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1. Find this session in the Cisco Events Mobile App
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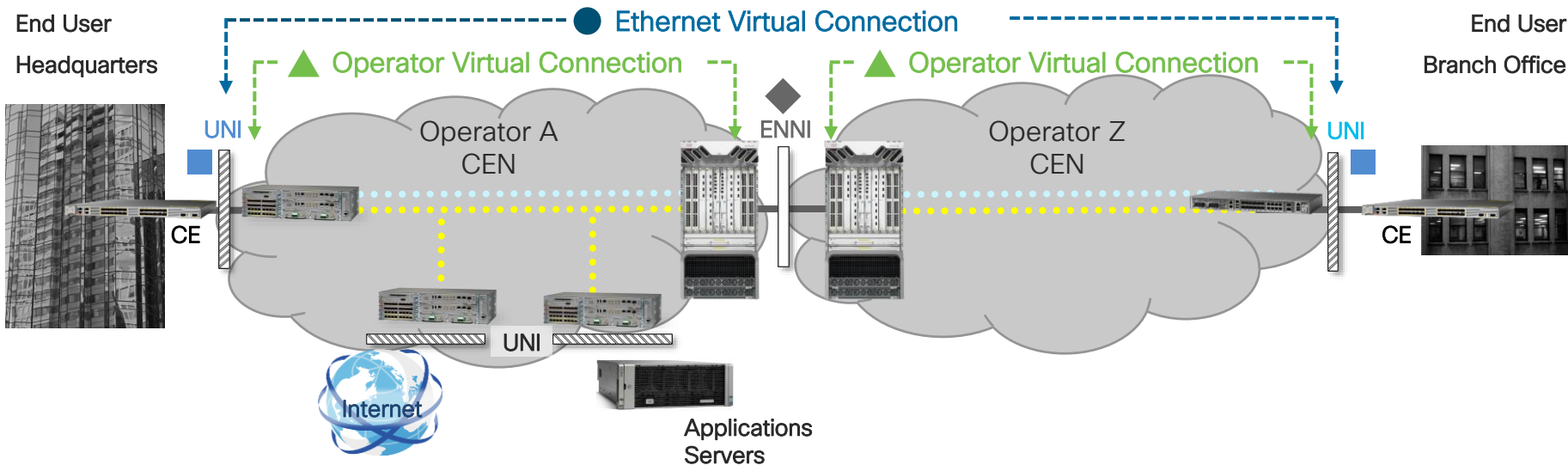4. Enter messages/questions in the team space

Agenda

- Recap of MEF Forum Carrier Ethernet Services

- MEF 3.0 Overview

- MEF L1 and L3 Services

- MEF LSO Reference Architecture and APIs

- Other MEF Work areas

- MEF LSO Implementation example

MEF Forum Carrier Ethernet Services Terminology

End User Headquarters

End User Branch Office

Ethernet Virtual Connection

Operator Virtual Connection

Operator Virtual Connection

UNI

UNI

CE

CE

ENNI

Operator A CEN

Operator Z CEN

UNI

Internet

Applications Servers

■ **UNI:** User Network Interface: demarcation point between Service Provider and Subscriber.
● **EVC:** Ethernet Virtual Connection: logical association of 2 or more UNIs.
▲ **OVC:** Operator Virtual Connection: logical connection between UNI and ENNI.
◆ **ENNI:** External Network to Network Interface: demarcation point between Service Providers.

Source: BRKSPG-2720 (2014)

MEF Carrier Ethernet Service Types

Service Type	MEF Service	Service Types	
		Port-based	VLAN Based
Point-to-point	E-Line	EPL	EVPL
	E-Access	Access EPL	Access EVPL
Multipoint	E-LAN	EP-LAN	EVP-LAN
Rooted Multipoint	E-Tree	EP-Tree	EVP-Tree

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MEF Carrier Ethernet Service Attributes

UNI Attributes

UNI ID	Arbitrary String			
Speed	10Mb	100Mb	1Gb	10Gb
Mode	Full	Auto		
MAC Layer	802.3			
Service Multiplexing	Yes	No		
Bundling	Yes	No		
All to One Bundling	Yes	No		
In/Egress BW Profile Per UNI	No	CIR, CBS EIR, EBS		
In/Egress BW Profile Per EVC	No	CIR, CBS EIR, EBS		
In/Egress BW Profile Per Class of Svc ID	No	CIR, CBS EIR, EBS		
CE-VLAN ID/EVC Map	{CE-VLAN ID → EVC(i)}i			

EVC Attributes

EVC Type	PTP (E-Line)	MP (E-LAN)	Rooted MP (E Tree)
EVC ID	Arbitrary String		
CE-VLAN ID Preservation	Yes	No	
CE-VLAN COS Preservation	Yes	No	
Unicast Frame Delivery	Conditional	Un-conditional	Discard
MCAST Frame Delivery	Conditional	Un-conditional	Discard
BCAST Frame Delivery	Conditional	Un-conditional	Discard
Class of Service ID	EVC		
	EVC, L2 CoS		
	EVC, L3 DSCP		
EVC Performance	Delay, Delay-Variation, Loss, …		

L2 Control Processing

	Peer	Discard	Pass
802.3x	☑	☑	☑
LACP	☐	☐	☐
802.1x	☐	☐	☐
GARP	☐	☐	☐
STP	☐	☐	☐
Bridge MCAST	☐	☐	☐
CDP	☐	☐	☐
VTP	☐	☐	☐
PAgP	☐	☐	☐
UDLD	☐	☐	☐

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MEF CE 2.0 Services Features

Multiple Classes of Service

- 3 Classes of Services: H, M, L.

- Adds Egress Bandwidth Profile.

- Performance objectives defined for SLS (Service Level Specification).

- Designed to support 20+ application types.

Manageability

- Service OAM functions for service management and reliability.

- Enhanced traffic management features to optimize bandwidth resources (Bandwidth Profiles).

Interconnectivity

- New E-Access service.

- Standardizes ENNI interconnects between carriers.

- Allows service providers to extend CE 2.0 services to off-net locations via an access provider.

Fast forward to 2020...

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… applying similar concepts to new services

…and a new framework to everything

MEF 3.0 at a glance

- Beyond L2 services

- Updated specifications for Carrier Ethernet

- LSO – Lifecycle Services Orchestration

- Data/info models and APIs

- Reference implementations, focused on developers and open source

- New certifications

MEF 3.0 program framework

Orchestrated Services

- L1 to L3 and beyond
- Underlay Services
- Overlay Services

New Certifications

- Cloud-based test platform
- Virtualized test probes
- Agile model
- Services & LSO APIs
- Subscription-based

Services	LSO APIs
Certification	Community

LSO APIs

- Orchestration across service providers and operators
- Orchestration over multiple network technology domains
- SDKs, implementation projects and specifications

Community

- MEF developer community implementation projects
- Liaisons with Open source projects & SDOs
- Enterprise advisory council
- Proof of Concepts

MEF 3.0 Overlay and Underlay Services
Orchestrated by MEF LSO APIs

MEF 3.0

Overlay Services
Application Centric, Policy-Driven, Assured

Cloud

SD-WAN Service

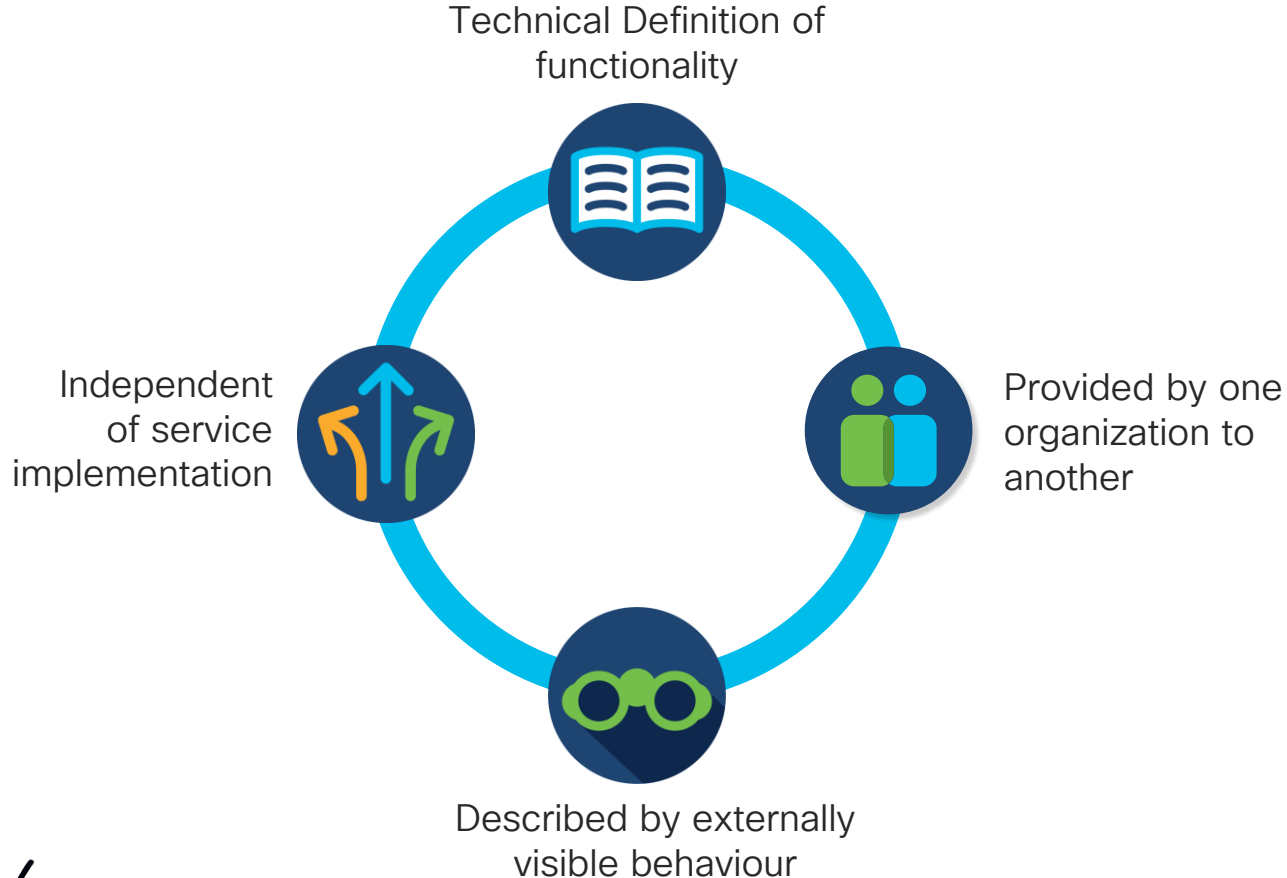Certified

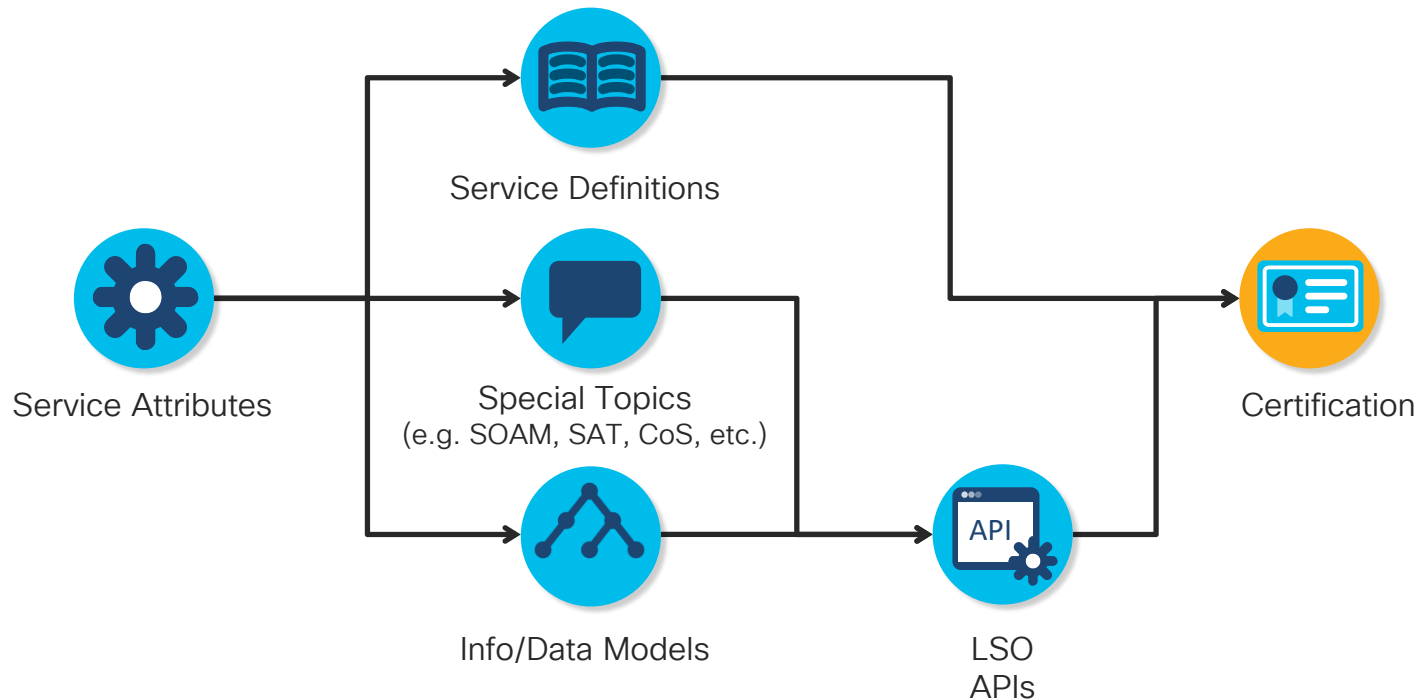Carrier Ethernet · IP Services · Optical Transport

Orchestrated
MEF LSO
LIFECYCLE SERVICE ORCHESTRATION

MEF 3.0

Underlay Connectivity Services
Assured, Dynamic, High-Speed

What is a MEF 3.0 Service?

Technical Definition of functionality

Independent of service implementation

Provided by one organization to another

Described by externally visible behaviour

Describing MEF 3.0 Services

Service Attributes

Service Definitions

Special Topics
(e.g. SOAM, SAT, CoS, etc.)

Info/Data Models

LSO
APIs

Certification

MEF Subscriber and Operator Services

Service Provider

London

Barcelona

Milan
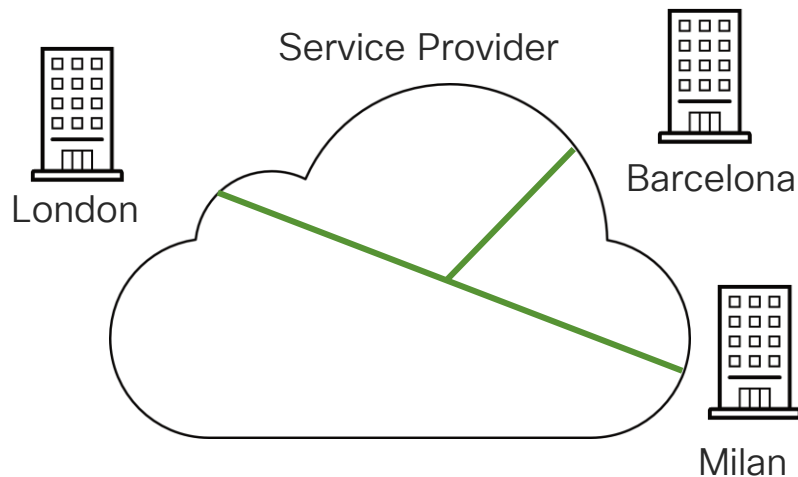
Subscriber Services
(Provided to end users)

Service Provider

London

Barcelona

Operator

Milan
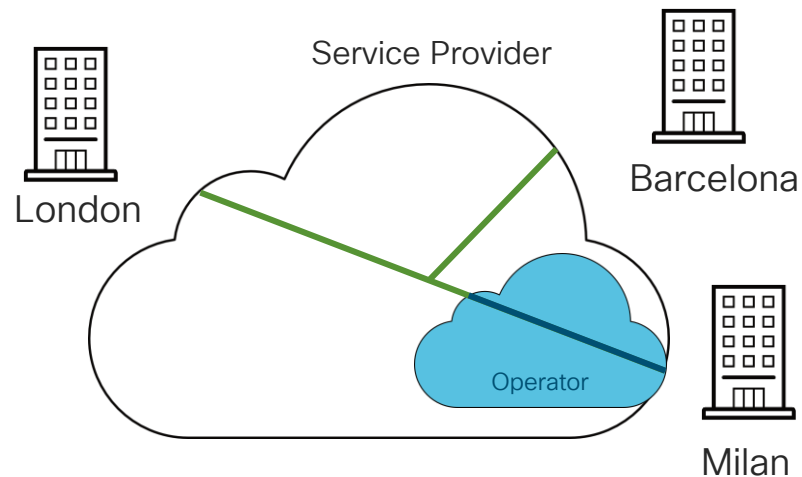
Operator Service
(Between Providers/Operators)

MEF 3.0 services

Goal: provide an on-demand, cloud-centric experience with unprecedented user or application-directed control over network resources and service capabilities over single or multi-provider scenarios

