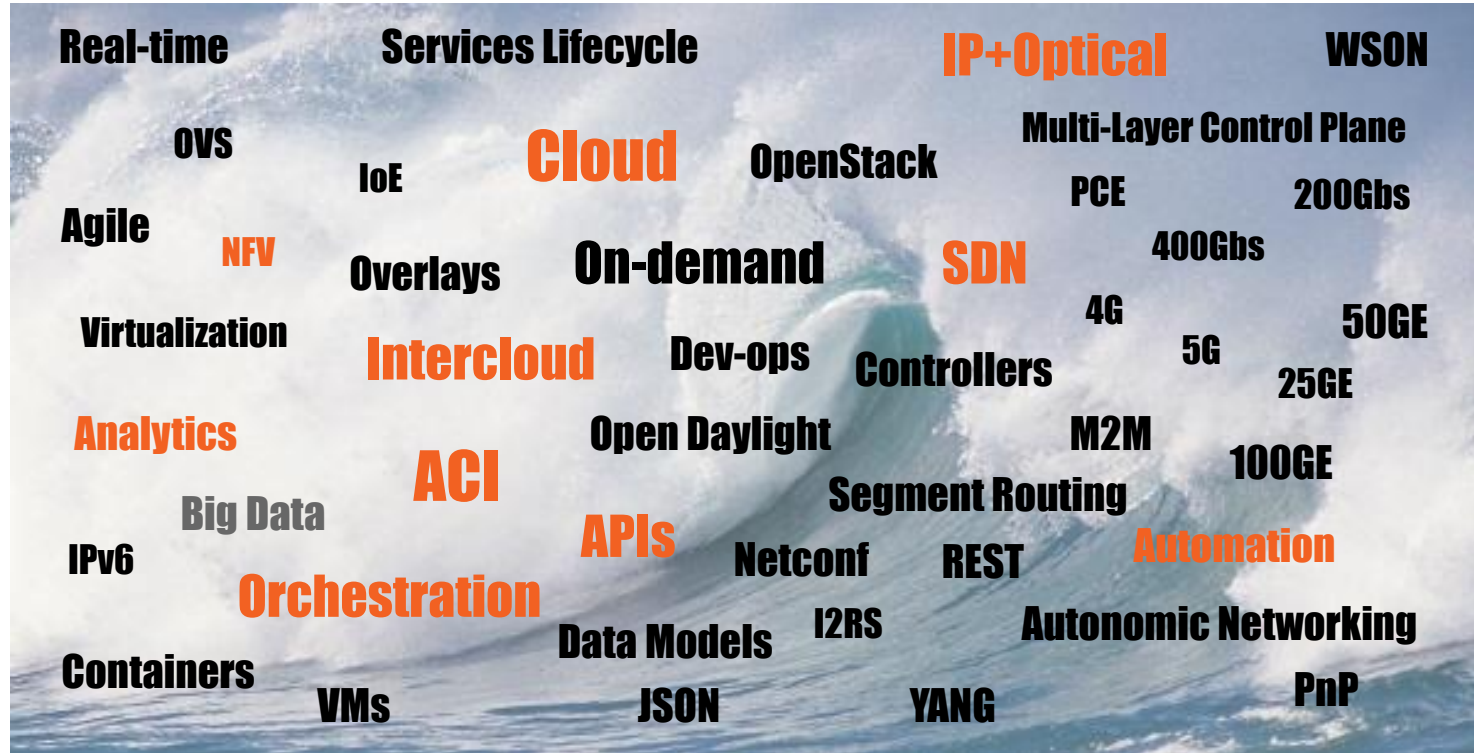# Carrier Ethernet 2.0

BRKSPG-2720

Kashif Islam – Solutions Architect

Cisco live!

Agenda

- Introduction

- Carrier Ethernet Fundamentals

- Carrier Ethernet 2.0
  - Service Definitions and Enhancements
  - Service Design and Deployment

- Next Gen Carrier Ethernet Architecture

- Conclusion

The Network Industry Is Changing ≡*Fast*

"Tsunami of Innovations"

Real-time
Services Lifecycle
IP+Optical
WSON
OVS
Cloud
OpenStack
Multi-Layer Control Plane
IoE
PCE
200Gbs
Agile
NFV
400Gbs
Overlays
On-demand
SDN
Virtualization
4G
50GE
Intercloud
Dev-ops
5G
Controllers
25GE
Analytics
M2M
ACI
Open Daylight
100GE
Big Data
Segment Routing
APIs
IPv6
Netconf
REST
Automation
Orchestration
I2RS
Autonomic Networking
Data Models
Containers
JSON
YANG
PnP
VMs

