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Juniper® Validated Design
Test Report Brief: Metro as a Service MEF 3.0

Introduction

The Metro as a Service (MaaS) introduces the first supplier-approved comprehensive validation of MEF 3.0 compliance conducted over a production-emulated network. The Metro as a Service MEF3.0 JVD enhances the solution established with Metro Ethernet Business Services JVD, qualifying over 12,000 MEF 3.0 end-to-end test cases across all featured E-Line, E-LAN, E-Tree, and Access E-Line (E-Access) services.

The Metro as a Service MEF 3.0 JVD enhances the solutions with key benefits to service providers:

- Seamless Interoperability: MEF 3.0 certified products ensure that products work well with other MEF-compliant systems, reducing integration complexity and making it easier to deliver reliable, multi-vendor services.

- Faster Time-to-Market: MEF-compliant solutions come pre-tested with industry standards, enabling service providers to deploy new services quickly, stay competitive, and meet customer demands efficiently.

- Guaranteed Service Quality: MEF 3.0 standards include stringent performance, security, and reliability benchmarks, allowing providers to deliver high-quality, dependable services and maintain customer trust.

Juniper Networks is committed to deliver quality, interoperability, and compliance with industry standards for Carrier Ethernet services. With the Metro Ethernet Business Services JVD setting the foundation, this validation assures our customers that Juniper products and solutions are reliable, compatible, and capable of delivering high-performance Ethernet connectivity in diverse networking environments. The primary devices under test include MEF 3.0-certified products: ACX7024, ACX7100, ACX7509, and MX304.

Equipment Information

Following solution architecture and equipments are validated with Iometrix, the official MEF test laboratory, in accordance with the MEF 3.0 Test Plan for Service Attributes and Traffic Management. These equipments comply with all applicable service requirements as detailed in this Test Report.

- **Product Model**: ACX7100-48L, ACX7100-32C, ACX7509, MX304, MX204, ACX710, ACX5448

- **Software Version**: 23.2R2

- **Test Infrastructure:** Iometrix Lab in the Sky

Test Objectives

The Metro Ethernet Business Services (EBS) solution validates a comprehensive multidimensional architecture that includes best practices for designing and implementing L2/L3 services portfolio across intra-domain and inter-AS regions.

The solution architecture is extended to validate MEF 3.0 compliance, ensuring all featured Layer 2 services meet or exceed MEF standards for high performance, reliability, interoperability, and QoS. With adherence to MEF standards, operators can ensure consistent, high-quality Ethernet connectivity across different networks and providers. The MEF 3.0 test cases provide assurance that Carrier Ethernet services are reliable and capable of delivering on Service Level Agreements (SLA).

The MEF 3.0 test cases are qualified across the presented transport and services architectures and include the following major categories.

- Functional Service Attributes and Parameters:
    - This category tests the service functionalities and attributes defined for service types, including E-Line, E-LAN, E-Tree, and Access E-Line. It validates that services meet the necessary operational characteristics and behaviors, such as Ethernet Virtual Connections (EVCs), VLAN handling, and service multiplexing.
    - Tests include verifying the correct mapping of service attributes (e.g., CE-VLAN ID, CoS, EVC Service Attributes) and ensuring that services operate as intended.

- Layer 2 Control Protocol (L2CP) and Service OAM (SOAM) Frame Behavior:
    - This category tests the handling of Layer 2 Control Protocols (L2CP) and Service OAM (SOAM) frames, ensuring they are properly processed and managed by the system. It involves testing the correct tunneling and forwarding of control and management frames (e.g., CCM, LBM, LTM, LTR).
    - This also includes validating whether frames are correctly identified and handled according to MEF network operations and maintenance standards.

- Bandwidth Profile Attributes and Parameters:
    - This category verifies whether Bandwidth Profiles are implemented correctly. It tests attributes such as Committed Information Rate (CIR), Excess Information Rate (EIR), and traffic to ensure that the service adheres to the agreed-upon bandwidth allocations.
    - Performance metrics like traffic policing are validated to ensure proper traffic flow management in different service conditions.

- Service Performance Attributes and Parameters:
    - This category tests performance characteristics like latency, jitter, Frame Loss Ratio (FLR), and availability in compliance with the specified Service Level Agreements (SLAs).
    - It ensures that the service can meet the agreed-upon performance parameters for various traffic types (e.g., unicast, multicast, and broadcast) under real-world conditions, validating that service performance aligns with customer requirements.
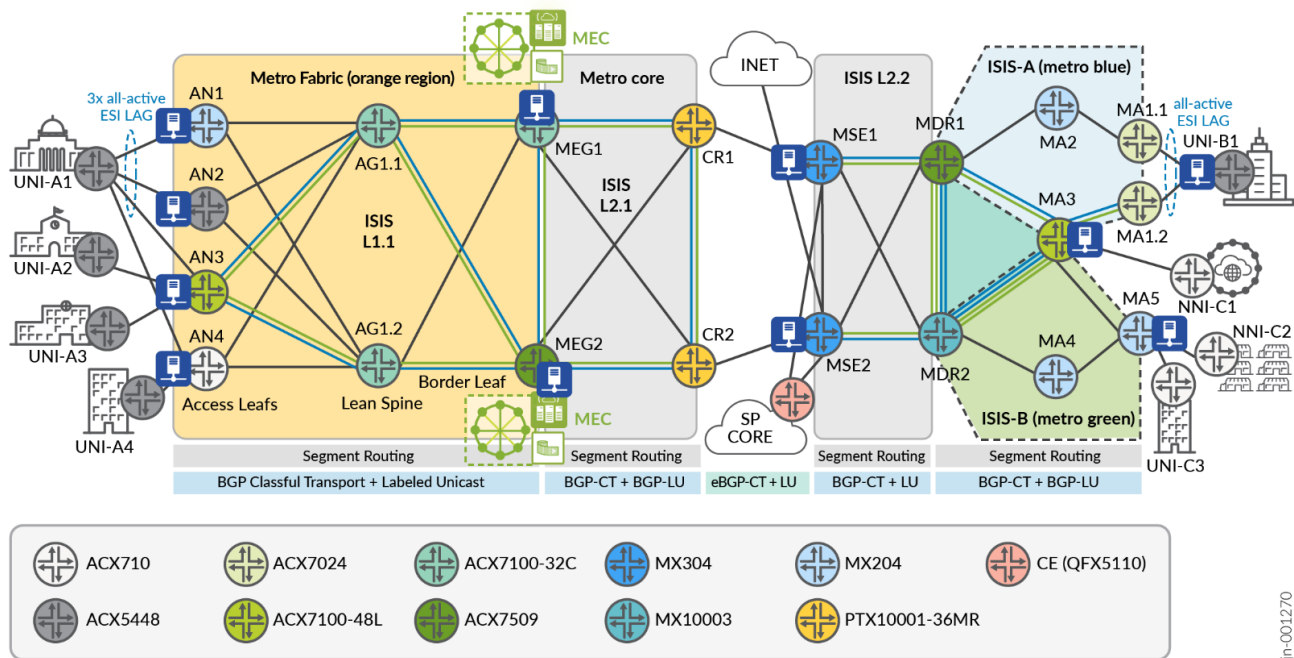
These categories ensure that the service and equipment meet MEF 3.0 standards for functionality, performance, interoperability, and service assurance required to deliver the expected service quality and reliability.