Ex.: SD-WAN Service

portal → subscriber intent → Business Apps + Service Orchestration

service realization

Internet

MPLS VPN
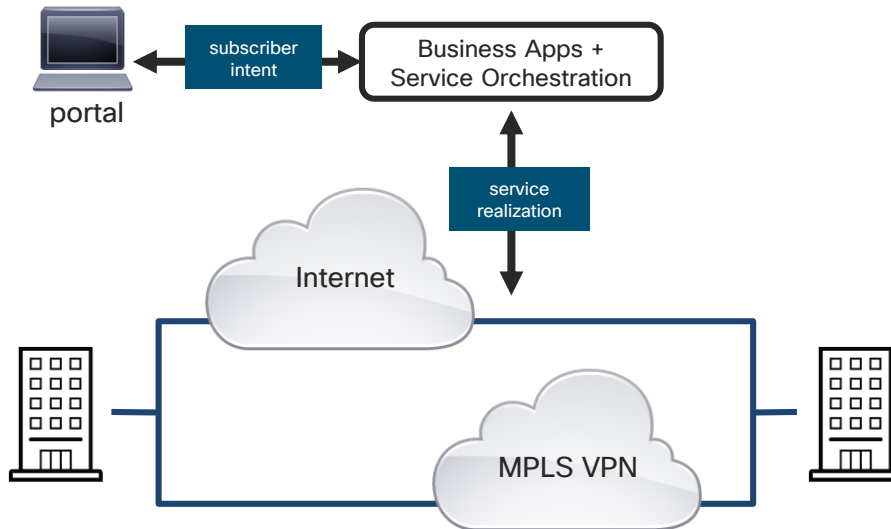
MEF 3.0 Services:

- Enhanced traditional L2 services and created data Models (UML, YANG)

- New services:
  - SD-WAN
  - L3: IP Service Attributes
  - L2: E-Transit
  - L1: SONET/SDN, FC, others
- Future Services:
  - Security-as-a-Service
  - Application Services

MEF 3.0 Carrier Ethernet Services

MEF 3.0 Carrier Ethernet Standards
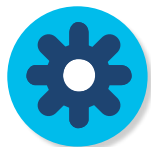
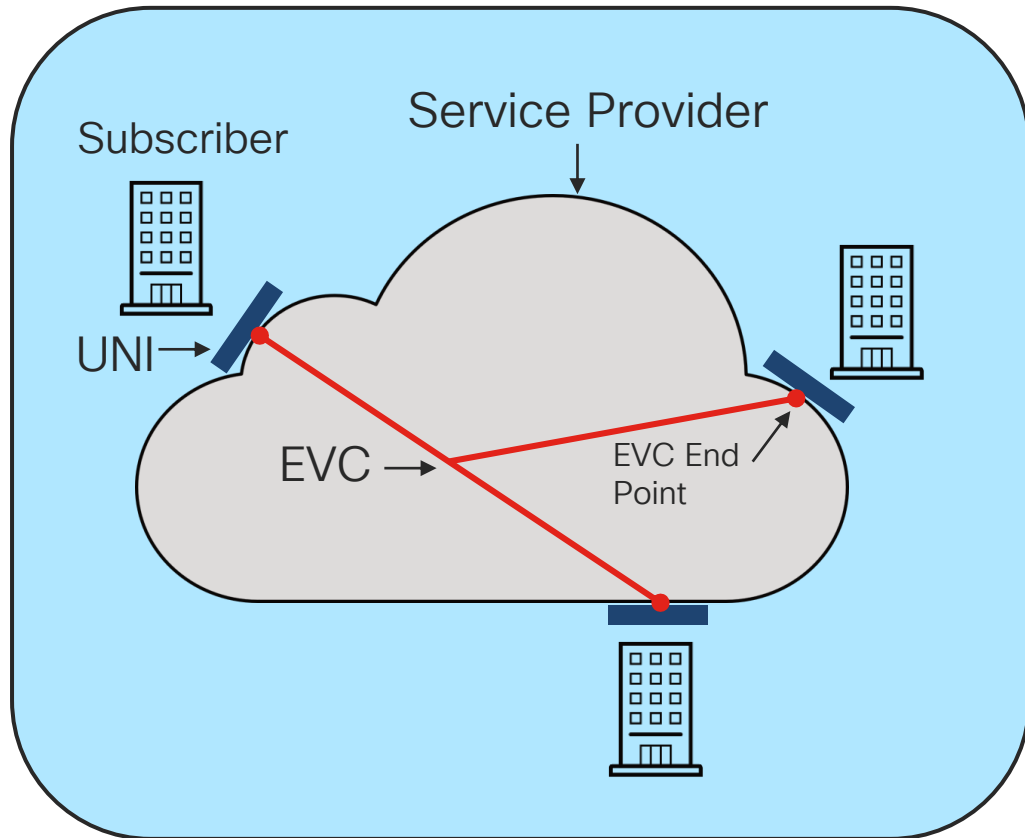|	Service Attributes	Service Definitions
Subscriber Services	MEF 10.4	MEF 6.3 MEF 22.3 (Mobile)
Operator Services	MEF 26.2	MEF 51.1 MEF 62 MEF 65
Special Topics	SOAM MEF 30.1 MEF 35.1 — L2CP MEF 45.1	CoS/BWPs MEF 23.2(.1) — SAT MEF 48.1

MEF Subscriber Ethernet Service Attributes

MEF Specification: MEF 10.4

- Main Concepts:
  - Service Provider, Subscriber
  - UNI, EVC, EVC End Point
- Main Service Attributes
  - End Point VLAN Map
  - Class of Service Map
  - Service Level Specification
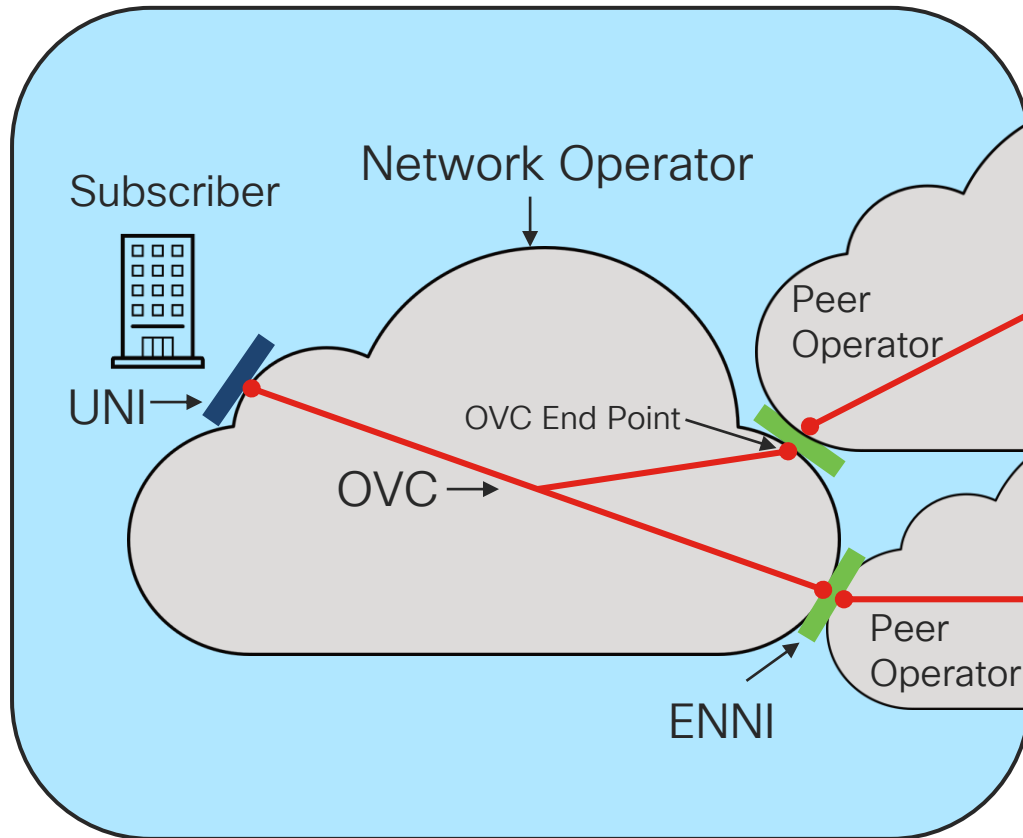 - Bandwidth Profiles
  - PCP/DEI Preservation

MEF Subscriber Ethernet Service <u>Definitions</u>
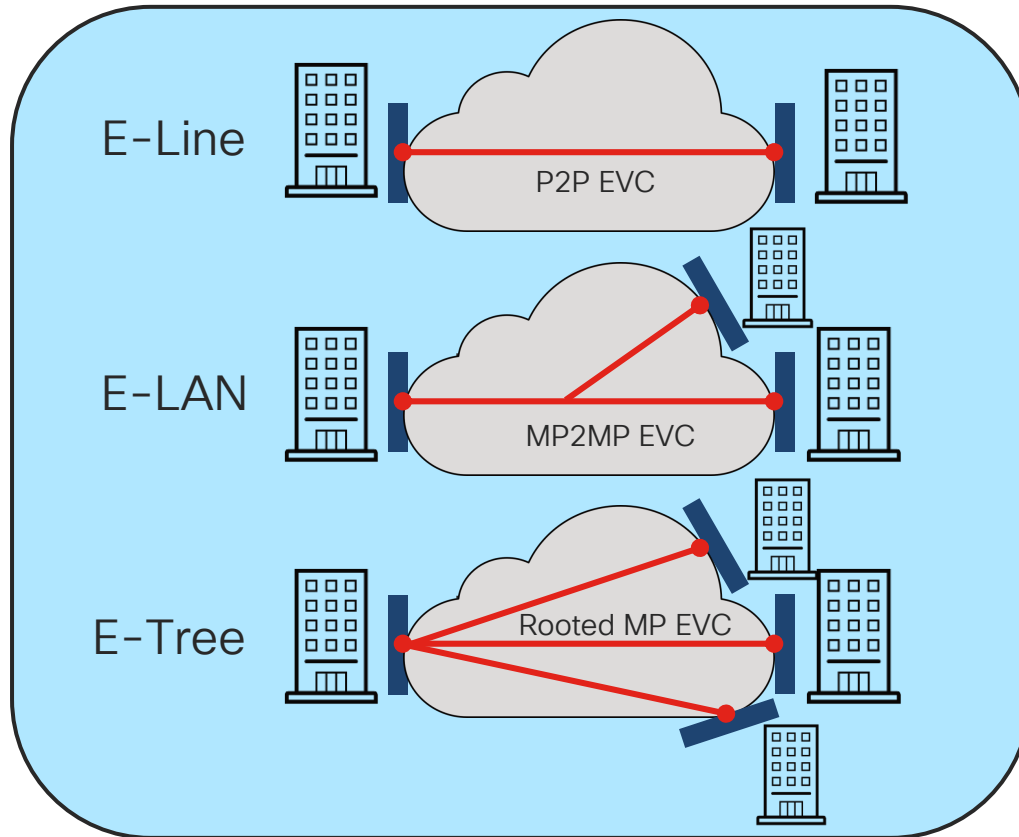
MEF Specification: MEF 6.3

- Three Subscriber Service Types:
  - E-Line – point-to-point
  - E-LAN – multipoint
  - E-Tree – rooted multipoint
- "Port"-based or "VLAN"-based Types:
  - E-Line : EPL and EVPL
  - E-LAN : EP-LAN and EVP-LAN
 - E-Tree : EP-Tree and EVP-Tree

MEF Operator Ethernet Service <u>Attributes</u>

MEF Specification: MEF 26.2

- Key New Concepts:
  - Operator, Super-Operator
  - ENNI, OVC, OVC End Point
  - VUNI, Feeder OVC
- Service Attributes as for Subscribers, plus:
  - OVC EP VLAN Map
  - OVC EP Egress CoS Map
  - Available MEG Level
  - ENNI S-VLAN ID Control
 - ENNI Common and Multilateral Attributes

MEF Operator Ethernet Service <u>Definitions</u>
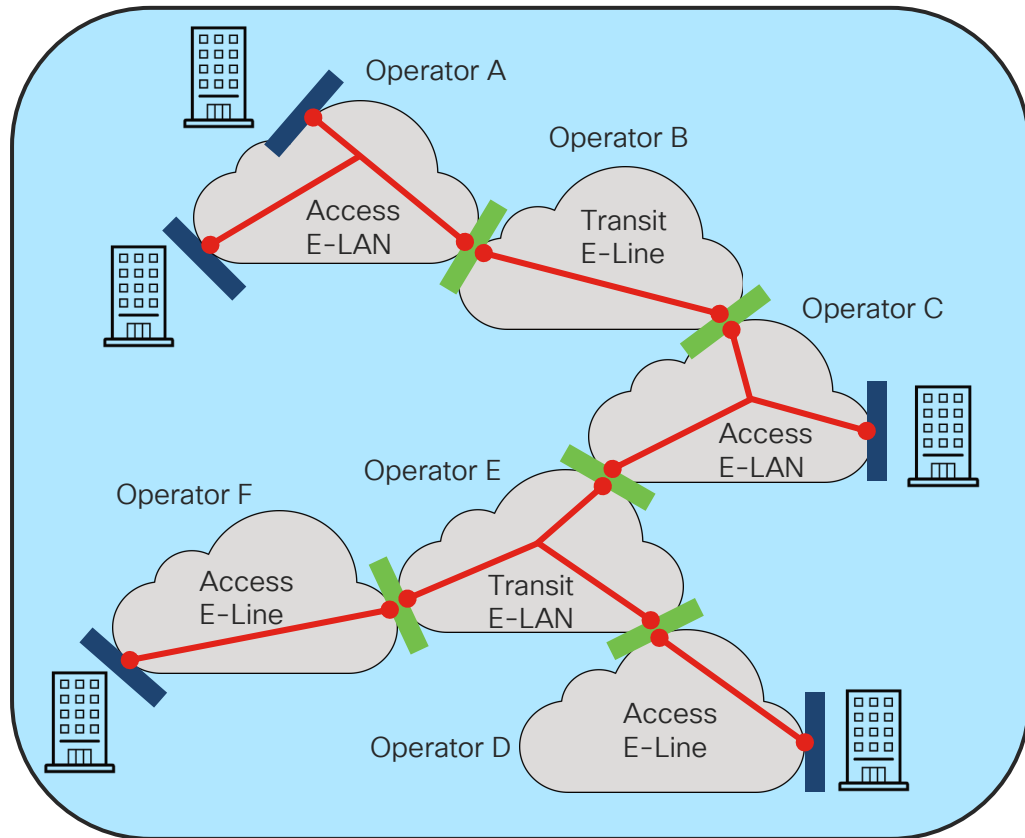
MEF Specification: MEF 51.1

- Three Operator Services:
  - O-Line (P2P)
  - O-LAN (MP)
  - O-Tree (Rooted MP)
- Four Specific Services
  - Access E-Line (P2P, ENNI+UNI)
  - Access E-LAN (MP, ENNI+UNI)
  - Transit E-Line (P2P, ENNI only)
  - Transit E-LAN (MP, ENNI only)

Managed Access E-Line (MAEL)

Service Provider

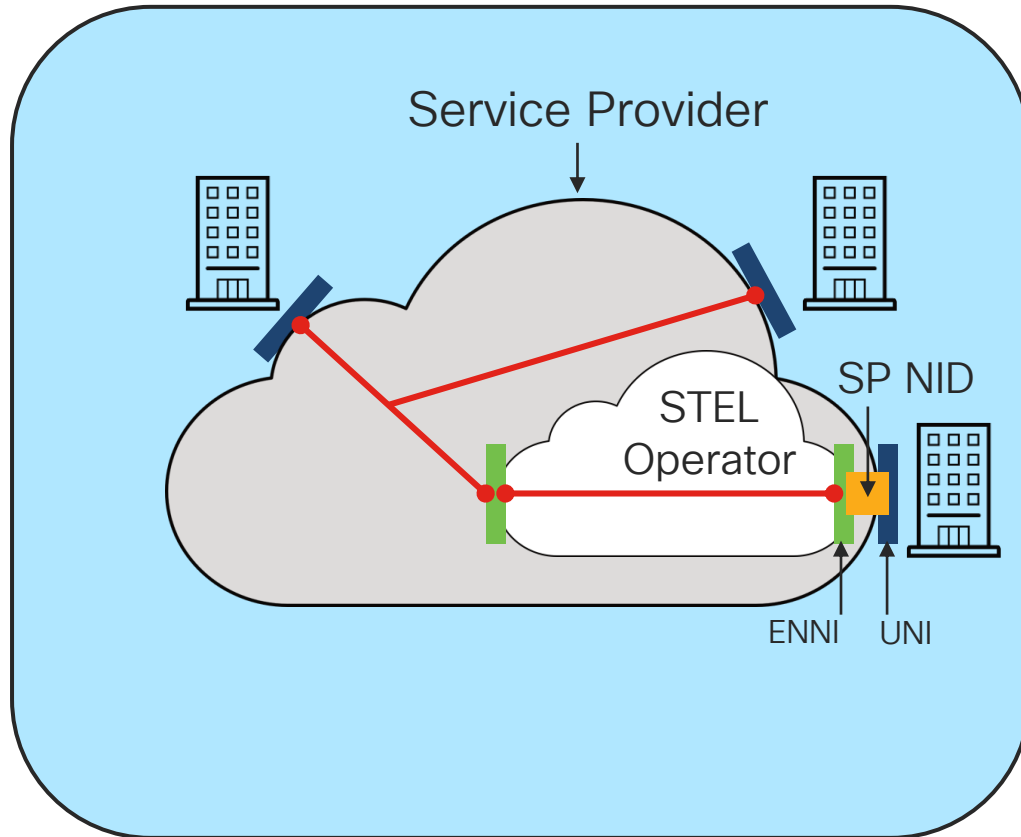MAEL Operator

No need for SP NID
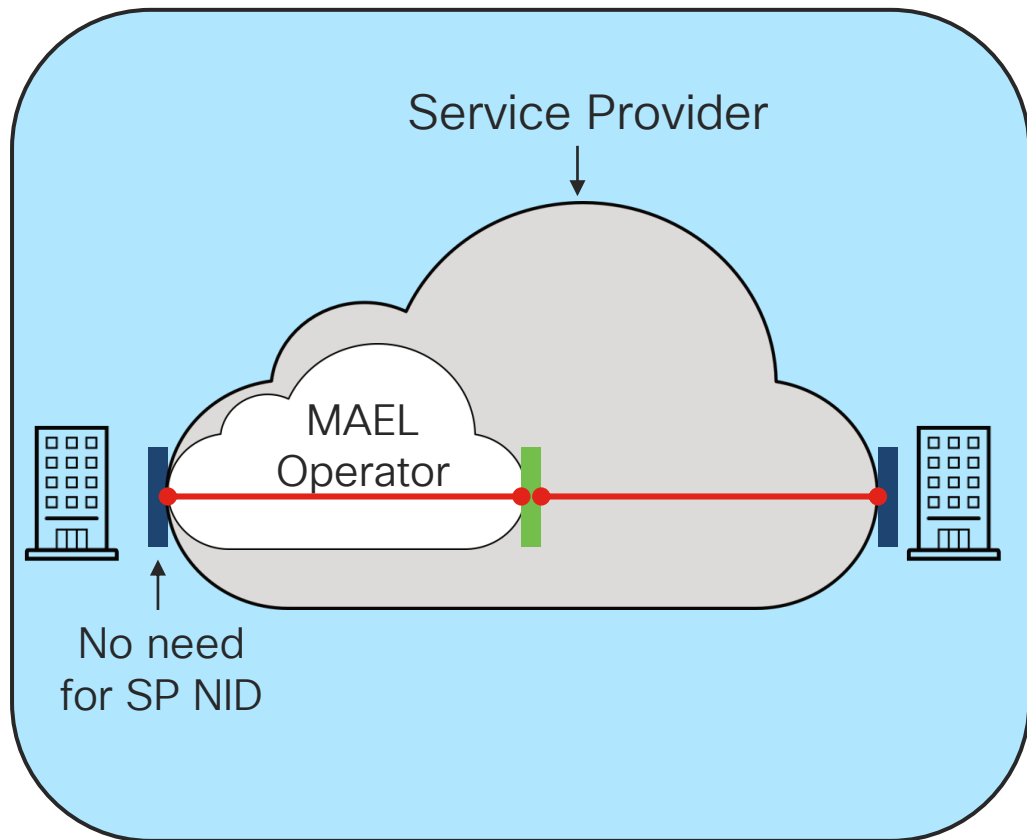
MEF Specification: MEF 62