Industry Changes Drive Demand for Carrier Ethernet

Traffic

Big Data and Cloud

Internet of Everything

Consumer Video

CAPEX/OPEX

Mobility

Business Video

Carrier Ethernet Growth Brings Many Challenges

- Network growth;

- Diversity of requirements;

- Off-net customers reach;

- Operational complexity;

- Services differentiation;

Carrier Ethernet 2.0 Aims To Help Service Providers

Expanding and Enhancing Services, Simplifying Operations and Extending Services Reach:

Multiple Classes of Services	Interconnected Networks	Service Management

Foundation:

+10 years of standards bodies work (MEF, IEEE, ITU-T)	Carrier Industry Best Practices

MEF Specifications and Equipment/Service Certification

Key Applications:

Business Services	Mobile Backhaul	Wireline Aggregation	Access Services	Cloud Connectivity

MEF CE 2.0: A Comprehensive Program

Focus of this session

```
                    ┌──────────────┐
                    │   MEF        │
                    │   CE 2.0     │
                    └──────┬───────┘
         ┌─────────────────┼─────────────────┐
┌────────────────┐ ┌──────────────┐ ┌──────────────┐
│   Technical    │ │  Marketing   │ │ Certification│
│ Specifications │ │  Program     │ │  Program     │
└────────────────┘ └──────────────┘ └──────┬───────┘
                            ┌───────────────┼───────────────┐
                    ┌──────────────┐ ┌──────────────┐ ┌──────────────┐
                    │   Products   │ │   Services   │ │ Professionals│
                    └──────────────┘ └──────────────┘ └──────────────┘
```
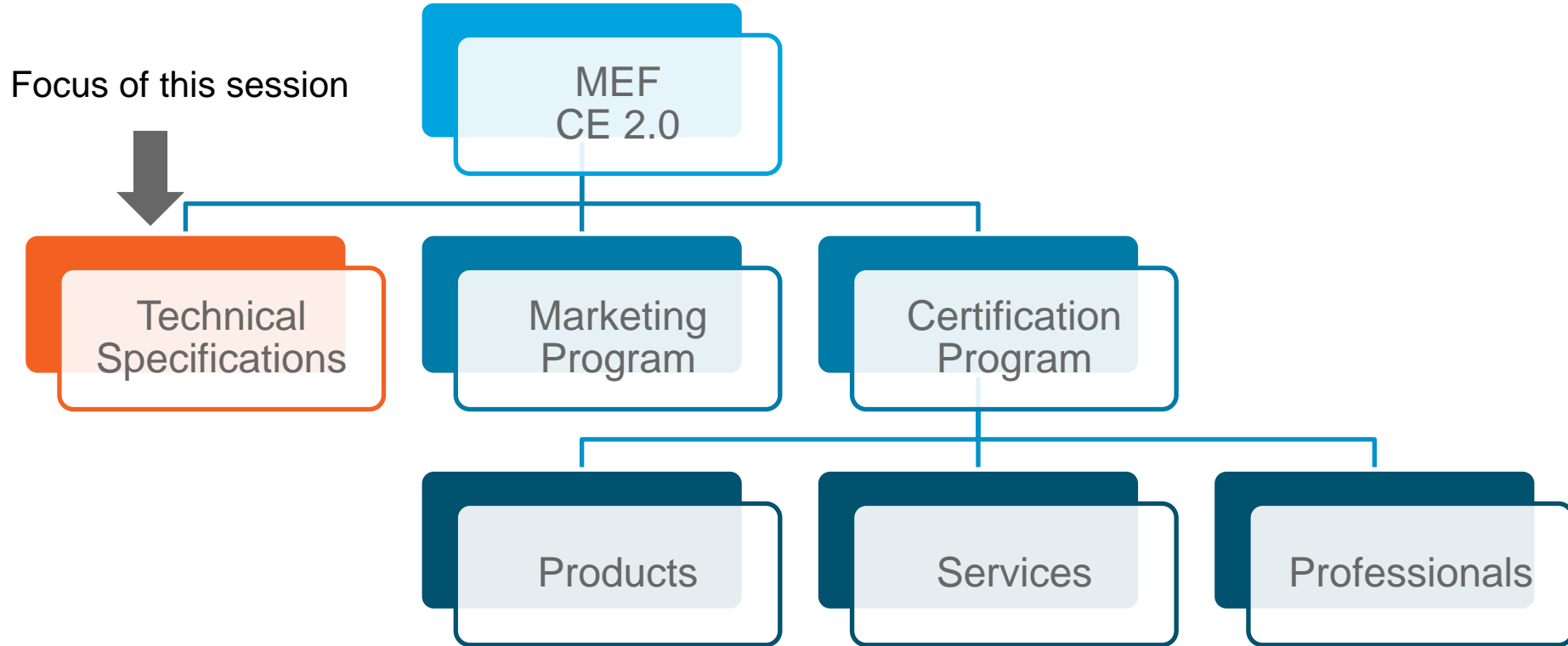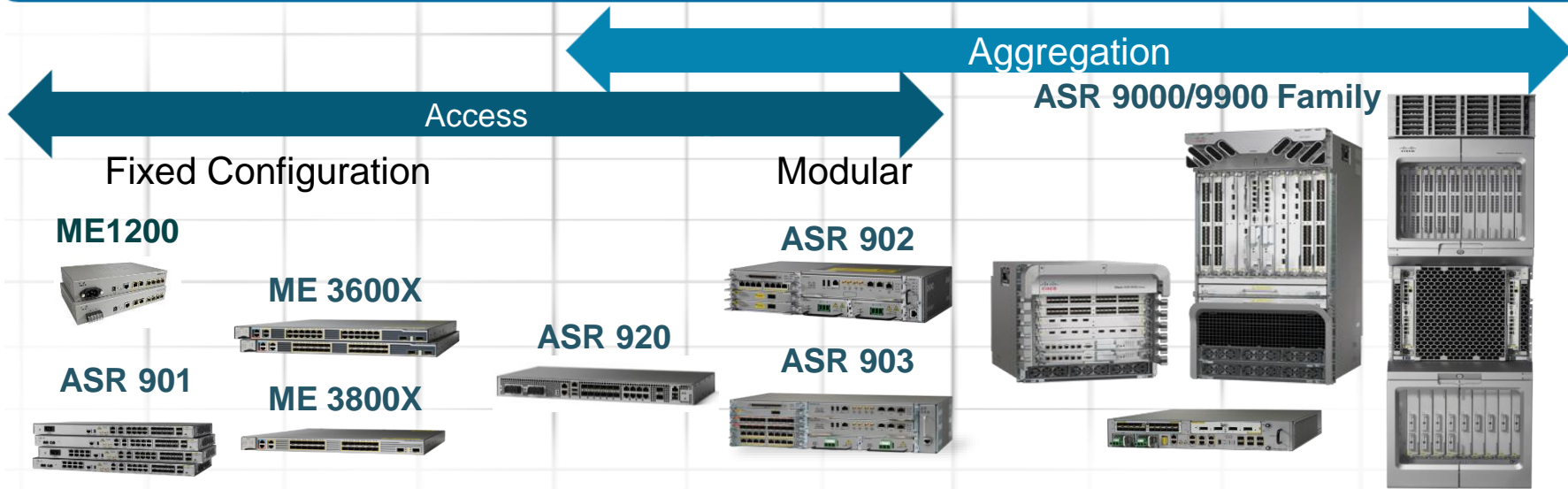
Cisco's Provides the Only CE 2.0 Services Certified End-to-End Solution