Test Topology

The Metro as a Service MEF JVD leverages two foundational components: the physical infrastructure introduced in Metro EBS JVD and the Iometrix Lab in the Sky testing infrastructure. The JVD solution presents a design for the integration of traditional Metro ring architectures utilizing multi-instance ISIS with Metro fabrics. Segment Routing (SR) MPLS is the underlay technology of choice. Flex-Algo is leveraged to enable lightweight traffic engineering. Transport classes are associated with the Flex-Algo tunnels to create slices through the network established by the lowest delay, best traffic engineering metrics, or preferred IGP metrics. Three paths are created in the topology: Gold (Delay metric), Bronze (TE metric), and Best Effort (IGP metric). Each VPN service is selectively mapped to the specific Flex-Algos using BGP extended color community attributes to perform color-aware traffic steering. A cascade-style resolution scheme allows Gold paths to failover to Bronze and Bronze paths to failover to Best Effort.

Figure 1 explains connectivity for building metro fabric spine-and-leaf and multi-ring topologies. For more details, see Metro EBS JVD.
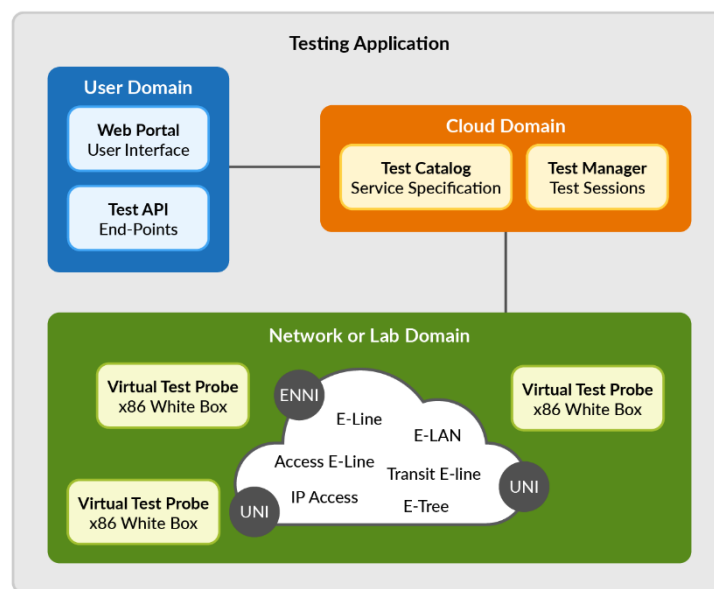
Figure 1: Metro Ethernet Business Services Solution Architecture

The Iometrix Lab in the Sky is a Network as a Service (NaaS) cloud-based testing infrastructure enabling MEF certification. The testing application leverages virtual test probes utilizing x86 whitebox probes. The IoTesting infrastructure consists of the following components.

Figure 2: Iometrix Lab in the Sky Infrastructure

Platforms Tested

Selected access platforms include ACX7024, ACX7100-48L, ACX710, ACX5448 and MX204. Aggregation or spine platforms include the ACX7100-32C in the metro fabric and ACX7509 with MX10003 routers as metro distribution routers in the ring architecture. The Metro Edge Gateway (MEG) performs border leaf functions with the ACX7509 and ACX7100-32C, providing connectivity into edge compute complexes. The metro core uses the PTX10001-36MR core and peering platform. The MX304 is ideally situated for the multi-services edge, supporting complex services termination and interconnect points.

Table 1: Topology Abstract

Devices Under Test			
Platform	Role	Device	Junos OS and Junos OS Evolved Release
Access Leaf	AN	ACX7100-48L (DUT), ACX710, ACX5448, MX204	23.2R2
Lean Spine	AG1	ACX7100-32C	23.2R2
Lean Edge Border Leaf	MEG	Metro Edge Gateway: ACX7509 (DUT), ACX7100-32C (DUT)	23.2R2
Core	CR	PTX10001-36MR	23.2R2
Multi-Services Edge	MSE	MX304 (DUT)	23.2R2
Metro Distribution Router	MDR	MX10003, ACX7509 (DUT)	23.2R2
Metro Access Node	MA	ACX7024 (DUT), ACX7100-48L (DUT), MX204	23.2R2

Test Bed Configuration

For configuration details used in this JVD and in Metro Ethernet Business Services JVD, see **https://github.com/Juniper/jvd** or contact your Juniper Networks representative.

Version Qualification History

This JVD has been qualified in Junos OS and Junos OS Evolved Release 23.2R2.

Scale and Performance Data

This document may contain Key Performance Indicators (KPIs) used in solution validation. Validated KPIs are multi-dimensional and reflect our observations in your network or reasonably represent solution capabilities. These numbers do not indicate the maximum scale and performance of individual tested devices. For uni-dimensional data on individual SKUs, kindly contact your Juniper Networks representatives.

Our JVD team continuously strives to enhance solution capabilities. Consequently, solution KPIs may change without prior notice. Always refer to the latest JVD test report for up-to-date solution KPIs. For the latest comprehensive test report, please reach out to your Juniper Networks representative.

High Level Features Tested

Following high level features are tested:

- EVPN-VPWS

- EVPN-FXC (aware + unaware)

- EVPN-ELAN (VLAN based, Vlan-bundle)

- EVPN-ETREE

- L2Circuit, L2VPN, BGP-VPLS

- Floating PW with Anycast-SID

- Local Switching (LSW) EVPN-VPWS & L2Circuit

- Service OAM

- Layer 2 Control Protocol (L2CP)

- Performance (Frame delay, Mean Frame Delay, Frame delay variation, Frame loss)

- Class of Service & Policing

The MaaS JVD covers the following Metro Ethernet use cases for delivering services:

- E-Line: Point-to-point connections like EPL and EVPL.