- Special Case of Access E-Line
  - Avoid need for SP to deploy NID at Subscriber Premises
- Standard CoS and OAM capabilities
  - Single Class of Service for all traffic
 - Specific requirements for SOAM FM, SOAM PM, and Latching Loopback

MEF Simplified Transit E-Line (STEL)

MEF Specification: MEF 65

- Special Case of MEF 51.1 Transit E-Line Service

  - Inverse of MAEL (MEF 62)

  - Constrains selected ENNI/OVC attributes to simplify ordering and provisioning

  - Enables a SP to connect their CEN to a SP NID at the Subscriber premises

  - Supports a single CoS Name and multiple UNIs/Subscribers on the SP NID

Ethernet Layer 2 Control Protocols
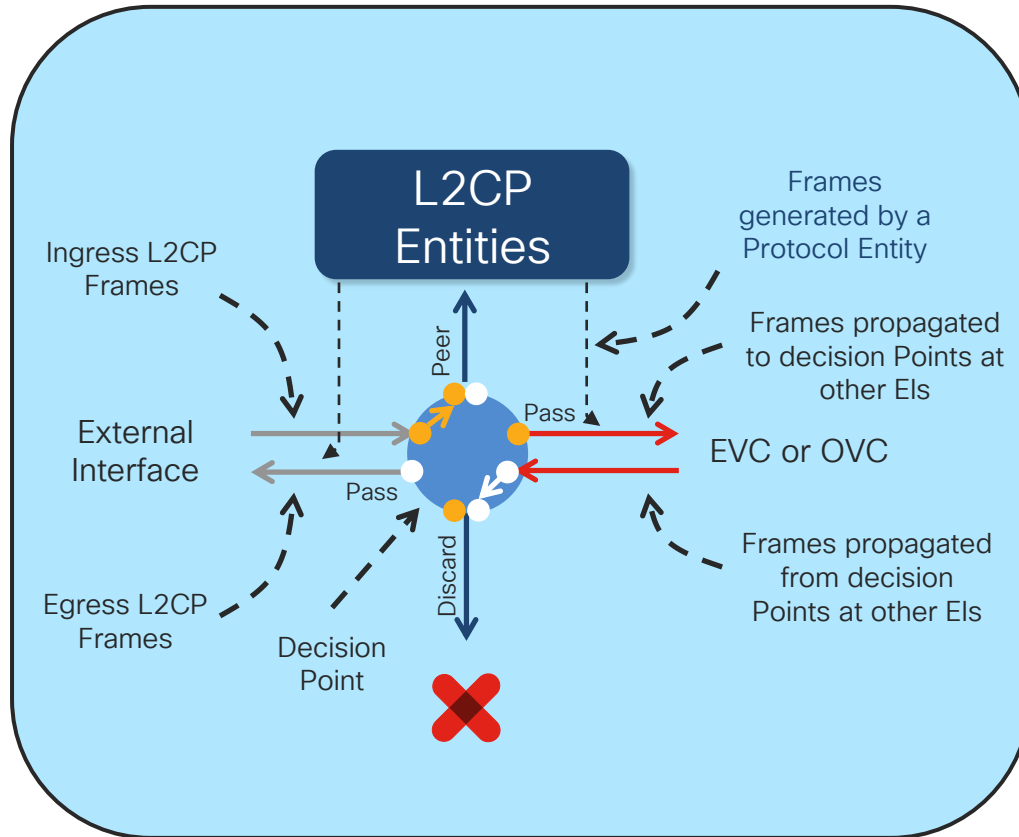
MEF Specification: MEF 45.1

- Comprehensive coverage of L2CP service behaviour

  - Service Attributes

  - L2CP Processing Requirements

  - Application to specific services

    - E-Line, E-LAN, E-Tree
    - Access E-Line/E-LAN
    - Transit E-Line/E-LAN

Additional MEF 3.0 enhancements for CE services

- CE services are orchestration ready

- Adds token sharing bandwidth profile models

- L2CP fully augmented for wholesale services

- Link aggregation is strengthened to support 'all-active' links

- Adds Virtual Instantiation of UNI for use with VMs

- Simplification of quantity and complexity of service attributes

- Service OAM is Enhanced for OVC management

- Performance objectives are upgraded for mp2mp services and add performance tiers for data centers

Summary: MEF 3.0 Carrier Ethernet services (L2)

	CE 2.0	MEF 3.0 CE	
Retail Services			
E-Line	✅	✅	Covered by MEF 6.3
E-LAN	✅	✅	Covered by MEF 6.3
E-Tree	✅	✅	Covered by MEF 6.3
Wholesale Services			
E-Access	✅	❌	Access E-Line superseeded CE 2.0 E-Access
Access E-Line, E-LAN	❌	✅	Covered by MEF 51.1
Transit E-Line, E-LAN	❌	✅	Covered by MEF 51.1
Managed Access E-Line	❌	✅	Covered by MEF 62

MEF 3.0
L1 Services

Subscriber Layer 1 Service Attributes

- What it is:
  - Standardized definition for L1 subscriber and operator services and services attributes
  - Services are defined using abstractions, similar to MEF L2 services, i.e. it does not mandate any implementation
  - Addresses Ethernet and non-Ethernet end services

- What it is not:
  - A new L1 protocol or technology

- End goal:
  - Address broader L1 service requirements (e.g. beyond Ethernet)
  - Simplify, drive consistency, certification, pave the road to LSO – e.g. orchestrated L1 services

- Covered by MEF 63 specification

MEF Subscriber L1 Service Attributes

Subscriber

Service Provider

UNI
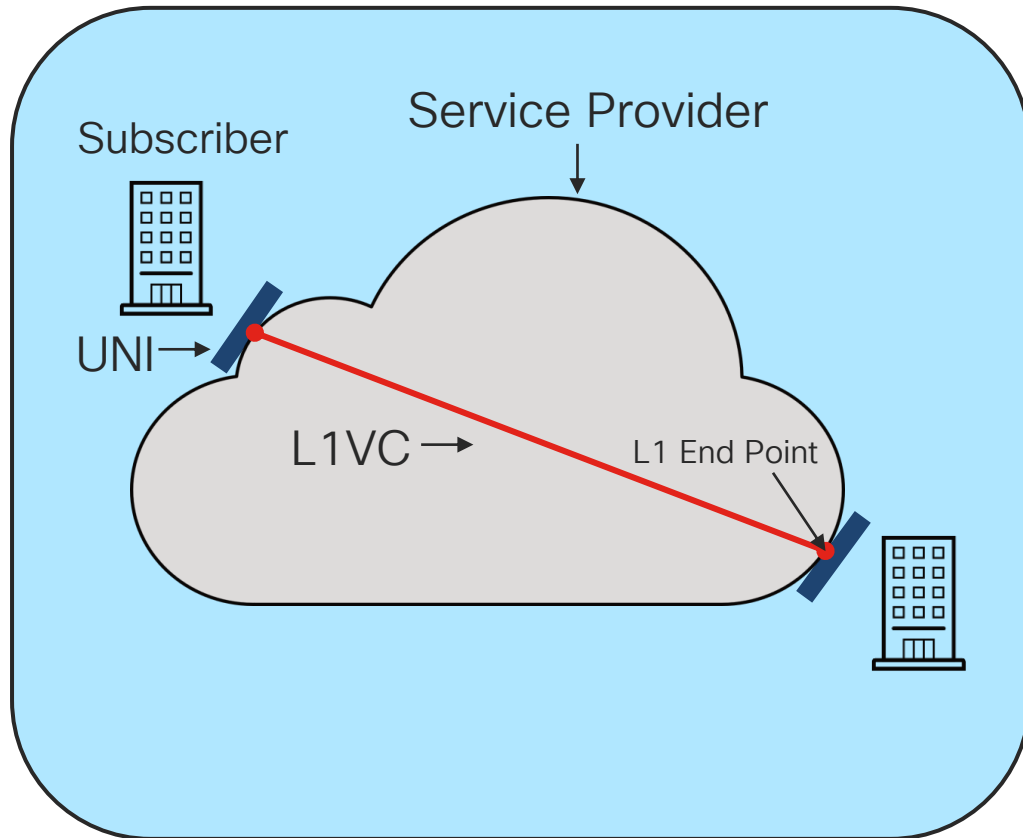
L1VC

L1 End Point

MEF Specification: MEF 63

- Defines Only 7 Service Attributes
  - UNI (2): ID, Physical Layer (Protocol, Coding, Optical Interface)
  - L1VC (3): ID, End Point List, Service Level Specification
  - L1VC End Point (2): ID, End Point UNI

Example: UNI Service Attributes

L1 UNI Service Attributes		
UNI ID Service Attribute	UNI ID	Non-null RFC 2579 String Must not contain characters 0x00 through 0x1f (up to 45 characters)
Physical Layer Service Attribute <p, c, o>	*p* – Client Protocol Value must be the same at both UNIs	Ethernet, Fibre Channel, SDH or SONET
	c – Coding Function Value must be the same at both UNIs	e.g. PCS clause 49 for 10GBASE-R (LAN-PHY)
	o – Optical Interface Function Value may be different at each UNIs	e.g. SX, LX, LR, ER for Ethernet
	Duplex mode	Full

MEF 63 L1 service client protocols

	Client Protocol / Physical Port	Rate (Gb/s)	Coding	L1 CI
Ethernet	GigE	1.250	8B/10B	10-bit block
	10GigE WAN	9.95328	Scrambled	STS-192c frame
	10GigE LAN	10.3125	64B/66B	66-bit block
	40GigE	41.250	64B/66B	66-bit block
	100GigE	103.125	64B/66B	66-bit block
Fibre Channel	FC-100	1.0625	8B/10B	10-bit block
	FC-200	2.125	8B/10B	10-bit block
	FC-400	4.250	8B/10B	10-bit block
	FC-800	8.500	8B/10B	10-bit block
	FC-1200	10.51875	64B/66B	66-bit block
	FC-1600	14.025	64B/66B	66-bit block
	FC-3200	28.05	64B/66B (1)	66-bit block
SONET / SDH	OC-3 / STM-1	0.15552	Scrambled	STS-3/STM-1 Frame
	OC-12 / STM-4	0.62208	Scrambled	STS-12/STM-4 Frame
	OC-48 / STM-16	2.48832	Scrambled	STS-48/STM-16 Frame
	OC-192 / STM-64	9.95328	Scrambled	STS-192/STM-64 Frame
	OC-768 / STM-256	39.81312	Scrambled	STS-768/STM-256 Frame

(1) At ingress the FC-3200 L1CI is extracted after FEC decoding and 256B/257B transcoding

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L1VC Service Level Specification Service Attribute

- SLS service attribute can have a *None* or a 3-tuple value *<t_s, T, PM>*

  - t_s = date and time for the start of the SLS, specified to the nearest second

  - *T* = duration used in conjunction with t_s, for example a calendar month

  - *PM* = list where each element in the list consists of a performance metric name, a list of parameter values and the performance metric objective

- L1VC Performance Metrics:

  - One-way Delay

  - One-way Errored Second

  - One-way Severely Errored Second

  - One-way Unavailable Second

  - One-way availability

Example of L1VC SLS with one PM

Subscriber L1VC Service Level Specification

Tuple Entry	Value
t_s	2017-07-01, 08:00:00 UTC
T	One calendar month
PM	One-way Availability Performance Metric
	Ordered Subscriber L1VC End Point pairs *<U1, U2>* and *<U2, U1>*
	Â = 99.99%

MEF Operator L1 Services
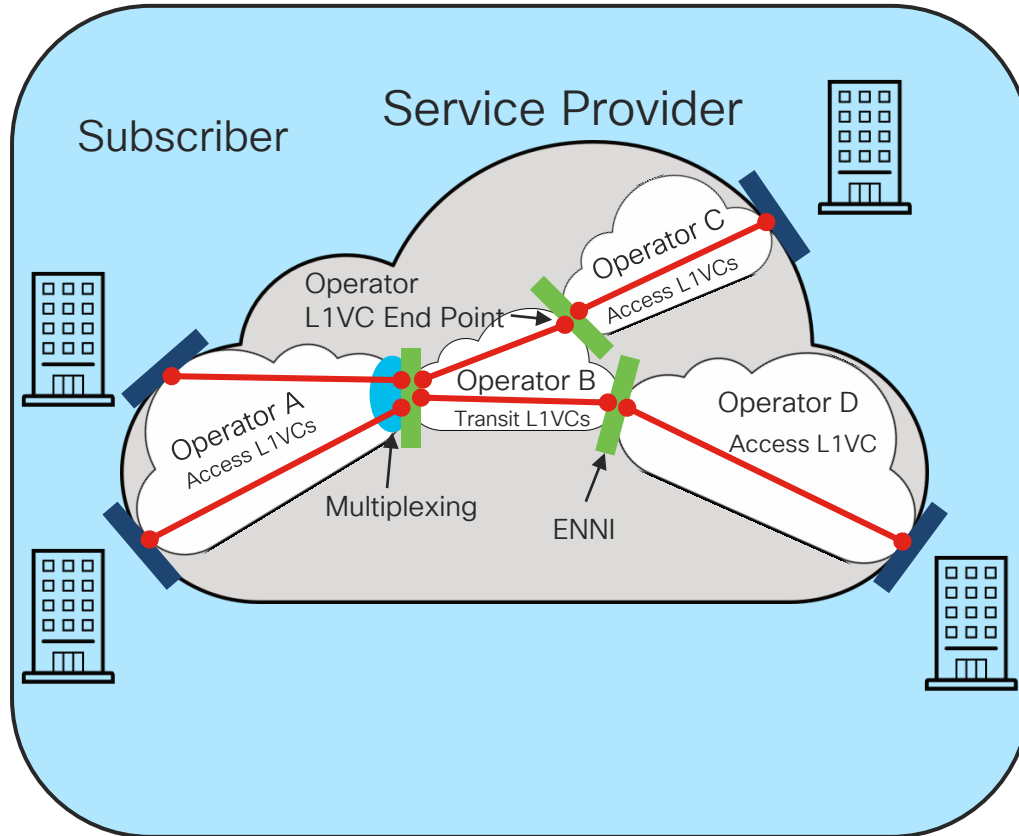
MEF Specification: MEF 64

- Main concepts:

  - Operator L1VC and L1VC End Points

  - Access L1 Services

  - Transit L1 Services

  - E-NNI (OTUk Interface)

Operator L1 service characteristics

- Same client protocols at the UNI as for Subscriber Layer 1 Service (by definition)
  - Ethernet, Fibre Channel, SONET, SDH

- The client protocol at the ENNI is OTN – OTUk (k=1, 2, 2e, 3, 4)

- Access L1 Virtual Connections from multiple UNIs may be aggregated to a single OTUk port at the ENNI

- Transit L1 Virtual Connections from multiple ENNIs may be aggregated to a single OTUk port at another ENNI

- An ENNI may support multiple Service Provider L1 Virtual Connections (Shared ENNI)

Future MEF Work on L1 Services

- Service OAM

- Service Activation Testing

- Add latest Ethernet and Fibre Channel interfaces

- Add support for 'Beyond 100G' OTN ENNI and FlexO interfaces

- Add support for L1 Services in LSO Legato and Presto

MEF 3.0
IP Services

IP Service Attributes for Subscriber IP Services

- ## What it is:

