \sum_{j=3+1}^{4} IR_S^j\right)$ = min(**100**, (**200** + **0**) – (40)) = min(100, 160) = 100	$\min\left(CIR_{max}^2, \sum_{j=2}^{4} CIR^j - \sum_{j=2+1}^{4} IR_S^j\right)$ = min(**300**, (**200** + **0** + **100**) – (40 + 100)) = min(300, 160) = 160	$\min\left(CIR_{max}^1, \sum_{j=1}^{4} CIR^j - \sum_{j=1+1}^{4} IR_S^j\right)$ = min(**300**, (**200** + **0** + **100** + **0**) – (40 + 100 + 160)) = min(300, 0) = 0	$\frac{(\sum_{j=1}^{4} IR_S^j) * T_{SC}}{8}$ = (40 + 100 + 160 + 0) * 600 / 8 = 22500 MB

Table 33: Green Frame Calculation for a Green Token Source Test

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