- E-LAN: Multipoint-to-multipoint connections like EP-LAN and EVP-LAN.

- E-Tree: Rooted multipoint hub-and-spoke connections like EP-TREE and EVP-TREE.

- Access E-Line: Wholesale point-to-point services connecting UNI to NNI.

- Internet Access: IP service connecting IPVC endpoints for dedicated Internet access.

Metro as a Service Event Testing and Results

The JVD team has successfully validated E-Line, E-LAN, E-Tree, and Access E-Line services included in the **Metro Ethernet Business Services JVD** using Iometrix Lab in the Sky infrastructure. Over 12,000 test cases are executed to ensure featured services meet MEF 3.0 compliance. The validation includes use cases delivered with EVPN-VPWS, EVPN Flexible Cross Connect, L2Circuit, L2VPN, and BGP-VPLS in intra-AS and inter-AS scenarios.

Test Status

Throughout the JVD validation, our goal is to remain aligned with the MEF 3.0 mandatory certification requirements as defined by the **MEF 91 Carrier Ethernet Test Requirements** standard. The test cases are categorized as mandatory or conditional mandatory.

- Mandatory test cases must be included in the MEF 3.0 certification and are therefore covered in the JVD.

- Conditional Mandatory test cases are not enforced, typically due to reliance upon optional features or attributes. In other words, these test scenarios only become mandatory when certain optional attributes are utilized. Depending on whether the conditions already exist in the Metro EBS network design, optional test cases may or may not be covered in the JVD.

The solution architecture supports additional features and functionalities defined by MEF but beyond the scope of the unconditional mandatory certification criteria.

In some cases, optional (conditional mandatory) attributes are covered to preserve the intentionality of the JVD itself, such as UNI resiliency. The test data identifies certification applicability criteria with additional columns to clearly identify areas where the validation is tested beyond the scope of MEF 3.0 requirements.

Test Results

E-LINE Point-to-Point Services Test Report

The protocol suite of point-to-point E-LINE services includes EVPN-VPWS, EVPN Flexible Cross Connect (FXC), BGP-VPLS (as a point-to-point service), L2Circuit, Floating PW, and L2VPN. The profile implements 11 distinct E-Line use cases to deliver different connectivity options.

E-Line services come in two main variations:

- Ethernet Private Line (EPL) is a port-based point-to-point "all-to-one bundling" service providing a dedicated, transparent data path.
- Ethernet Virtual Private Line (EVPL) is similar to EPL but supports service multiplexing (VLAN-based), allowing multiple services to share the same physical interface at a User Network Interface (UNI).

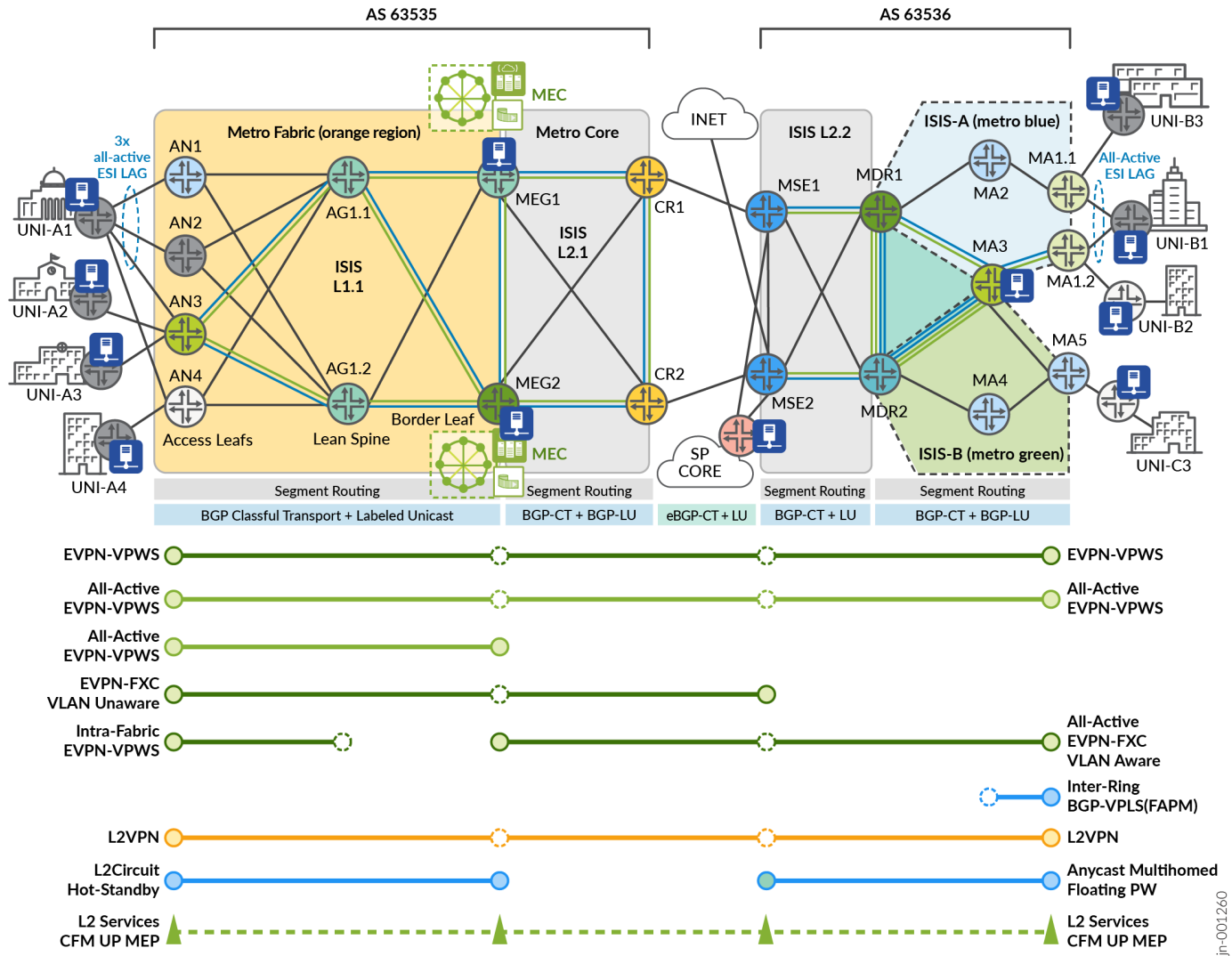Table 2 shares E-Line services covered as part of this JVD.