  - Standardized definition for subscriber IP service attributes based on MEF framework, i.e. based on abstractions – not tied to any implementation. For instance RFC 4364 – BGP/MPLS IP VPNs is referenced and a valid implementation

  - Other service attributes beyond connectivity applied to IP Services

- ## What it is not:

  - A new IP protocol or VPN solution

- ## End goal:

  - Drive consistency, support a broad set of use cases and automate inter-provider service lifecycle via LSO for IP Services – e.g. Info & Data Models, APIs

- ## Covered by MEF 61 specification

MEF 3.0 IP Service Standards

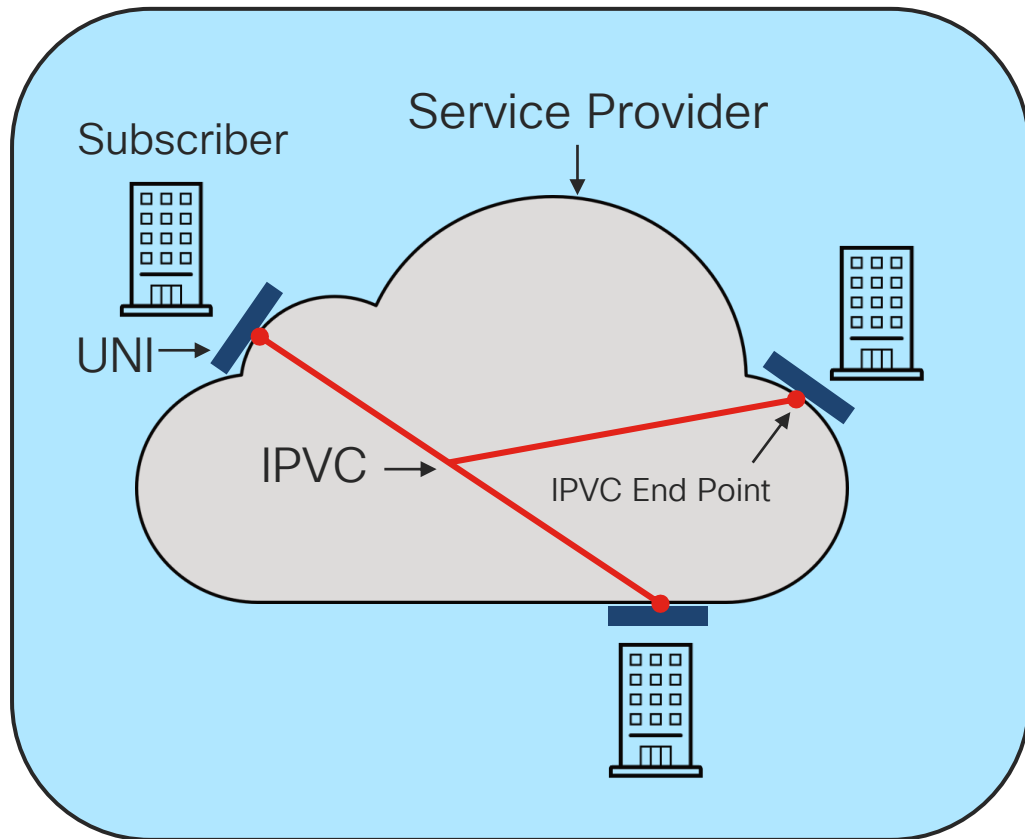|	Service Attributes	Service Definitions
Subscriber Services	MEF 61.1	MEF 69
Operator Services	MEF 61.1	Not Defined Yet
Special Topics	SOAM Pending IETF STAMP publication	CoS/BWPs To Be Defined SAT Work in Progress

MEF IP Subscriber Service Attributes

MEF Specification: MEF 61.1

- Main Concepts:
  - UNI, IPVC, IPVC End Point
  - UNI Access Link
- Main Service Attributes
  - UNI Connection Addressing
  - UNI Routing Protocols
  - Class of Service Maps
  - Service Level Specification
  - Bandwidth Profiles

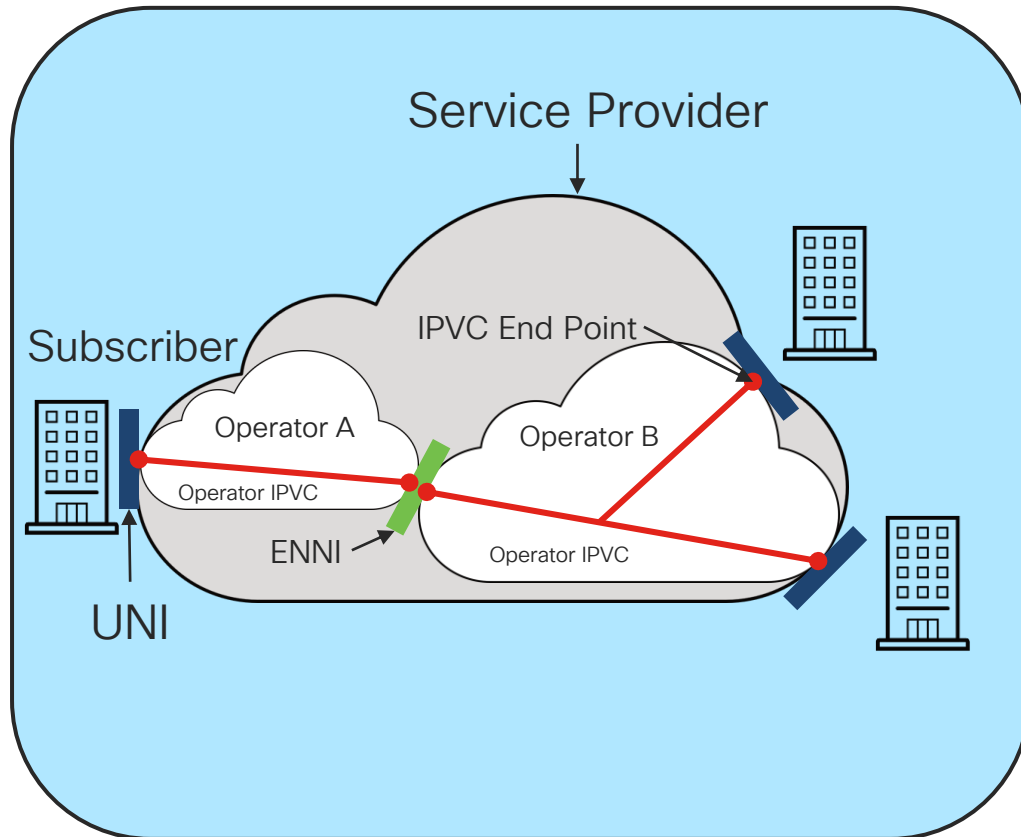# BWP Flow Parameter Example

$$MaxIR_E = 100 \text{ Mb/s}$$

Rank	CIR	MaxIR	Weight
1	20 Mb/s	20 Mb/s	0
2	0	40 Mb/s	1
3	0	100 Mb/s	5
4	0	100 Mb/s	2

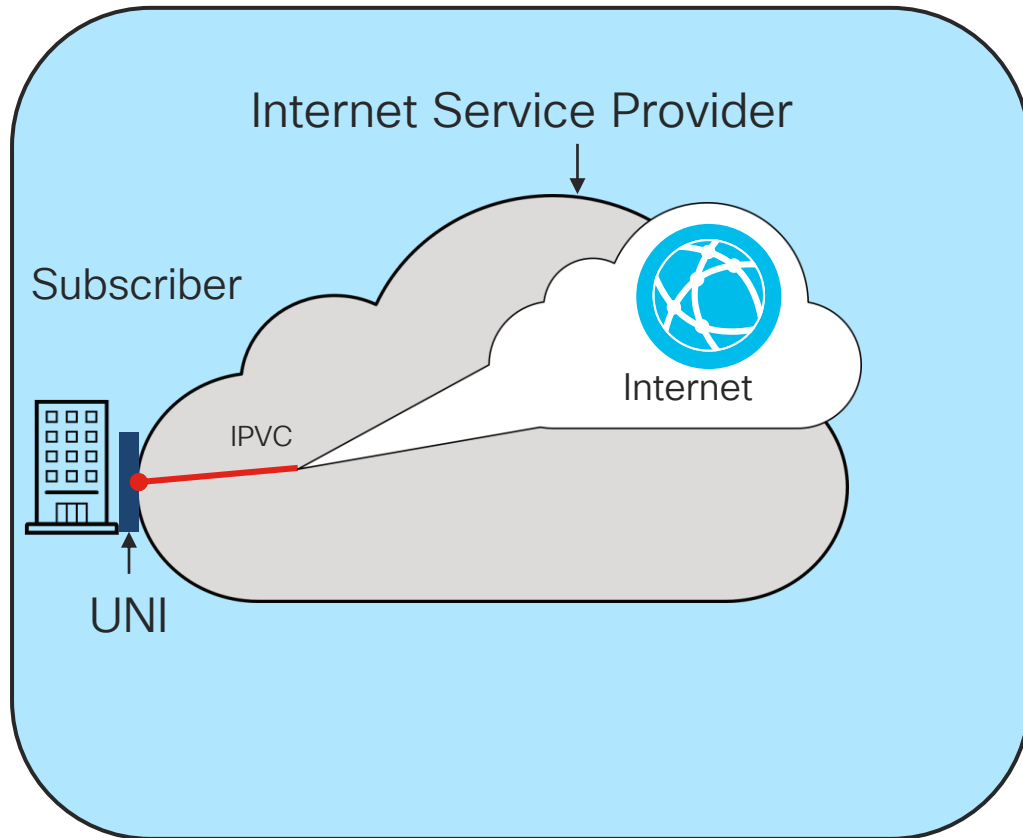Reference: MEF 61, Table 23

MEF IP Operator Service <u>Attributes</u>

MEF Specification: MEF 61.1

- Operator Services
  - Agreed between SP and an Operator
  - New concepts: ENNIs, Operators
- RFC 4364 Option A
  - No MPLS Labels at the ENNI
  - New attributes for mapping services across an ENNI
- Not covered
  - RFC 4364 Option B and C

# MEF IP Internet Service <u>Definition</u>

MEF Specification: MEF 69

- Two types of Internet Access:

  - Basic
    - Best-effort, plug and play
    - Residential or SME use

  - Advanced
    - SLS, static addressing, etc
    - Commercial use

- Boundary between the ISP and "the Internet" is invisible to the Subscriber:

  - Internet Access can include access to things within and outside SP's own network

UNI Management Models for IP Services

Provider Managed CE
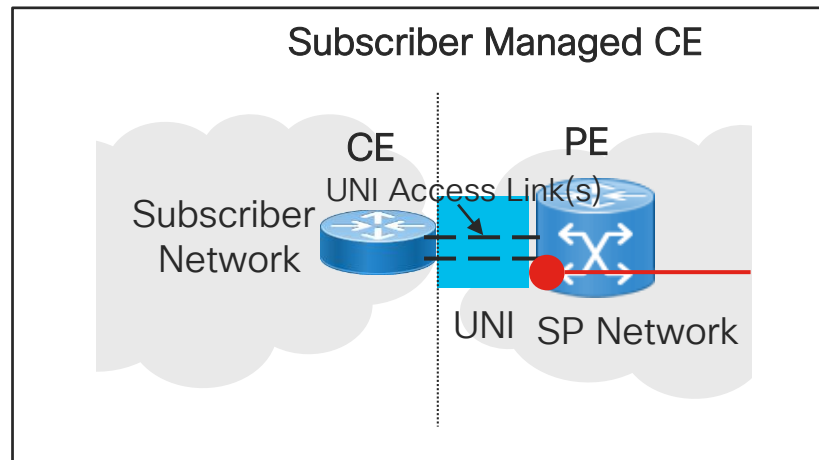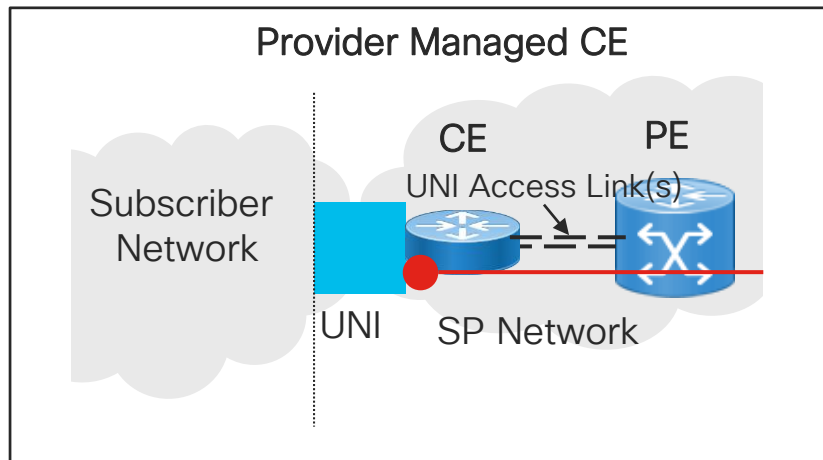
- UNI can have one or more UNI Access links
  - Terminate at one or more devices
  - Separate physical or at L2 (e.g. VLANs)

Subscriber Managed CE

- UNI Routing Protocols – BGP, Static, OSPF
- UNI Link Addressing - Static, DHCP, SLAAC, IP unnumbered

MEF IP Services Attributes – Phase 1 Scope

- L3 VPN services
  - Unicast traffic
  - UNI L3 Control Protocols (BGP, OSPF)
  - Multi-CoS (ex. H, M, L)
  - BW Profiles (CIR, MaxIR, Weight, Burst)
  - SLS Performance Objectives and Metrics between UNIs or other reference points
  - Multipoint or Rooted Multipoint
  - Extranets

- Internet access services
  - NAT
  - DNS
  - Bandwidth Profiles
  - Data Limits

- To be addressed in Phase 2+:
  - Multicast
  - Private Cloud access
  - Policy Based Routing and Route manipulation
  - Egress Class of Service Map
  - BFD and OSPF Authentication, and OSPF sham links
  - Operator Service Attributes

Mapping between MEF IP Services and IETF IP VPNs

Equivalent Definitions

RFC 8299*

MEF 61

Ex. mcast, CsC

Ex. SLS

Unique Definitions
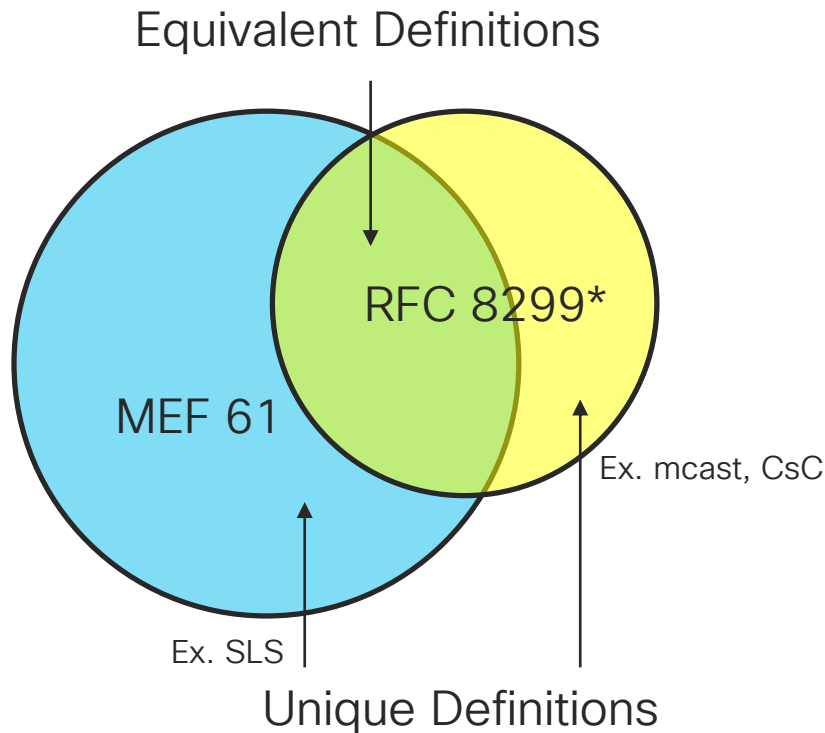
RFC 8299 – YANG Data Model for L3VPN Service Delivery

MEF 61 to IETF RFC 8299 mapping examples

MEF IP Services Term	Closest RFC 8299 Term
Customer Edge (CE)	Customer Edge (CE) – same definition
Provider Edge (PE)	Provider Edge (PE) – same definition
Service Provider (SP)	Network Operator
Subscriber	Customer
IP Virtual Connection (IPVC)	VPN Service
IPVC End Point	No equivalent
IPVC Topology	vpn-service-topology
UNI	Site
UNI Access Link	Site Network Access