Table 2: EVPL Services

Index	Service Type	VPN Type	High Availability	Service Instantiation	Testcase count
1	E-Line	EVPN-VPWS_EDGE	Single-Homed/Active-Active Multihoming	Inter-AS Fabric to Ring	460
2	E-Line	EVPN-VPWS-MH-E2E	Active-Active Multihoming	Intra-AS Intra-Fabric	460
3	E-Line	EVPN-VPWS-SH-fabric	Single-Homed	Intra-AS Intra-Fabric	460
4	E-Line	EVPN Flexible Cross-Connect VLAN Aware	Active-Active Multihoming	Inter-AS Fabric to Ring	460
5	E-Line	EVPN Flexible Cross-Connect VLAN Unaware	Single-Homed	Inter-AS Fabric to MSE	460
6	E-Line	Layer 2 Circuit	Hot-Standby	Intra-AS Metro Fabric	460
7	E-Line	L2VPN VLAN-based	Single-Homed	Inter-AS Fabric to Ring	460
8	E-Line	BGP-VPLS VPWS	Single-Homed	Intra-AS Inter-Rings	460
9	E-Line	Floating Pseudo wire	Anycast	Intra-AS Metro Ring	460

Table 3: EPL Services

Index	Service Type	VPN Type	High Availability	Service Instantiation	Testcase count
1	E-Line	EVPN-VPWS Port Based	Single-Homed	Inter-AS Fabric to Ring	508
2	E-Line	L2VPN Port Based	Single-Homed	Inter-AS Fabric to Ring	508

Figure 3 : E-Line Point-to-Point Service Termination

MEF 3.0 Conformance Tests for E-LINE: The MEF 3.0 test plan defines a series of conformance test cases for the Metro Ethernet services. The test plan comprises of two main categories. Part 1 covers MEF 3.0 Services Attributes, and Part 2 covers MEF 3.0 Traffic Management. The following two tables list all the MEF 3.0 test cases.

Table 4: E-Line (EPL and EVPL)

Test Cases Summary – Service Attributes			
Test case	Test Case Name	EPL Test Result	EVPL Test Result
1	Non-looping Frame Delivery	PASS	PASS
2	L2CP Service Frames - Must not Tunnel	PASS	PASS
3	Service Frame Transparency Tag Exception 1 (Tag –Tag)	PASS	PASS
4	Service Frame Transparency Tag Exception 2 (Untag - Untag)	PASS	-

5	Service Frame Transparency Tag Exception 3 (Tag1 – Tag2) (P-Tag-Tag)	PASS	-
6	CE-VLAN ID Preservation - Untag	PASS	-
7	CE-VLAN ID Preservation – Tag & P-Tag	PASS	PASS
8	CE-VLAN PCP Preservation – Tag & P-Tag	PASS	-
9	CE-VLAN DEI Preservation Enabled	PASS	-
10	L2CP Service Frames - Must Tunnel	PASS	-
11	UNI Physical Layer, Mode and Speed	PASS	PASS
12	EVC Maximum Service Frame Size - Untagged	PASS	-
13	EVC Maximum Service Frame Size - Tagged	PASS	PASS
14	Maximum Number of CE-VLAN IDs per EVC EPs - All to One Bundling Enabled	PASS	-
15	Service OAM Continuity Check Message Transparency	PASS	PASS
16	Service OAM Multicast Loopback Message Transparency	PASS	PASS
17	Service OAM Unicast Loopback Message Transparency	PASS	PASS
18	Service OAM Loopback Response Transparency	PASS	PASS
19	Service OAM Linktrace Message Transparency	PASS	PASS
20	Service OAM Linktrace Response Transparency	PASS	PASS

Table 5: Test Cases Summary of Traffic Management

Test Cases Summary – Traffic Management			
Test case	Test Case Name	EPL Test Result	EVPL Test Result
1	One-Way Frame Delay Performance	PASS	PASS
2	One-Way Mean Frame Delay Performance	PASS	PASS
3	One-Way Inter-Frame Delay Variation Performance	PASS	PASS
4	One-Way Frame Delay Range Performance	PASS	PASS
5	One-Way Frame Loss Ratio Performance	PASS	PASS
6	Ingress Bandwidth Profile - CIR Enforcement	PASS	PASS
7	Ingress Bandwidth Profile - CBS Enforcement	PASS	PASS
8	Ingress Bandwidth Profile - EIR Enforcement Tagged Frames	PASS	PASS
9	Ingress Bandwidth Profile - EIR Enforcement Untagged Frames	PASS	-
10	Ingress Bandwidth Profile - EBS Enforcement Tagged Frames	PASS	PASS
11	Ingress Bandwidth Profile - EBS Enforcement Untagged Frames	PASS	-
12	Ingress BWP - CIR and EIR Enforcement Tagged Frames	PASS	PASS
13	Ingress BWP - CBS and EBS Enforcement Tagged Frames	PASS	PASS
14	Ingress BWP - Unconditional Delivery of Broadcast Frames and CoS ID per EVC & PCP	PASS	PASS
15	Ingress BWP - Unconditional Delivery of Multicast Frames and CoS ID per EVC & PCP	PASS	PASS

| 16 | Ingress BWP - Unconditional Delivery of Unicast Frames and CoS ID per EVC & PCP | PASS | PASS |
| 17 | Ingress BWP - Class of Service Discard and CoS ID per EVC & PCP | PASS | PASS |

- **E-LAN Services Test Report**: E-LAN services allow communication between multiple locations by connecting UNIs, enabling any site to communicate directly with any other site within the network. E-LAN is designed to simulate the functionality of a traditional Local Area Network (LAN) over a Metro Ethernet Network (MEN).

  E-LAN services come in two main variations depending on the degree of control delegated between the provider and your end user:

  - Ethernet Private LAN (EP-LAN) is a port-based multipoint-to-multipoint "all-to-one bundling" service providing a dedicated and private, transparent data path. All traffic on the physical port is mapped to a single EVC.
  - Ethernet Virtual Private LAN (EVP-LAN) is similar to EP-LAN however it supports service multiplexing and shared bandwidth across the network. EVP-LAN enables multiple EVCs on one or more UNIs, providing greater flexibility for delivering multiple multipoint-to-multipoint E-LAN services and/or in parallel with point-to-point E-Line EVCs over a single UNI.

The protocol suite of multipoint-to-multipoint E-LAN services includes EVPN-ELAN and BGP-VPLS. The profile implements five distinct E-LAN use cases to deliver different connectivity options.

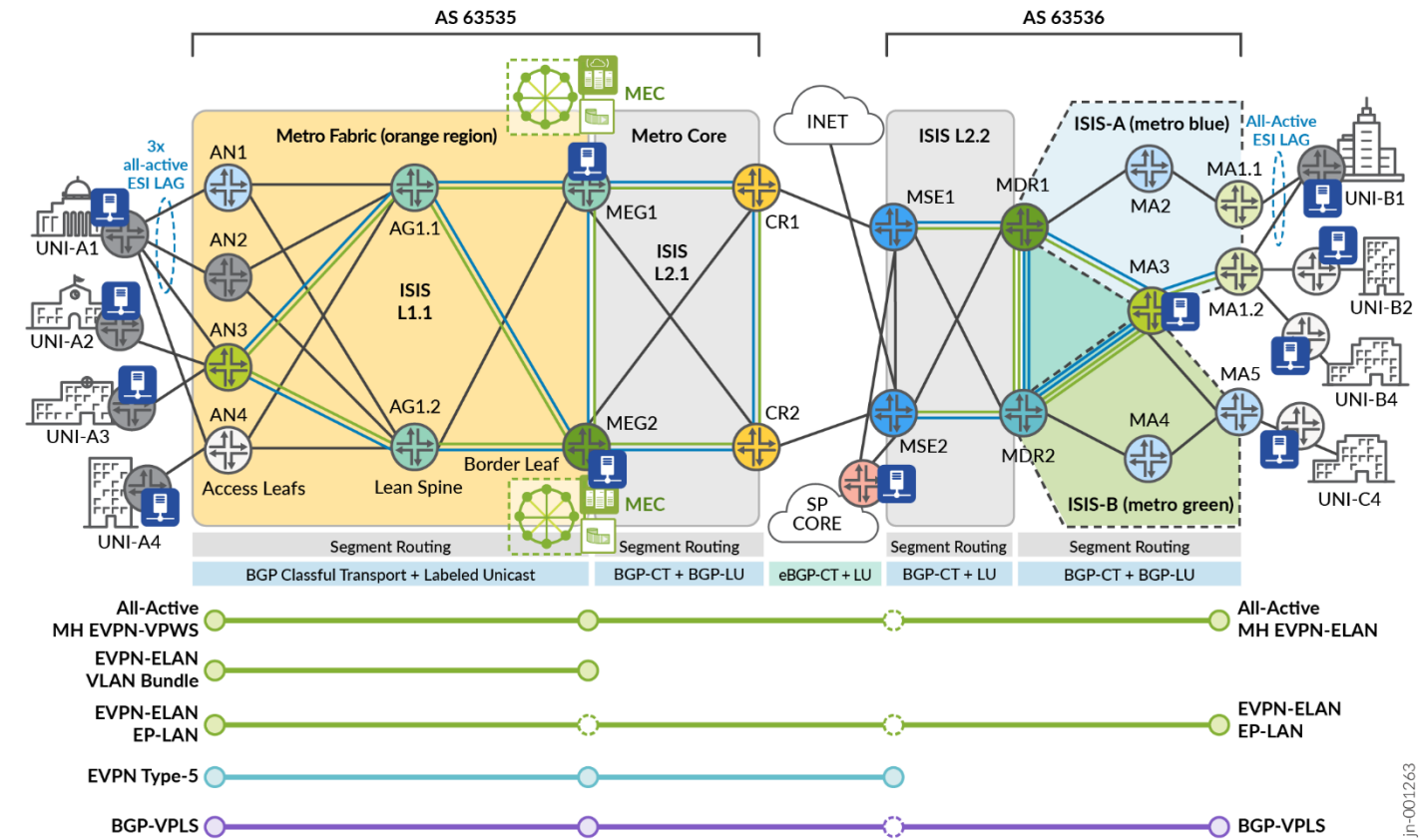The following E-LAN services are covered as part of this JVD.

Table 6: EVP-LAN Services

Index	Service Type	VPN Type	High Availability	Service Instantiation	Testcase count
1	E-LAN	EVPN-ELAN VLAN-based	Active-Active Multihoming	Inter-AS Fabric to Ring	1149
2	E-LAN	EVPN-ELAN VLAN Bundle	Active-Active Multihoming	Intra-AS Metro Fabric	478
3	E-LAN	EVPN-ELAN Type 5	Active-Active Multihoming	Inter-AS Fabric to MSE	1139
4	E-LAN	BGP-VPLS	Single-Homed	Inter-AS Fabric to Ring	1149

Table 7: EP-LAN Services:

Index	Service Type	VPN Type	High Availability	Service Instantiation	Testcase count
1	E-LAN	EVPN-ELAN Port Based	Active-Active Multihoming	Inter-AS Fabric to Ring	1266

Figure 4: E-LAN Multipoint-to-Multipoint Service Termination

MEF 3.0 Conformance Tests for E-LAN Services

The MEF 3.0 test plan defines a series of conformance test cases for the following Carrier Ethernet services:

● ELAN (EP-LAN and EVP-LAN)

The test plan comprises of two main categories. Part 1 covers MEF 3.0 Services Attributes, and Part 2 covers MEF 3.0 Traffic Management. The following two tables list all the MEF 3.0 Test Cases.

Table 8: MEF 3.0 Services Attributes

Test Cases Summary – Services Attributes		Test Results	
Test case	Test Case Name	EP LAN	EVP-LAN
1	Non-looping Frame Delivery	PASS	PASS
2	Single Copy Broadcast, Multicast, Unknown DA Service Frame Delivery in Multipoint EVC	PASS	PASS
3	L2CP Service Frames - Must Not Tunnel	PASS	PASS
4	Service Frame Transparency Tag Exception 1 (Tag to Tag)	PASS	-