For a more exhaustive mapping, please refer to MEF 61 – Appendix A

MEF 3.0
SD-WAN Service
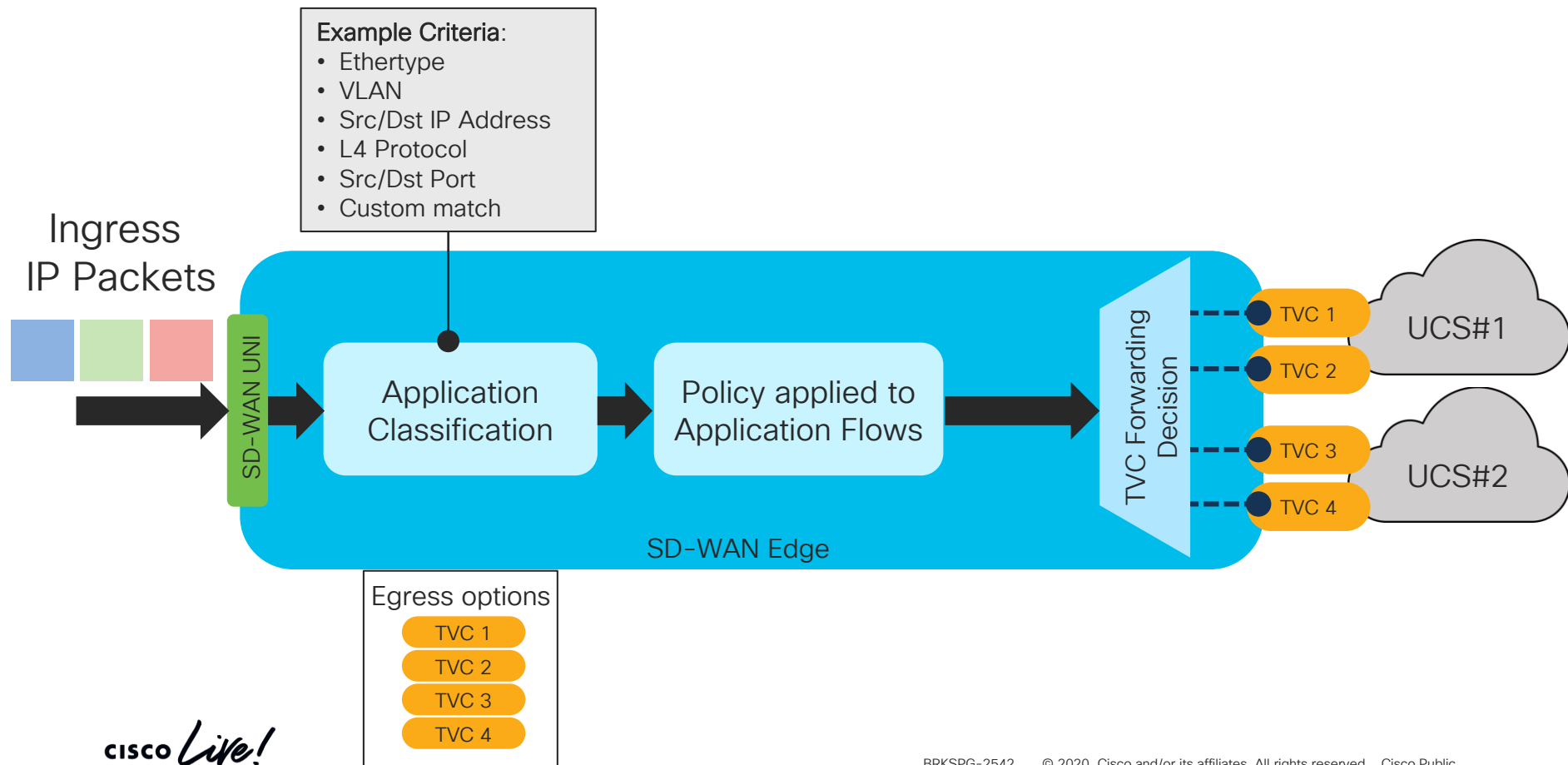
MEF SD-WAN Service

Reference: MEF 70

1. **UNI - SD-WAN User to Network Interface**
   Demarcation between SP and Subscriber

2. **SWVC - SD-WAN Virtual Connection**
   Logical multipoint connection between the SD-WAN UNIs that in the SD-WAN Service

3. **SWVC EP - SD-WAN Virtual Connection End-Point**
   Logical point where application flow policies are assigned and applied

4. **SD-WAN Edge**
   Connects SD-WAN UNI to UCSs, maps packets to application flows, enforces policies, and selects TVC over which to forward each flow

5. **UCS - Underlay Connectivity Service**
   Any WAN service used by the SD-WAN, e.g., MEF Ethernet Services (MEF 6.2), MEF IP Services (MEF 61.1), MPLS VPNs and Internet Access, and MEF Optical Transport Services (MEF 63)

6. **Tunnel Virtual Connection (TVC)**
   Point-to-point paths across UCSs that compose an SD-WAN Service

7. **Internet Breakout**
   Application Flows forwarded from an SD-WAN UNI directly to the Internet rather than delivered to another SD-WAN UNI.
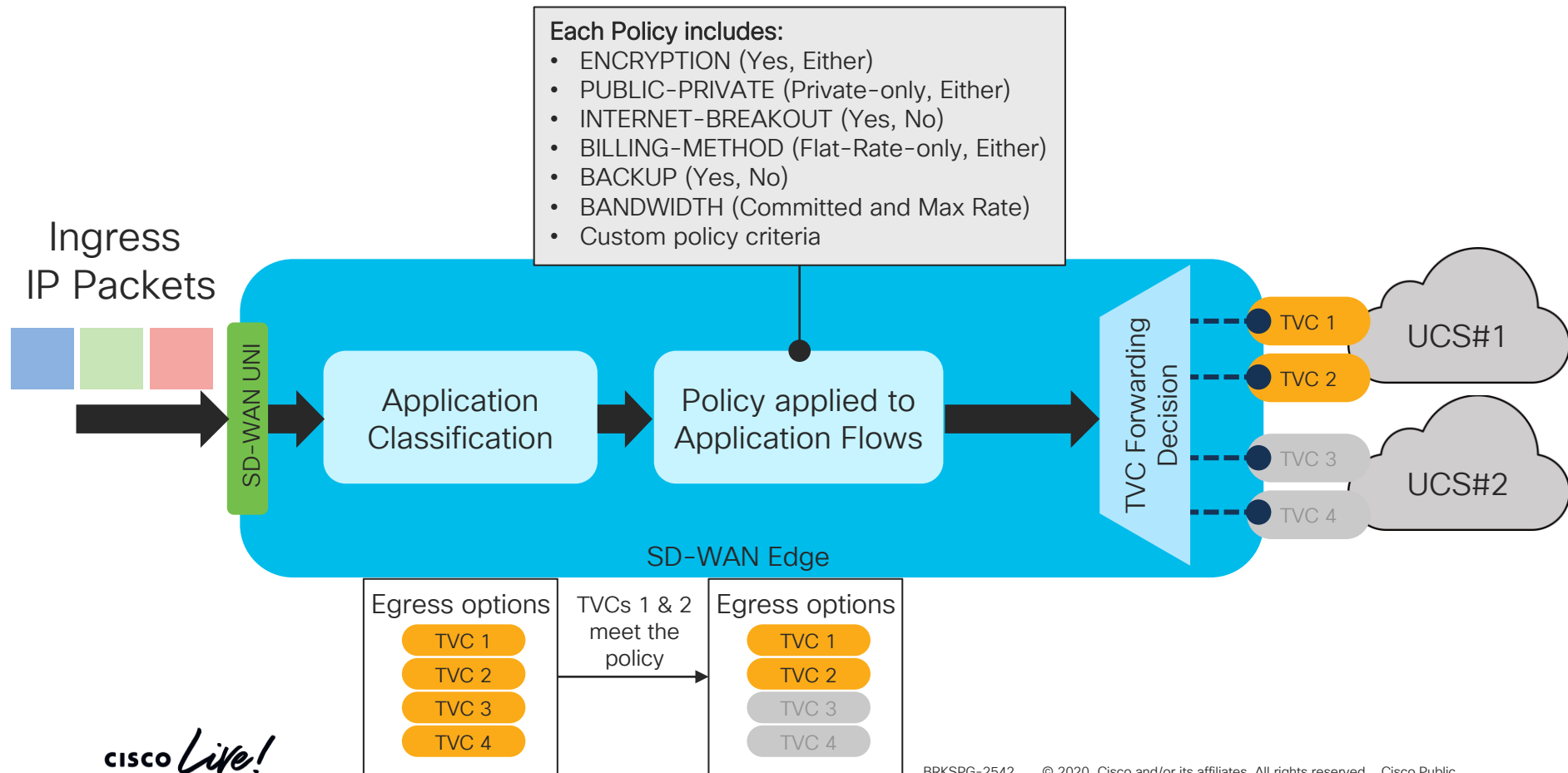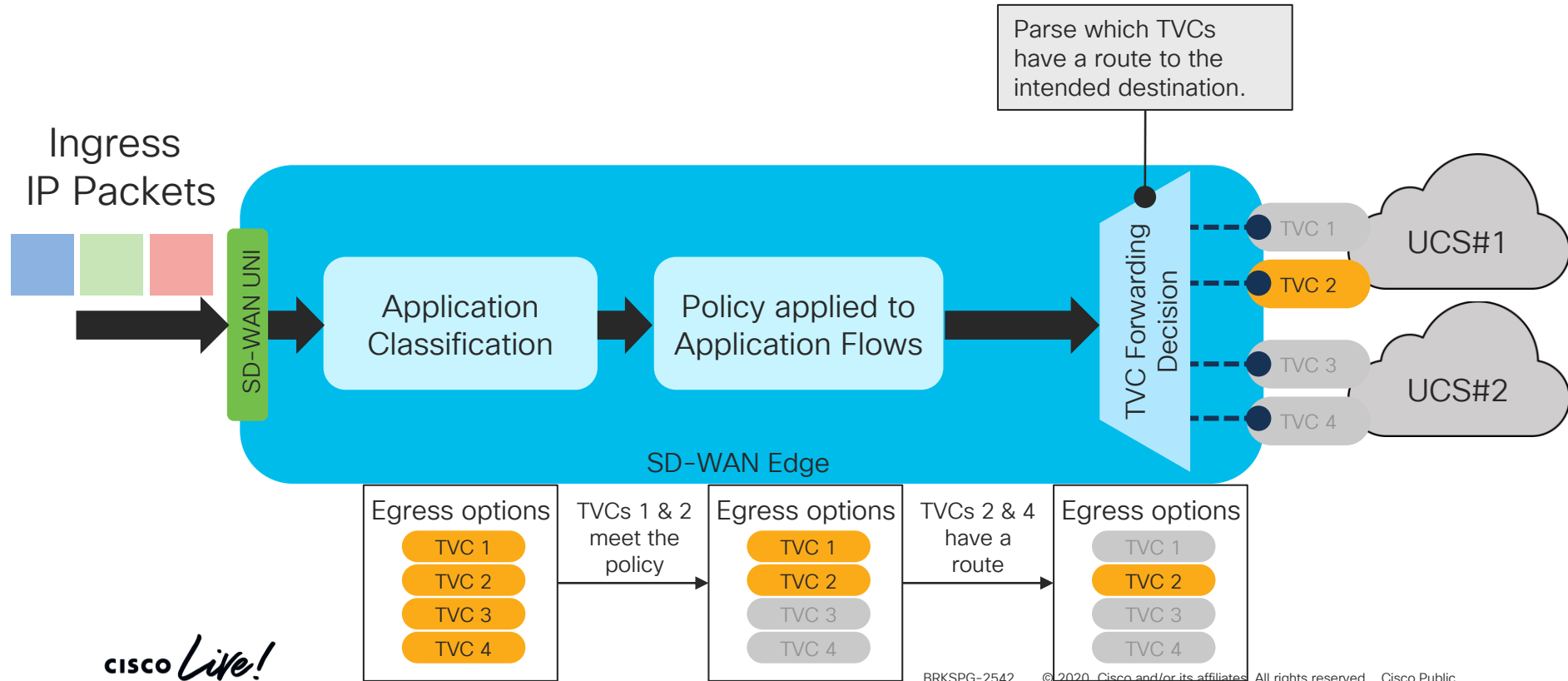
SD-WAN Application Flow & Policy Function

SD-WAN Application Flow & Policy Function

SD-WAN Application Flow & Policy Function

Each Policy includes:
- ENCRYPTION (Yes, Either)
- PUBLIC–PRIVATE (Private-only, Either)
- INTERNET–BREAKOUT (Yes, No)
- BILLING–METHOD (Flat-Rate-only, Either)
- BACKUP (Yes, No)
- BANDWIDTH (Committed and Max Rate)
- Custom policy criteria

Ingress
IP Packets

SD-WAN UNI

Application Classification

Policy applied to Application Flows

TVC Forwarding Decision

TVC 1
TVC 2
UCS#1

TVC 3
TVC 4
UCS#2

SD-WAN Edge

Egress options
- TVC 1
- TVC 2
- TVC 3
- TVC 4

TVCs 1 & 2 meet the policy

Egress options
- TVC 1
- TVC 2
- TVC 3
- TVC 4

SD-WAN Application Flow & Policy Function

Ingress IP Packets

SD-WAN UNI

Application Classification

Policy applied to Application Flows

TVC Forwarding Decision

Parse which TVCs have a route to the intended destination.

TVC 1
TVC 2
TVC 3
TVC 4

UCS#1

UCS#2

SD-WAN Edge

Egress options
TVC 1
TVC 2
TVC 3
TVC 4

TVCs 1 & 2 meet the policy

Egress options
TVC 1
TVC 2
TVC 3
TVC 4

TVCs 2 & 4 have a route

Egress options
TVC 1
TVC 2
TVC 3
TVC 4

MEF SD-WAN Service Use Case
Hybrid WAN: SD-WAN Service over Internet and MPLS UCSs

- Encrypted SD-WAN TVCs over the Internet UCS

- Internet and MPLS VPN UCS can be provided by different service providers

- Option to increase site-to-site bandwidth can be offered

- Increased network availability and resiliency with back-up UCS

MEF SD-WAN Service Use Case
Dual Internet UCSs: SD-WAN Service over Multiple ISPs
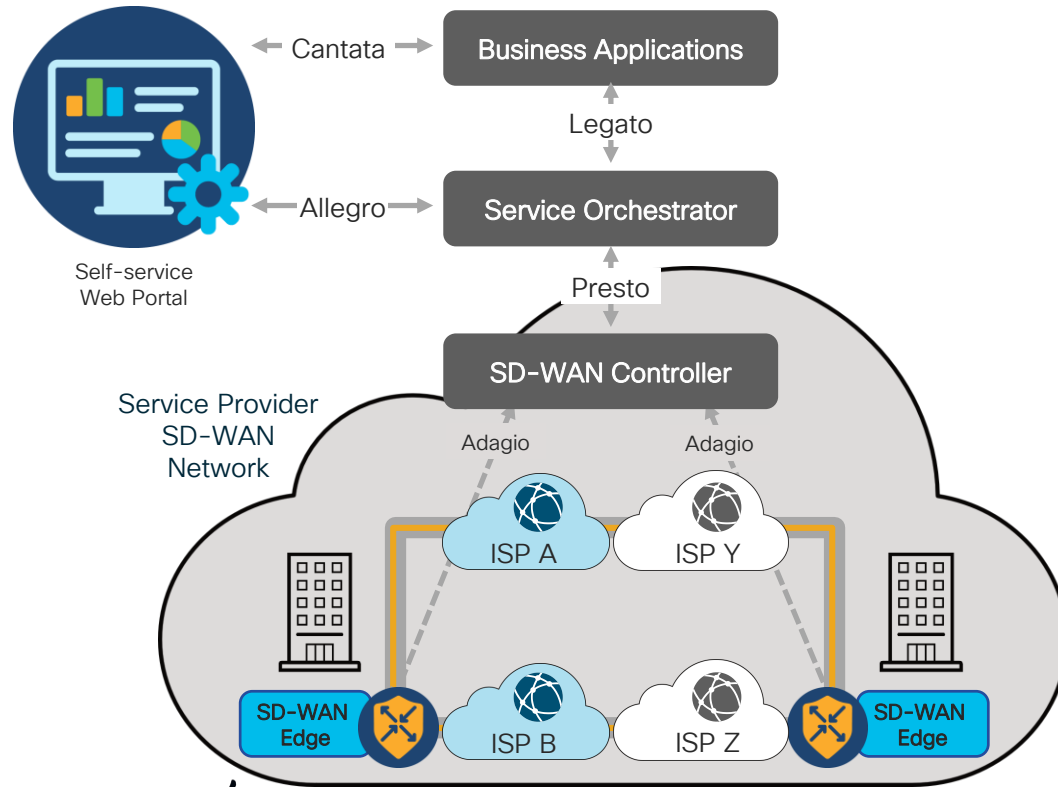
- Encrypted SD-WAN TVCs over each Internet UCS from each ISP

- ISPs may not be the SD-WAN Service Provider

- Using multiple ISPs achieves provider diversity, increased network availability and resiliency

MEF SD-WAN Next Steps and Related Projects

MEF W70.1 (Phase 2 of MEF 70)

- Additional service attributes related to application business importance and prioritization
- Underlay Connectivity Service parameters required to deploy an SD-WAN Service

MEF W88 - Application Security for SD-WAN services

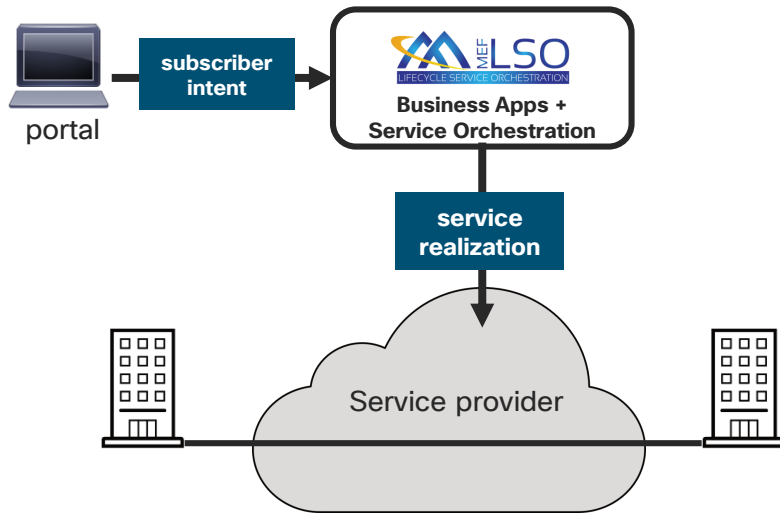## Information and data modeling standards including LSO Legato

Intent-based networking for SD-WAN

MEF 3.0
Lifecycle Services
Orchestration

MEF Lifecycle Services Orchestration (LSO) and related APIs

Goal: provide open APIs at device, infrastructure, services and business layers to enable multi-vendor solutions across single or multi provider scenarios.

Ex.: Dynamic Services

portal → subscriber intent → **MEF LSO** LIFECYCLE SERVICE ORCHESTRATION
Business Apps + Service Orchestration

service realization

Service provider

MEF Specifications and API SDKs:

- MEF Specification: **MEF 55** – The LSO Framework Specification

- APIs are released as **SDKs** in two flavors *:

  - **Experimental**: not public, based on unfinished specs
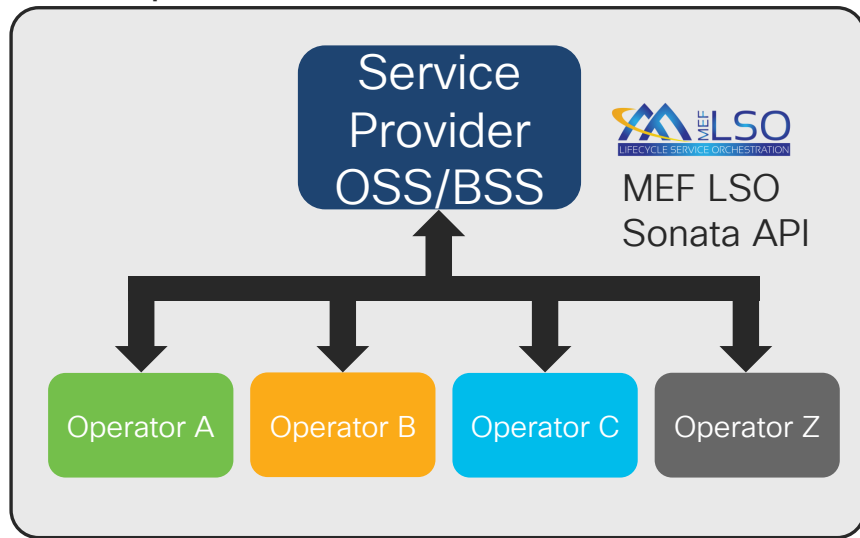
  - **Published**: public, based on released specs

* As of 2018, only experimental SDKs were available.
* SDKs developed in 6 months sprints –goal is to reduce to 3 months.
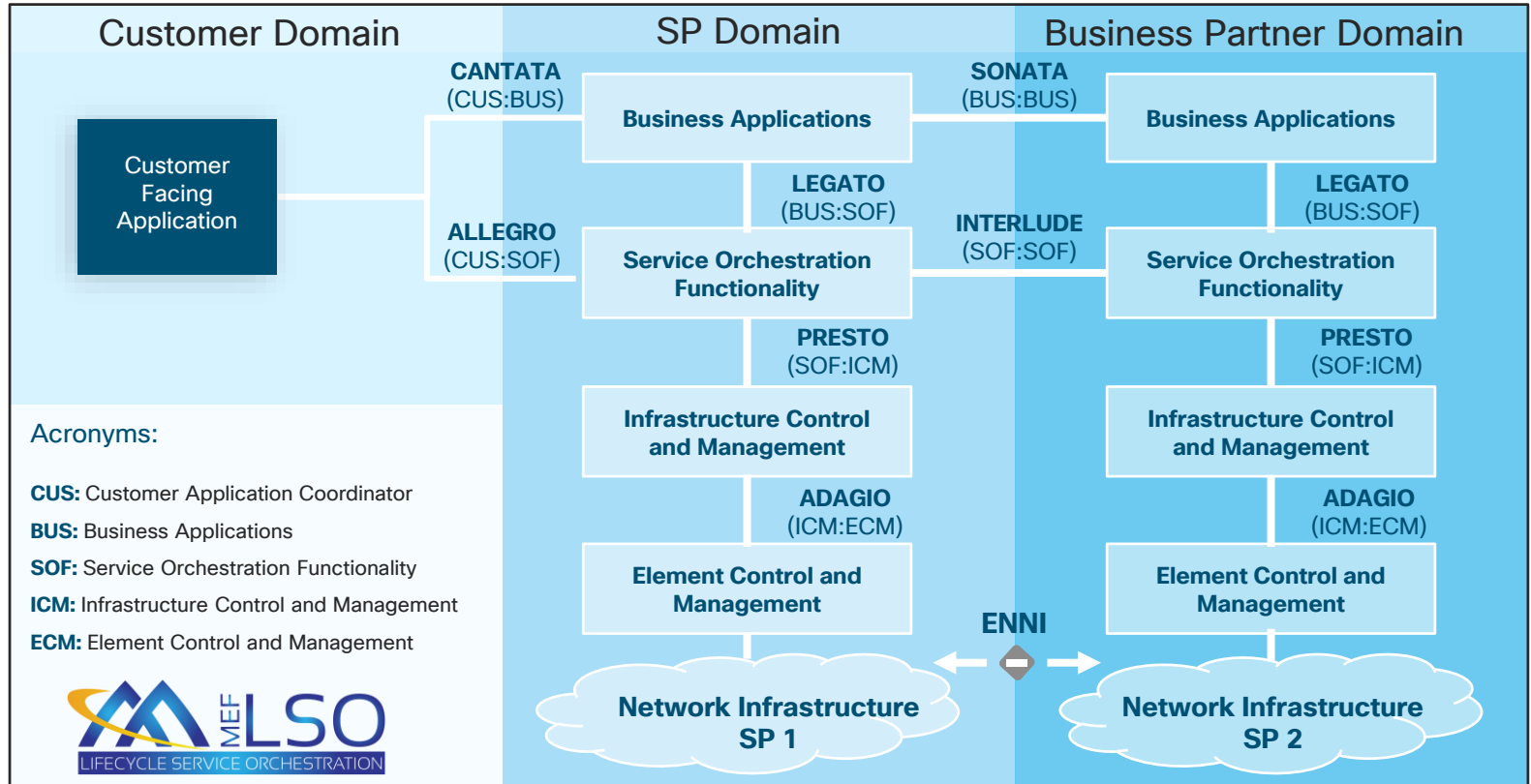
cisco Live!

Why are LSO APIs important?

- Streamline B2B transactions via APIs
  - Reduce time and cost
  - Scale operations

- Define standard APIs for:
  - Intra and inter-carrier scenarios
  - Service provisioning
  - Service changes
  - SLA reporting
  - Many other use cases

- Cover full service lifecycle
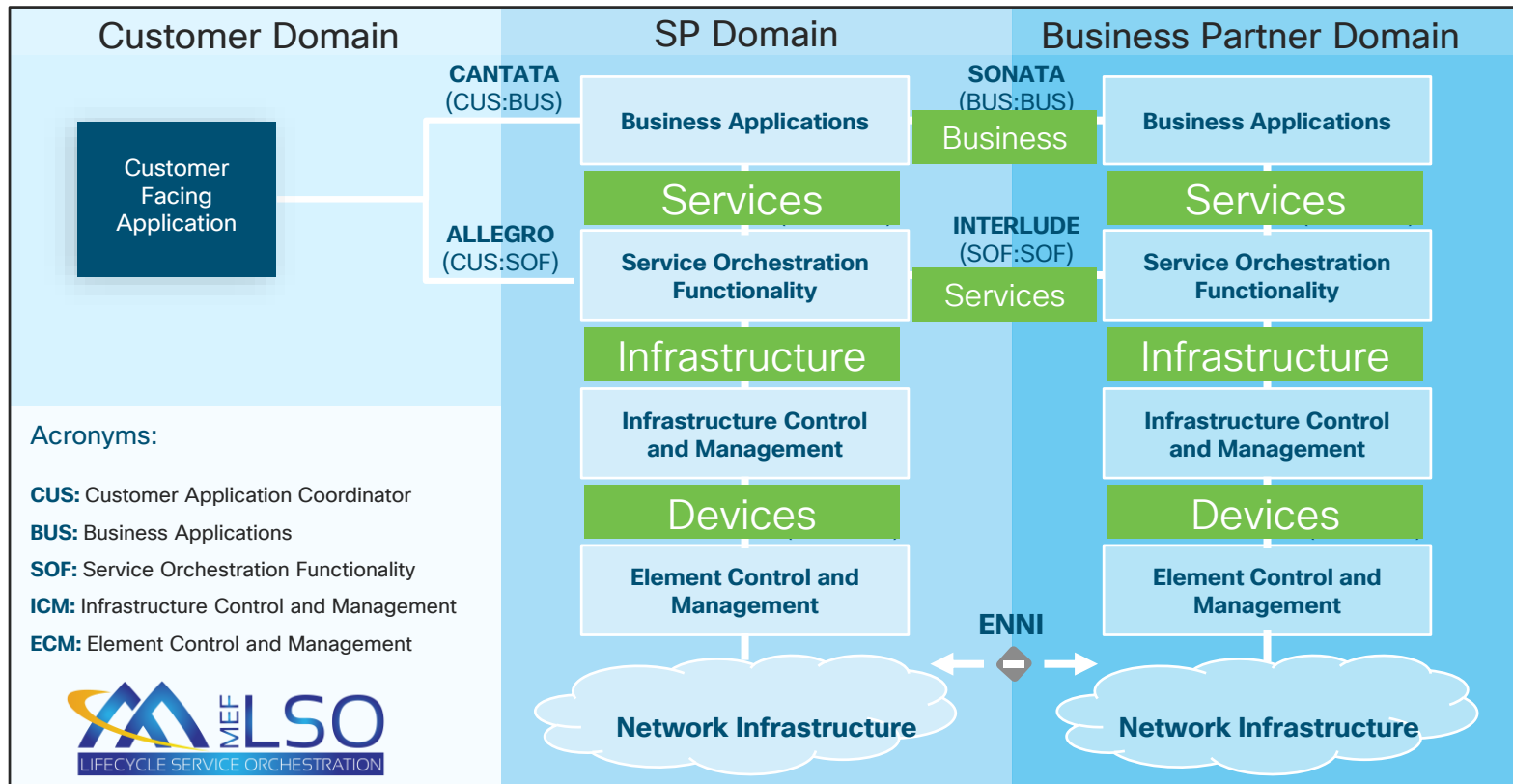 - Quote, ordering, monitoring, trouble-ticketing, others

Example: Sonata API
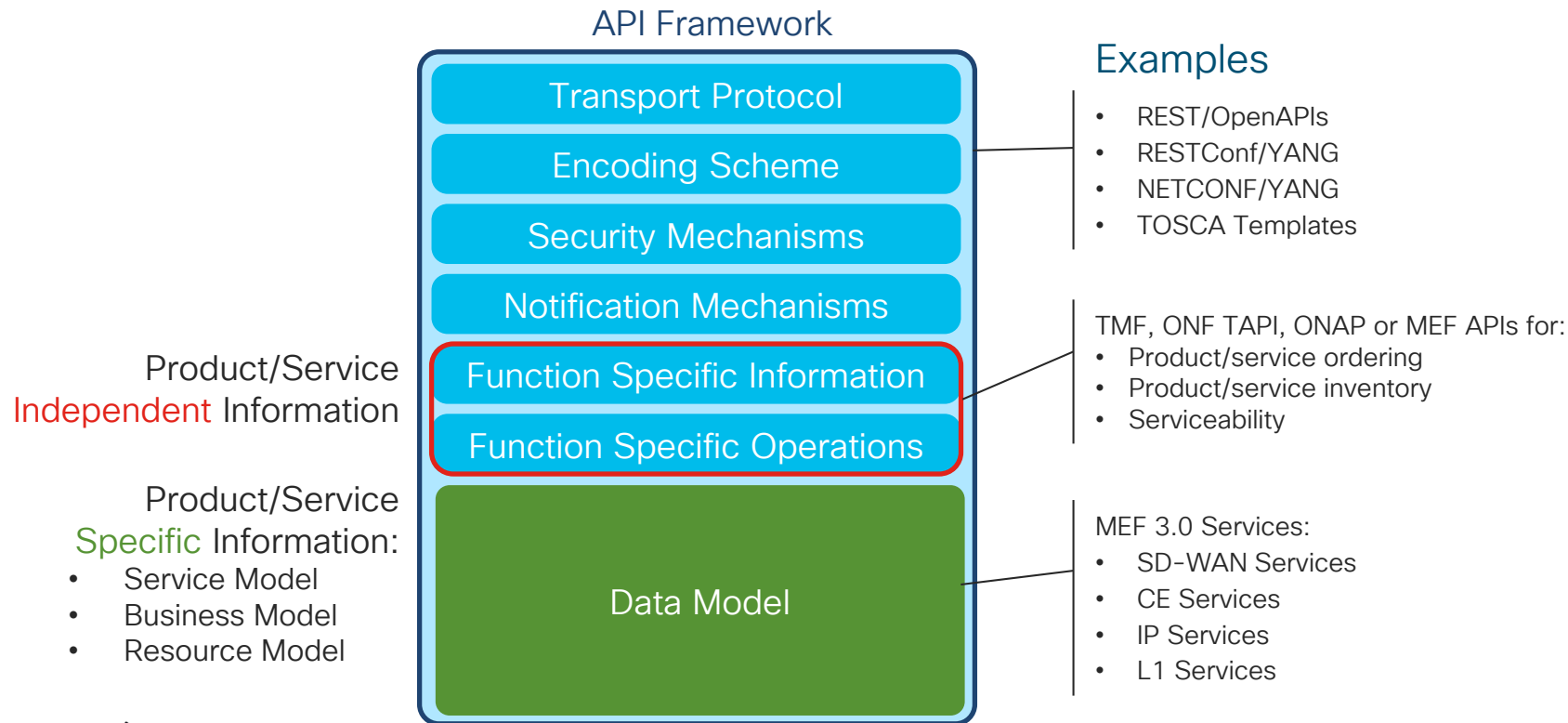

MEF LSO Sonata API

MEF LSO Reference Architecture (MEF 55)

Customer Domain

Customer Facing Application

SP Domain

CANTATA (CUS:BUS)

ALLEGRO (CUS:SOF)

Business Applications

LEGATO (BUS:SOF)

Service Orchestration Functionality

PRESTO (SOF:ICM)

Infrastructure Control and Management

ADAGIO (ICM:ECM)

Element Control and Management

Network Infrastructure SP 1

Business Partner Domain

SONATA (BUS:BUS)

INTERLUDE (SOF:SOF)

Business Applications

LEGATO (BUS:SOF)

Service Orchestration Functionality

PRESTO (SOF:ICM)

Infrastructure Control and Management

ADAGIO (ICM:ECM)

Element Control and Management

ENNI

Network Infrastructure SP 2

Acronyms:

CUS: Customer Application Coordinator
BUS: Business Applications
SOF: Service Orchestration Functionality
ICM: Infrastructure Control and Management
ECM: Element Control and Management

MEF LSO
LIFECYCLE SERVICE ORCHESTRATION

MEF LSO Abstraction Layers

Customer Domain

SP Domain

Business Partner Domain

CANTATA (CUS:BUS)

SONATA (BUS:BUS)

ALLEGRO (CUS:SOF)

INTERLUDE (SOF:SOF)

Customer Facing Application

Business Applications

Business

Business Applications

Services

Services

Services

Service Orchestration Functionality

Services

Service Orchestration Functionality

Infrastructure

Infrastructure

Infrastructure Control and Management

Infrastructure Control and Management

Devices

Devices

Element Control and Management

Element Control and Management

ENNI

Network Infrastructure

Network Infrastructure

Acronyms:

CUS: Customer Application Coordinator
BUS: Business Applications
SOF: Service Orchestration Functionality
ICM: Infrastructure Control and Management
ECM: Element Control and Management

MEF LSO API Approach

Separation of API Framework, Functions and Product/service-specific data

API Framework

	Transport Protocol
	Encoding Scheme
	Security Mechanisms
	Notification Mechanisms
Product/Service Independent Information	**Function Specific Information**
	Function Specific Operations
Product/Service Specific Information: • Service Model • Business Model • Resource Model	**Data Model**

Examples

- REST/OpenAPIs
- RESTConf/YANG
- NETCONF/YANG
- TOSCA Templates

TMF, ONF TAPI, ONAP or MEF APIs for:
- Product/service ordering
- Product/service inventory
- Serviceability

MEF 3.0 Services:
- SD-WAN Services
- CE Services
- IP Services
- L1 Services

Example: LSO Sonata API and SDK

- Sonata API initial focus: MEF 3.0 CE Access E-Line services
- Updated API definitions for:

Inventory | Quote | Serviceability | Product Order

- Updated draft standards of the business requirements and use cases:
  - Address, Service Site, and Product Offering Qualification Management
  - Quote Management
  - Product Inventory Management: Requirements and Use Cases
- LSO Sonata SDK Release 4 - available on the MEF GitHub

LSO Sonata API Use Cases

Service Portal

subscriber intent

Business Application

Business Application

SONATA APIs

service realization

service realization

US Office

ENNI

Europe Office

Retail Service Provider

Wholesale Business Partner

- Address/Site Validation
- Product Offering Qualification
- Quote
- Order
- Inventory
- Trouble ticketing (future)
- Billing/Invoice (future)

MEF API Assets (MEF Members)