5	Service Frame Transparency Tag Exception 2 (Untag to Untag)	PASS	-
6	Service Frame Transparency Tag Exception 3 (P-Tag to P-Tag)	PASS	PASS
7	CE-VLAN ID Preservation - Untag	PASS	-
8	CE-VLAN ID Preservation – Tag & P-Tag	PASS	PASS
9	CE-VLAN PCP Preservation – Tag & P-Tag	PASS	-
10	L2CP Service Frames - Must Tunnel	PASS	-
11	UNI Physical Layer, Mode and Speed	PASS	PASS
12	EVC Maximum Service Frame Size	PASS	PASS
13	CE-VLAN DEI Preservation Enabled	PASS	-
14	CE-VLAN ID/EVC Map Service Frame Discard	-	PASS
15	Maximum Number of CE_VLAN IDs per EVC EPs	PASS	-
16	Service OAM Continuity Check Message Transparency	PASS	PASS
17	Service OAM Multicast Loopback Message Transparency	PASS	PASS
18	Service OAM Unicast Loopback Message Transparency	PASS	PASS
19	Service OAM Loopback Response Transparency	PASS	PASS
20	Service OAM Linktrace Message Transparency	PASS	PASS
21	Service OAM Linktrace Response Transparency	PASS	PASS

Table 9: MEF 3.0 Traffic Management

Test Cases Summary – Traffic Management		Test Results	
Test case	Test Case Name	EP LAN	EVP-LAN
1	One-Way Frame Delay Performance	PASS	PASS
2	One-Way Mean Frame Delay Performance	PASS	PASS
3	One-Way Inter-Frame Delay Variation Performance	PASS	PASS
4	One-Way Frame Delay Range Performance	PASS	PASS
5	One-Way Frame Loss Ratio Performance	PASS	PASS
6	Ingress Bandwidth Profile - CIR Enforcement	PASS	PASS
7	Ingress Bandwidth Profile - CBS Enforcement	PASS	PASS
8	Ingress Bandwidth Profile - EIR Enforcement Tagged Frames	PASS	PASS
9	Ingress Bandwidth Profile - EIR Enforcement Untagged Frames	PASS	-
10	Ingress Bandwidth Profile - EBS Enforcement Tagged Frames	PASS	PASS
11	Ingress Bandwidth Profile - EBS Enforcement Untagged Frames	PASS	-
12	Ingress BWP - CIR and EIR Enforcement Tagged Frames	PASS	PASS
13	Ingress BWP - CBS and EBS Enforcement Tagged Frames	PASS	PASS
14	Ingress BWP - Unconditional Delivery of Broadcast Frames and CoS ID per EVC & PCP	PASS	PASS

15	Ingress BWP - Unconditional Delivery of Multicast Frames and CoS ID per EVC & PCP	PASS	PASS
16	Ingress BWP - Unconditional Delivery of Unicast Frames and CoS ID per EVC & PCP	PASS	PASS
17	Ingress BWP - Class of Service Discard and CoS ID per EVC & PCP	PASS	PASS

E-TREE Rooted-Multipoint Services Test Report

An Ethernet service with a rooted-multipoint EVC attribute is classified as an E-Tree service type. E-Tree enables controlled communication between a central site (root) and multiple branch sites (leaves) while preventing communication between branches.

The E-Tree service model ensures clear hierarchical communication, suitable for scenarios requiring a single point of control with isolated downstream branches. In the following scenario, EVC supports multiple leaf EVCs. Service frames are exchanged between the Root EVC and any Leaf EVCs. You cannot exchange service frames between any Leaf-to-Leaf UNI EVCs. The behavior is consistent for all traffic types (Unicast, Multicast, Broadcast).

The following topology shows multiple root EVCs. In this scenario, leaf-to-leaf communication is still forbidden to only leaf-to-root or leaf-to-multiple roots. However, root-to-root communications are allowed, providing additional reliability and high availability. The Metro EBS JVD includes dual root nodes in active-active high availability modes.

The Iometrix MEF 3.0 validation covers the critical functionality required to deliver E-Tree services and provide robust, flexible, and scalable solutions for organizations that require reliable rooted-multipoint Ethernet connectivity. Leveraging the Metro EBS JVD solution architecture enables the ability to scale from best-effort services to high-performance, guaranteed service delivery with strict performance objectives.
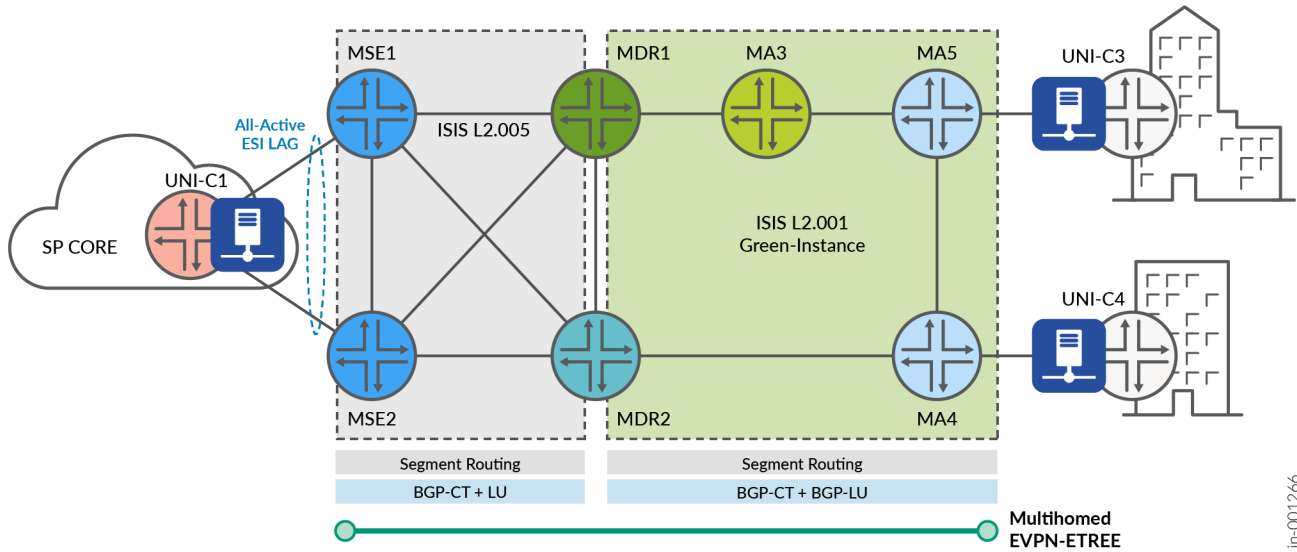
The protocol suite of rooted-multipoint E-Tree services include EVPN-ETREE with single or dual root nodes. It supports EP-Tree however is included in the validation.

The following tables list the services covered as part of this JVD.

Table 10: E-TREE Service

Index	Service Type	VPN Type	High Availability	Service Instantiation	Testcase count
1	E-Tree	EVPN-ETREE	Active-Active Multihoming Root	Intra-AS Metro Ring	1129

Figure 5 : E-TREE Rooted-Multipoint Service Termination

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MEF 3.0 Conformance Tests for E-TREE Services

The MEF 3.0 test plan defines a series of conformance test cases for the following Carrier Ethernet services:

E-TREE

The test plan is composed of two main categories. Part 1 covers MEF 3.0 Services Attributes, and Part 2 covers MEF 3.0 Traffic Management. The following two tables list all the MEF 3.0 Test Cases.

Table 11: MEF 3.0 Services Attributes

Test Cases Summary – Service Attributes		
Test case	**Test Case Name**	**EVP-TREE**
1	Non-looping Frame Delivery	PASS
2	EVC Leakage	-
3	Single Copy Broadcast, Multicast, Unknown DA Service Frame Delivery in Multipoint EVC	PASS
4	Service Frame with Invalid FCS - Discard	-
5	L2CP Service Frames - Must Not Tunnel	PASS
6	Service Frame Conditional Delivery	-
7	Service Frame Transparency Tag Exception 1 (Untag –Tag)	-
8	Service Frame Transparency Tag Exception 2 (Tag – Untag) (P-Tag – Untag)	-
9	Service Frame Transparency Tag Exception 3 (Tag1 – Tag2) (P-Tag-Tag)	PASS
10	CE-VLAN ID Preservation – Tag & P-Tag	PASS

11	CE-VLAN CoS Preservation – Tag & P-Tag	-
12	UNI Physical Layer, Mode and Speed	PASS
13	UNI MAC Layer - Minimum Frame Size and MTU Size	-
14	Service Multiplexing of Point-to-Point EVCs	-
15	Service Multiplexing of Multipoint EVCs	-
16	Service Multiplexing of Point-to-Point and Multipoint EVCs	-
17	CE-VLAN ID for untagged and priority tagged Service Frames	-
18	CE-VLAN ID/EVC Map Service Frame Discard	PASS
19	Maximum Number of EVCs per UNI - Must be Greater than or Equal to 1	-
20	EVC Maximum Service Frame Size - Tagged	PASS
21	Single Copy Broadcast, Multicast, Unknown DA Service Frame Delivery in Multipoint EVC	PASS
22	Service OAM Continuity Check Message Transparency	PASS
23	Service OAM Multicast Loopback Message Transparency	PASS
24	Service OAM Unicast Loopback Message Transparency	PASS
25	Service OAM Loopback Response Transparency	PASS
26	Service OAM Linktrace Message Transparency	PASS
27	Service OAM Linktrace Response Transparency	PASS

Table 12: MEF 3.0 Traffic Management

Test Cases Summary – Traffic Management		
Test case	Test Case Name	EVP-TREE
1	One-Way Frame Delay Performance	PASS
2	One-Way Mean Frame Delay Performance	PASS
3	One-Way Inter-Frame Delay Variation Performance	PASS
4	One-Way Frame Delay Range Performance	PASS
5	One-Way Frame Loss Ratio Performance	PASS
6	Ingress Bandwidth Profile - CIR Enforcement	PASS
7	Ingress Bandwidth Profile - CBS Enforcement	PASS
8	Ingress Bandwidth Profile - EIR Enforcement Tagged Frames	PASS
9	Ingress Bandwidth Profile - EBS Enforcement Tagged Frames	PASS
11	Ingress BWP - CIR and EIR Enforcement Tagged Frames	PASS
12	Ingress BWP - CBS and EBS Enforcement Tagged Frames	PASS
13	Ingress BWP - Unconditional Delivery of Broadcast Frames and CoS ID per EVC & PCP	PASS
14	Ingress BWP - Unconditional Delivery of Multicast Frames and CoS ID per EVC & PCP	PASS

15	Ingress BWP - Unconditional Delivery of Unicast Frames and CoS ID per EVC & PCP	PASS
16	Ingress BWP - Class of Service Discard and CoS ID per EVC & PCP	PASS

ACCESS E-LINE Services Test Report

Access E-Line is defined by MEF 51 technical specification as a wholesale Ethernet access service based on the usage of Operator Virtual Connections (OVCs) to associate External Network-to-Network Interface (ENNI) endpoint(s) to UNI endpoint(s). The OVC enables an operator to provide Ethernet connectivity between a Customer Edge (CE) at the UNI and another service provider at the External ENNI. This model allows Ethernet services to transport across multiple operators' networks while ensuring service consistency and quality.

The Access E-Line service formed by the point-to-point OVC is called O-Line, which may interconnect a UNI to an ENNI or between two ENNIs. Multiple O-Line services may be stitched together across provider domains or multi-operator networks.

Multiple combinations and service attributes of Access E-Line are supported beyond the scope of what is included in the JVD, such as Access E-LAN, Access E-Tree, and Access E-Transit permutations. O-Line services are point-to-point in nature and may be chained to connect disparate UNIs across multiple O-Line connections. OVC pairs forming O-Line services may consist of the following connectivity types:

- Connecting two External or Internal NNIs (ENNI or INNI)
- Connecting OVC endpoints (ENNI or INNI) within the same device (aka hair-pinning)
- Connecting ENNI or INNI to a UNI