- MEF maintains a github with many assets available:
  - API Guide
  - API swaggers (JSON & YML)
  - Postman collection
  - Reference code
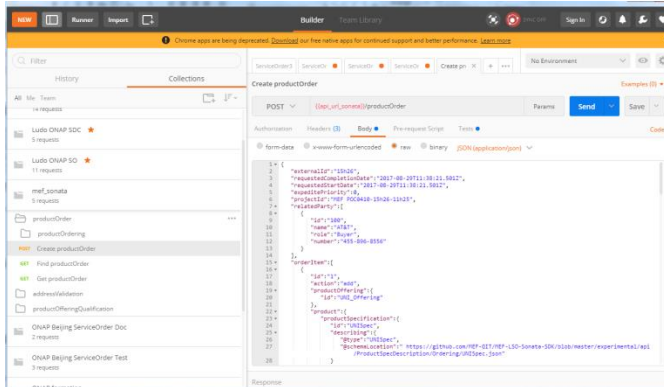
Collaboration with Open Source Projects & other standards groups

LSO Implementation Projects

Source: MEF

Customer Facing Open APIs

Inter-Carrier Open APIs

LSO FRAMEWORK

Business Applications

Service Orchestration

Technology Domain APIs

Self-service Web Portal

User Service Endpoint

User Service Endpoint

Head Office

UNI

Network Operator 1

ENNI

Network Operator 2

UNI

Cloud Service Provider

End-to-End Network-as-a-Service

Initiating Service Providers
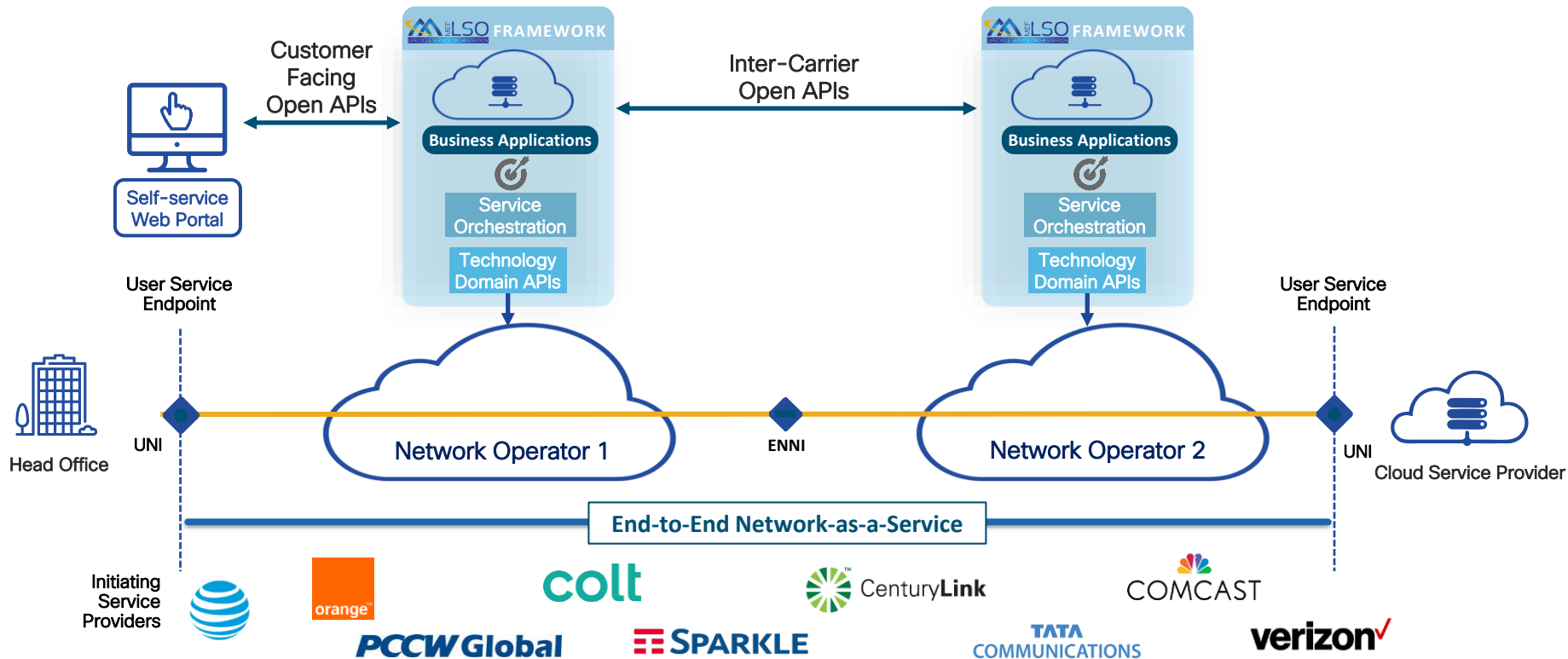
MEF LSO
Implementation Example

MEF LSO RA – Example Cisco Portfolio Mapping
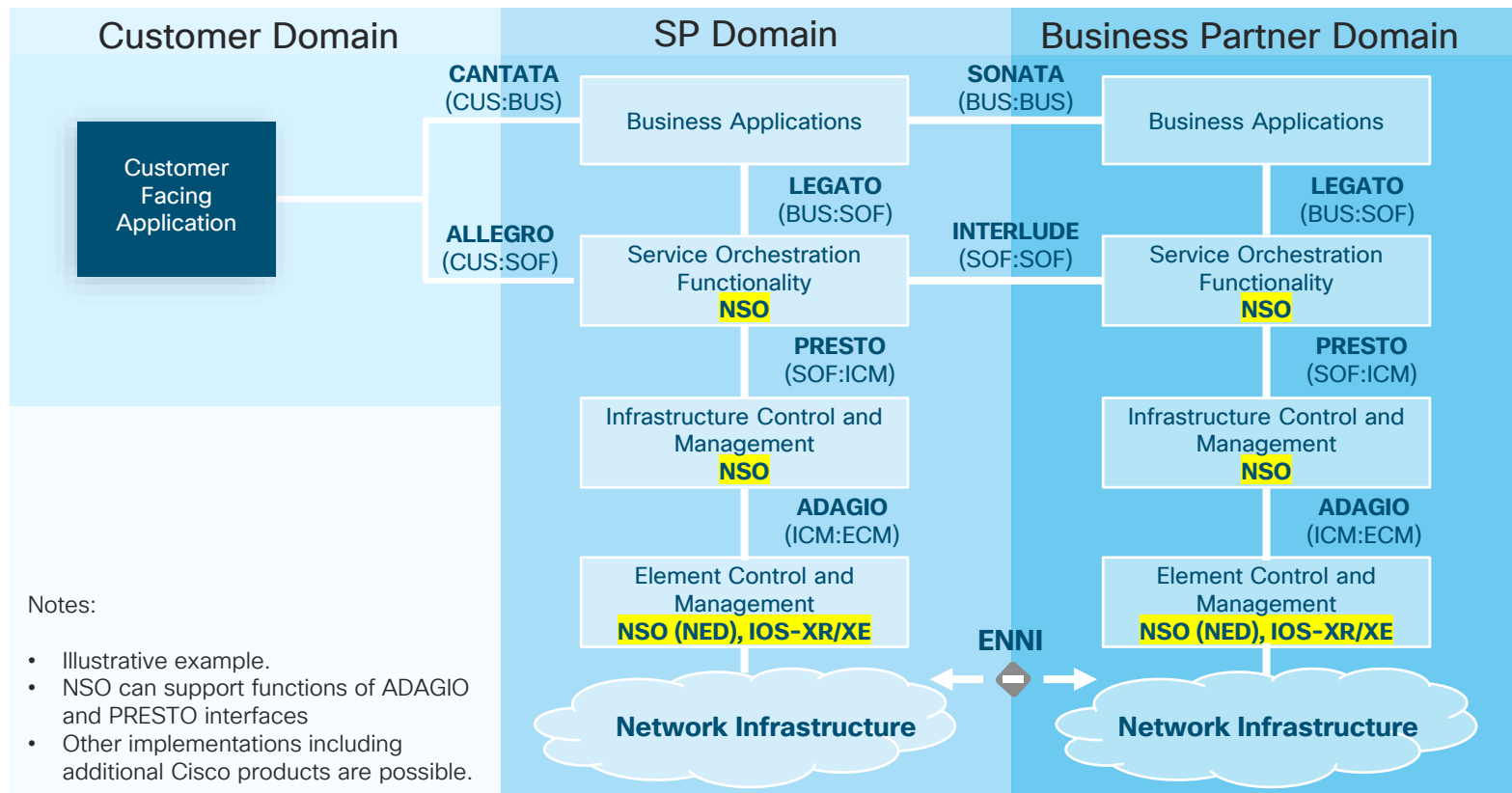
MEF LSO Legato provides a YANG defined API for L2 Services

MEF Legato Architecture

LSO Legato API belongs to the family of MEF LSO Reference Points

Ref: https://wiki.mef.net/display/CESG/LSO+Legato

Source: https://github.com/MEF-GIT/YANG-public

European Operator Lab Implementation

MEF Legato
RESTConf API

Cisco NSO
LSO Legato Service Orchestration

Operator's Network
Netconf API

Cisco NSO
Infra Control and Management

Netconf API   CLI   IOS-CLI   Netconf

Vendor A   Cisco

Vendor B   IETF Netconf

Operator chose this standard service definition over other options for its maturity

Source: Layer123 Zero Touch & Carrier Automation Congress. | March 20-23, 2018 | Madrid, Spain

MEF Legato Yang Models - Examples

Service Models

Interface Models

- Yang Models for MEF L2 connectivity services and related service attributes
  - EVC services
  - CoS
  - Bandwidth Profiles
  - Interface attributes
- Can be easily loaded in Cisco NSO
- Requires extensions for device and technology specific deployments

MEF 3.0 and 5G
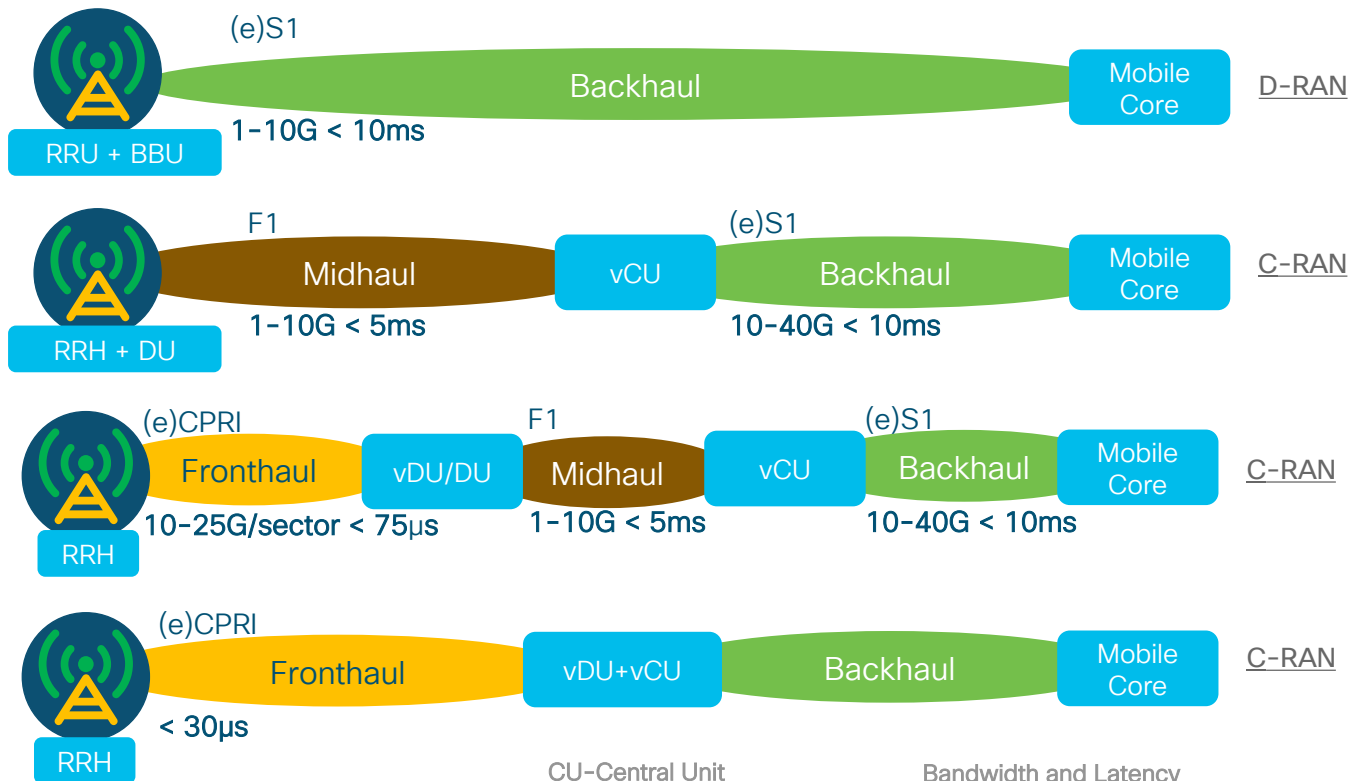
MEF 5G Work Areas

1 MEF Services for 5G

2 MEF Services over 5G

**3** Network Slicing

5G Transport Requirements

(e)S1 — RRU + BBU — Backhaul — Mobile Core — D-RAN
1-10G < 10ms

F1 — RRH + DU — Midhaul — vCU — **(e)S1** — Backhaul — Mobile Core — C-RAN
1-10G < 5ms ; 10-40G < 10ms

(e)CPRI — RRH — Fronthaul — vDU/DU — **F1** — Midhaul — vCU — **(e)S1** — Backhaul — Mobile Core — C-RAN
10-25G/sector < 75μs ; 1-10G < 5ms ; 10-40G < 10ms

(e)CPRI — RRH — Fronthaul — vDU+vCU — Backhaul — Mobile Core — C-RAN
< 30μs

CU–Central Unit
DU–Distributed Unit
BBU = CU +DU
RRH–Remote Radio Head

Bandwidth and Latency requirements are indicative only.

MEF Services for 5G

- Covered by MEF 22 Phase 4 (MEF 22.3.1)

- MEF Ethernet Service Types
  - Mobile Fronthaul 1,2,3
  - Mobile Backhaul
  - Ethernet Backhaul

- Multiple Ethernet Service Types can co-exist
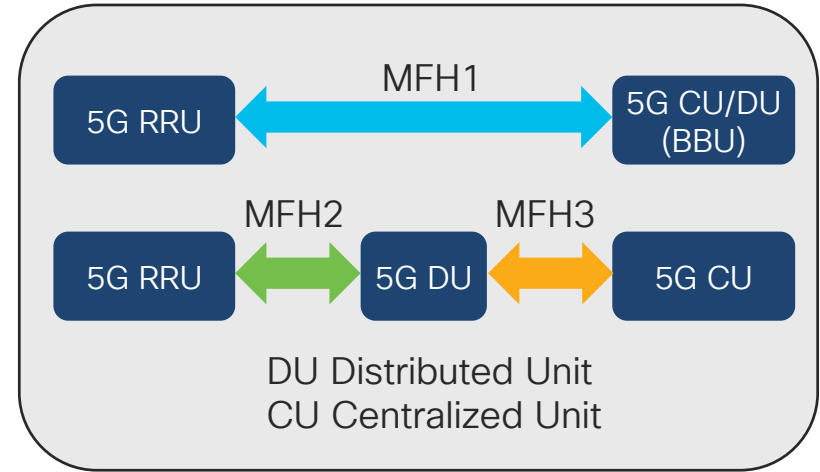
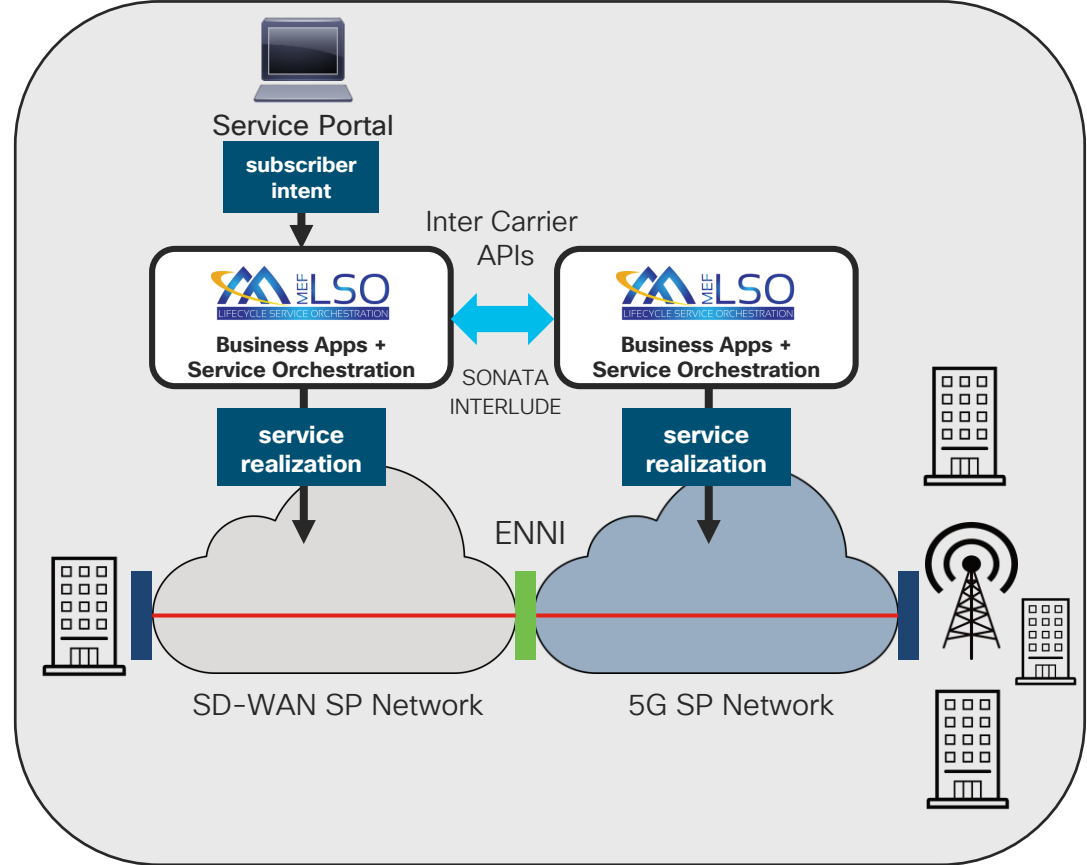**MEF 22**.3 – Transport Services for Mobile Networks:

- Identifies the requirements for MEF Ethernet Services and MEF External Interfaces such as UNIs for use in Mobile Backhaul networks based on MEF specifications

MEF 22.3.1 – Amendment:

- Add requirements in MEF 22.3 to allow support for Mobile Fronthaul Services (MFHS)

MEF Services over 5G

- Why?
  - More traffic is terminating on mobile devices
  - Fiber availability is limited
  - Copper plant may not meet demand
  - Cost (avoid truck-roll + technician)

- MEF vision
  - End-to-end MEF LSO orchestrated delivery of MEF Services leveraging 5G

- Use case example:
  - MEF SD-WAN Service with 5G Access

Service Portal

subscriber intent

Inter Carrier APIs

MEF LSO
LIFECYCLE SERVICE ORCHESTRATION
Business Apps + Service Orchestration

MEF LSO
LIFECYCLE SERVICE ORCHESTRATION
Business Apps + Service Orchestration

SONATA INTERLUDE

service realization

service realization

ENNI
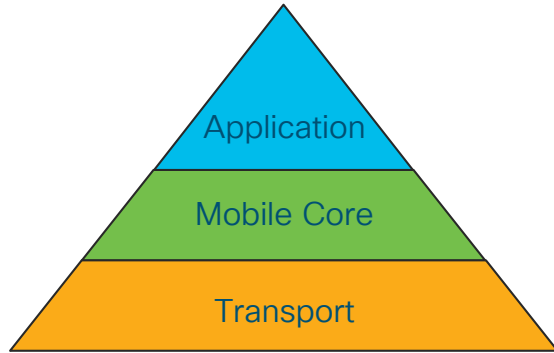
SD-WAN SP Network

5G SP Network

5G Network Slicing

- A means to structure and organize infrastructure and management to provide flexible solutions for different market scenarios
  - For Service Provider internal purposes
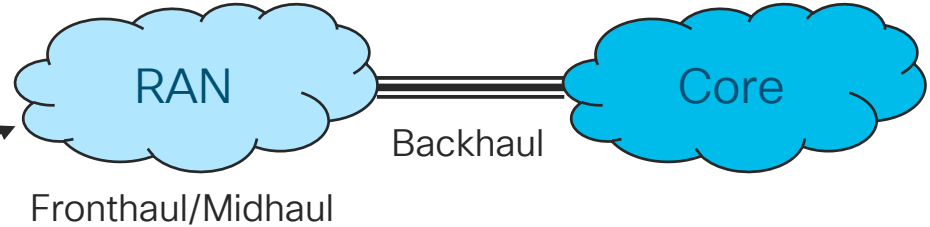 - For exposure to and use by Customer/Partner
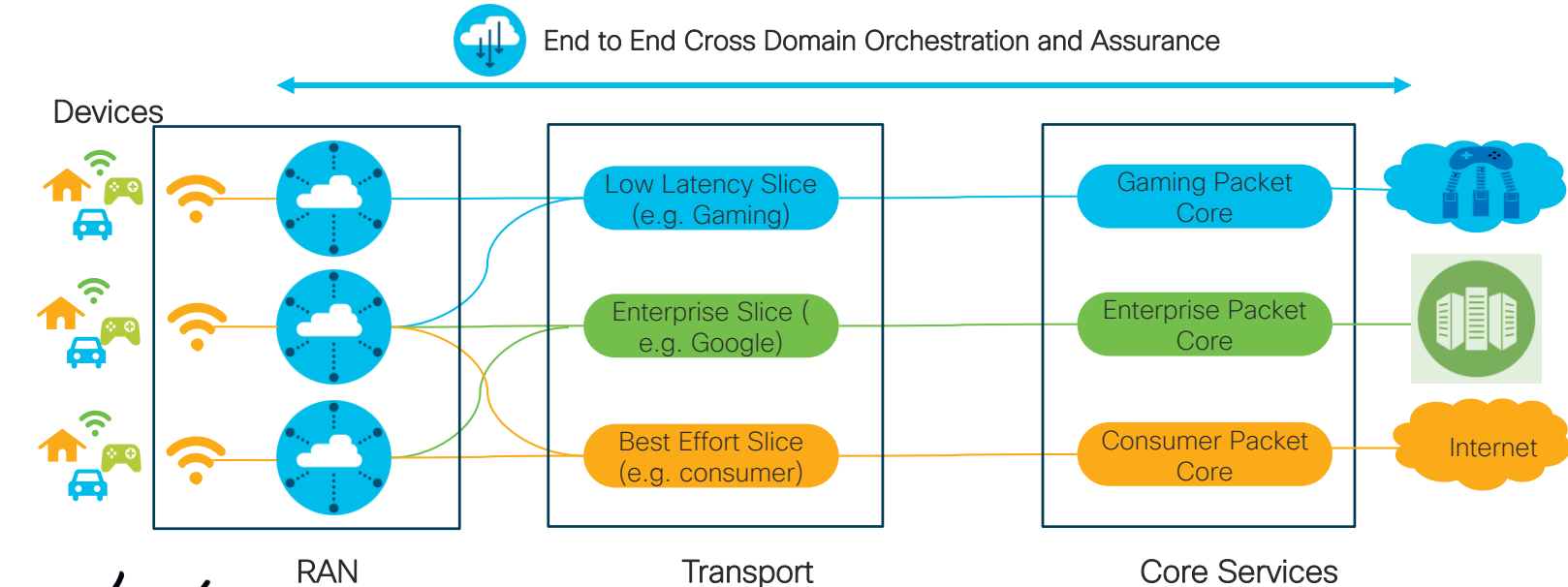
5G Network Slicing

5G Network Slicing Layers

Transport Network Slicing

Application

Mobile Core

Transport

RAN — Backhaul — Core

Fronthaul/Midhaul

Example: Slicing using MEF CE Services

EVC
- Mobile Slice 1
- Mobile Slice 2
- Mobile Slice 3
- Mobile Slice N

EVC
- Mobile Slice 1

Note:
Transport Network Slices are not defined as L2 only, i.e. they can be over L3/IP VPNs.

1:N EVC – Mobile Network Slice

1:1 EVC – Mobile Network Slice

Potential MEF Use Cases for Network Slicing

- MEF Services over 5G Network Slices, e.g. Fixed Wireless Access

- MEF SD-WAN Service mapping of applications to Network Slices

- MEF LSO orchestration of (Transport) Network Slices

MEF Certification

MEF 3.0 Certification

Equipment

Services

Software

New with MEF 3.0

Cloud-based test platform with virtualized test probes

Portal-driven continuous testing & certification

Subscription-based model

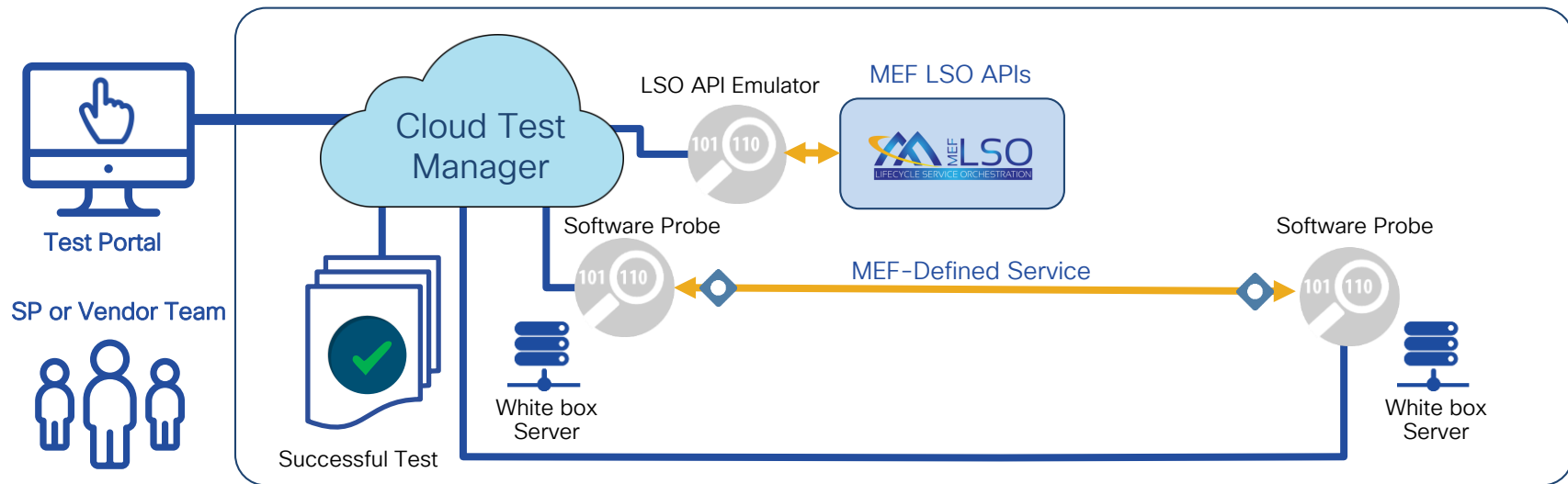Reminder: MEF Certification is exclusively done by external companies.

MEF 3.0 services and certification

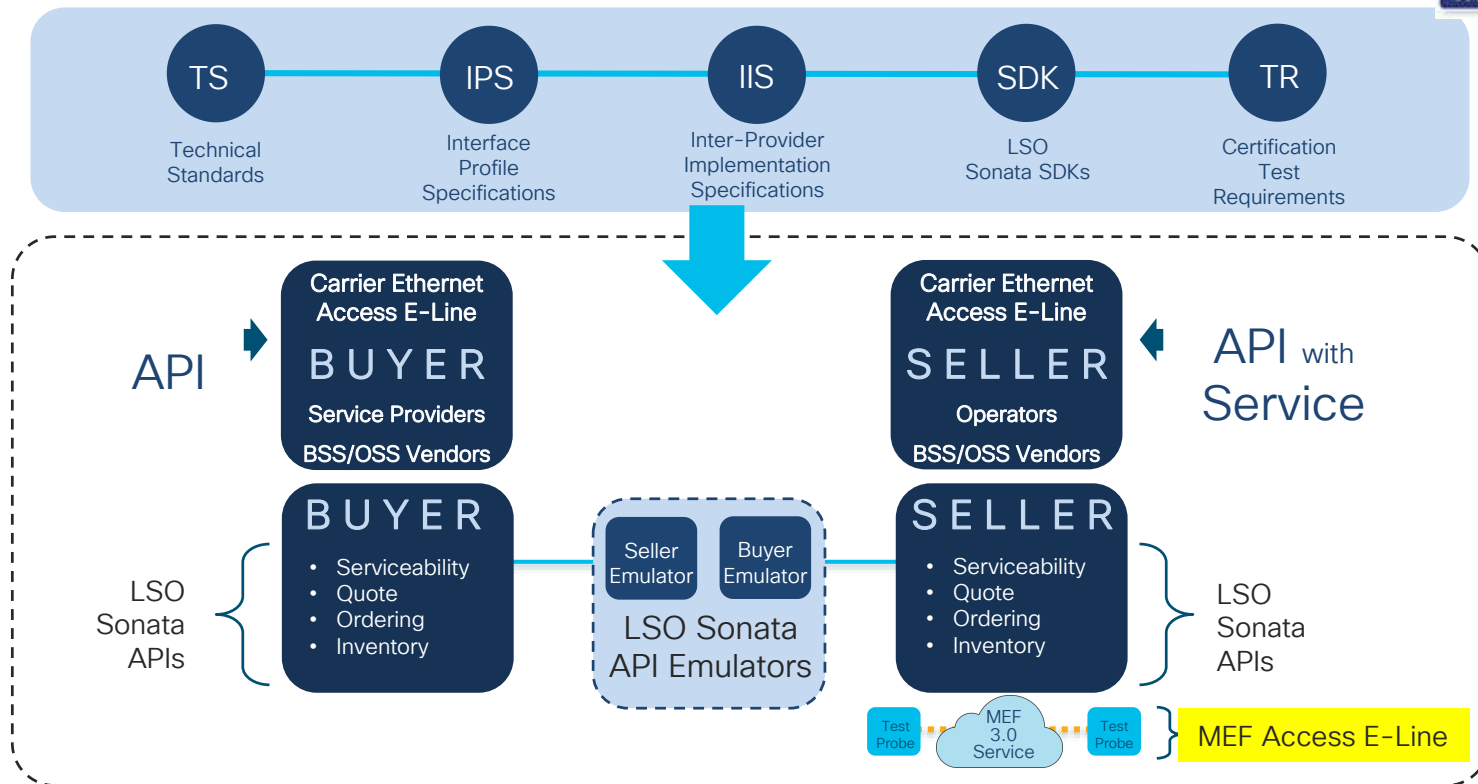|	CE 2.0 MEF CERTIFIED	MEF 3.0 CERTIFIED
E-Line, E-LAN	✓	✓
E-Tree, E-Access	✓	✓
Access E-Line, Transit E-Line *	✗	✓
LSO Orchestrated Services / LSO APIs *	✗	✓
L1 Connectivity and IP Services Attributes *	✗	✓

NEW

* MEF Roadmap

MEF 3.0 Agile Certification Platform

Test Portal

SP or Vendor Team

Cloud Test Manager

LSO API Emulator

MEF LSO APIs

Software Probe

Successful Test

White box Server

MEF-Defined Service

Software Probe

White box Server

MEF LSO Sonata Certification

Status: Pilot phase as of November 2019. First certifications expected by Q1 2020.

Cisco MEF 3.0 Certified Products*

ASR920

ASR9901

ASR9k

NCS540

NCS560

NCS 55A1

NCS 55A2

* As of January 2020. For details and updates refer to MEF Certification Registry (Public):
https://www.mef.net/certification/equipment_details?company=001U0000007OcrlIAS

Summary

Summary

- MEF 3.0 *supersedes* MEF CE 2.0 and *expands* in many areas
  - New services, new technical specs, updated specifications
  - LSO architecture and APIs
  - New certification model – currently available only for L2 connectivity services
  - Community driven implementations

- Practical impact:
  - Adds L2 service enhancements, new L1 and L3 services, *including SD-WAN*, with related terminology
  - Request for new MEF 3.0 services or service enhancements and related certifications
  - Availability of standard data models for services
  - Provides a services orchestration framework based on LSO with related APIs

MEF 3.0 Supporting material

MEF Website (public)
http://www.mef.net/mef-3-0-information-kit-downloads

MEF Wiki (log-in required)
https://wiki.mef.net

MEF LSO Git (login and access required)
https://github.com/orgs/MEF-GIT/teams

Useful Links

- MEF19 MEF 3.0 Workshop (Public):

https://www.youtube.com/playlist?list=PLJ35mJXaIMRYMNOFyNrvc8w1L7G9wA4yB

- MEF 3.0 Presentations (Member Login Required)

https://wiki.mef.net/display/MC/Standard+Presentations

- MEF Technology/Vendors Certification Registry (Public)

https://www.mef.net/certification/technology-certification-registry

- Cisco equipment certifications on MEF Registry:

https://www.mef.net/certification/equipment_details?company=001U0000007OcrIlAS

- MEF 3.0 Services Certification (Public)

https://www.mef.net/certification/services-certification-registry

Useful Links

- MEF SD-WAN White Paper

https://www.mef.net/resources/download?id=47&fileid=file1

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- Please complete your session survey after each session. Your feedback is very important.

- Complete a minimum of 4 session surveys and the Overall Conference survey (starting on Thursday) to receive your Cisco Live t-shirt.

- All surveys can be taken in the Cisco Events Mobile App or by logging in to the Content Catalog on ciscolive.com/emea.

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Cisco Webex Teams

Questions?
Use Cisco Webex Teams to chat
with the speaker after the session

How

1. Find this session in the Cisco Events Mobile App

2. Click "Join the Discussion"

3. Install Webex Teams or go directly to the team space

4. Enter messages/questions in the team space
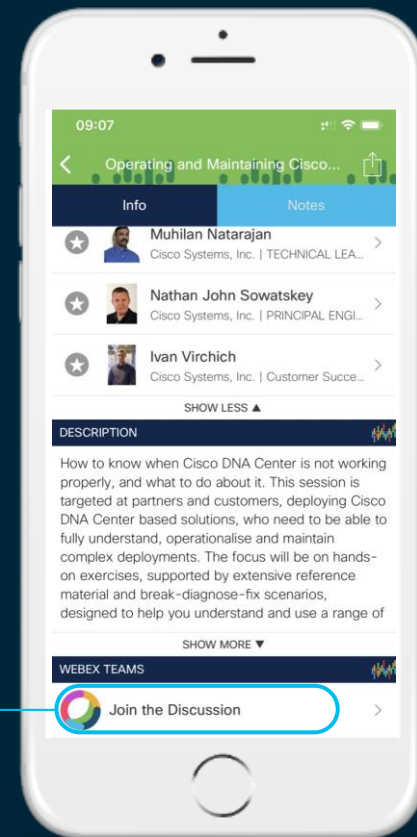
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Cisco Showcase

Walk-In Labs

Meet the Engineer
1:1 meetings

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