Two options featured in the JVD to facilitate Access E-Line include leveraging local-switched services: L2CCC with L2Circuit local-switching and EVPN-VPWS local-switching.
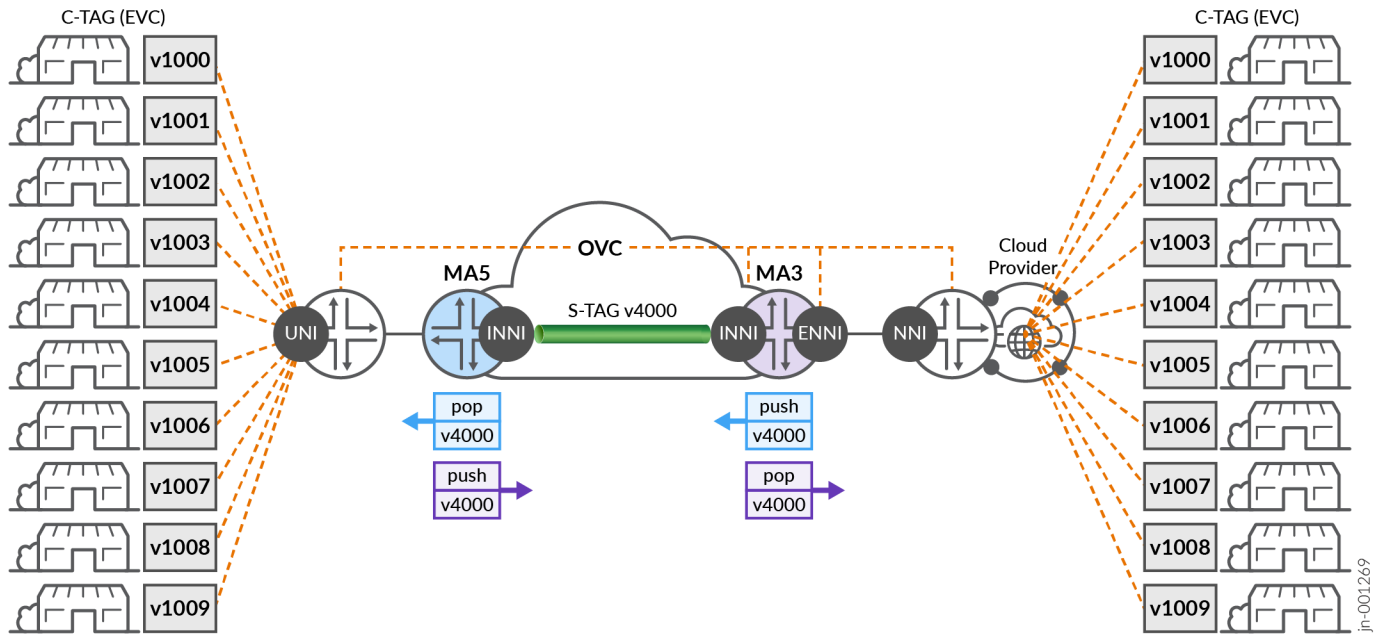
EVCs are service multiplexed, which may support multitenant use cases. At the transit point of MA5 (MX204), an S-TAG is mapped to the OVC endpoint toward MA3 (ACX7100-48L) to support INNI-to-INNI connectivity within the same Carrier Ethernet network. Traffic is exchanged across the interdomain segment using S-TAG information. C-TAGs and COS markings are preserved. The S-TAG may be removed at the ENNI OVC to expose the original C-TAG infrastructure to the cloud provider. The interworkings of how the O-Line services are achieved are flexible and dependent on the use case requirements. Extending or swapping S-TAG at the ENNI-to-NNI exchange may be preferred to continue transporting CE-VLANs transparently.

The following are the Access-ELINE services details covered as part of this JVD.

Table 13: Access E-Line Services

Index	Service Type	VPN Type	High Availability	Service Instantiation	Testcase count
1	Access E-Line	EVPN-VPWS Local-Switching	Single-Homed	Metro Ring	396
2	Access E-Line	Layer 2 Circuit (L2CCC) Local-Switching	Single-Homed	Metro-Ring	396

Figure 6: Access E-Line OVC Service Termination

MEF 3.0 Conformance Tests for Access E-Line Services

The MEF 3.0 test plan defines a series of conformance test cases for the following Carrier Ethernet services:

- Access E-Line

The test plan is composed of two main categories. Part 1 covers MEF 3.0 Services Attributes, and Part 2 covers MEF 3.0 Traffic Management. The following two tables list all the MEF 3.0 test cases.

Table 14: MEF 3.0 Services Attributes

Test Cases Summary – Service Attributes		Access E-Line	
		Access EVPL	
Test case	Test Case Name	UNI to ENNI	ENNI to UNI
1	Maximum Number of CE-VLAN IDs per OVC	PASS	PASS
2	OVC Maximum Frame Size	PASS	PASS
3	OVC CE-VLAN ID Preservation	PASS	PASS
4	CE-VLAN PCP Value Preservation	PASS	PASS
5	L2CP Service Frames - Must Not Tunnel	PASS	PASS
6	UNI/ENNI Physical Layer, Mode and Speed	PASS	PASS
7	OVC End Point Map - ENNI Frame Discard	-	PASS

8	Service OAM Continuity Check Message Transparency	PASS	PASS
9	Service OAM Multicast Loopback Message Transparency	PASS	PASS
10	Service OAM Unicast Loopback Message Transparency	PASS	PASS
11	Service OAM Loopback Response Transparency	PASS	PASS
12	Service OAM Linktrace Message Transparency	PASS	PASS
13	Service OAM Linktrace Response Transparency	PASS	PASS

Table 15: MEF 3.0 Traffic Management

Test Cases Summary – Traffic Management		Access E-Line	
Test case	Test Case Name	UNI to ENNI Access EVPL	ENNI to UNI Access EVPL
1	One-Way Frame Delay Performance	PASS	PASS
2	One-Way Mean Frame Delay Performance	PASS	PASS
3	One-Way Inter-Frame Delay Variation Performance	PASS	PASS
4	One-Way Frame Delay Range Performance	PASS	PASS
5	One-Way Frame Loss Ratio Performance	PASS	PASS
6	Ingress Bandwidth Profile - CIR Enforcement	PASS	PASS
7	Ingress Bandwidth Profile - Color Awareness Verification Tagged Frame when [CIR/CBS>0 and EIR/EBS=0]	-	PASS
8	Ingress Bandwidth Profile - CBS Enforcement	PASS	PASS
9	Ingress Bandwidth Profile - EIR Enforcement Tagged Frames	PASS	PASS
10	Ingress Bandwidth Profile - Color Awareness Verification Tagged Frames when [CIR/CBS=0 and EIR/EBS>0]	-	PASS
11	Ingress Bandwidth Profile - EBS Enforcement Tagged Frames	PASS	PASS
12	Color Awareness Verification Tagged Frames when [CIR/CBS>0, EIR/EBS>0	-	PASS
13	Ingress BWP - CIR and EIR Enforcement Tagged Frames	PASS	PASS
14	Ingress BWP - CBS and EBS Enforcement Tagged Frames	PASS	PASS
15	Ingress BWP - Unconditional Delivery of Broadcast Frames and CoS ID per EVC & PCP	PASS	PASS
16	Ingress BWP - Unconditional Delivery of Multicast Frames and CoS ID per EVC & PCP	PASS	PASS
17	Ingress BWP - Unconditional Delivery of Unicast Frames and CoS ID per EVC & PCP	PASS	PASS
18	Ingress BWP - Class of Service Discard and CoS ID per EVC & PCP	PASS	PASS

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