Cisco Evolved Programmable Network - EPN

Cisco Prime and Unified MPLS

Aggregation

Access

ASR 9000/9900 Family

Fixed Configuration

Modular

ME1200

ME 3600X

ASR 902

ASR 920

ASR 901

ME 3800X

ASR 903

Agenda

- Introduction

- **Carrier Ethernet Fundamentals**

- Carrier Ethernet 2.0
  - Service Definitions and Enhancements
  - Service Design and Deployment

- Next Gen Carrier Ethernet Architectures

- Conclusion

MEF Defines Carrier Ethernet As A Service

Metro Ethernet Forum: industry body that standardized Carrier Ethernet Services.

Carrier Ethernet is a *service* that is *ubiquitous*, *standard* and *carrier class*, differentiated from classic Ethernet technology by *5 key attributes*:
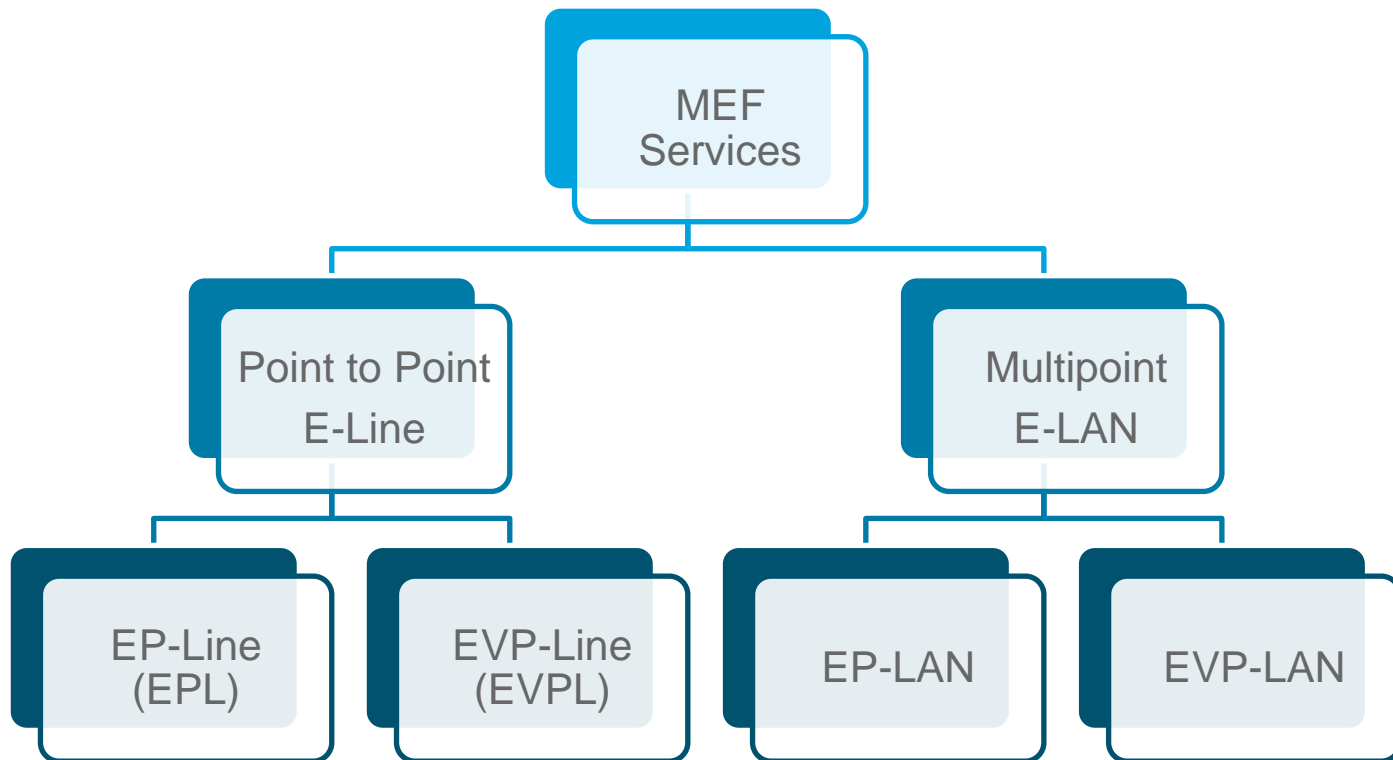
- Standardized
- Scalable
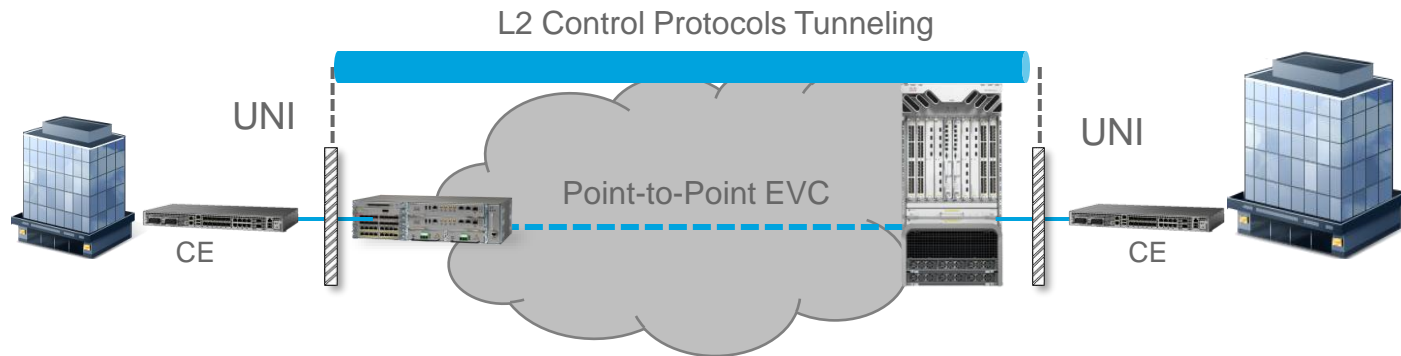- Resilient
- Manageable
- Quality of Service

Carrier Ethernet Services Terminology Explained

Ethernet Virtual Connection (EVC)

End User *Branch*

End User *HQ*

Operator Virtual Connection (OVC)

Operator Virtual Connection (OVC)

UNI

ENNI

UNI

Operator A CEN

Operator Z CEN

CE

CE

Internet

UNI

UNI

Applications Servers
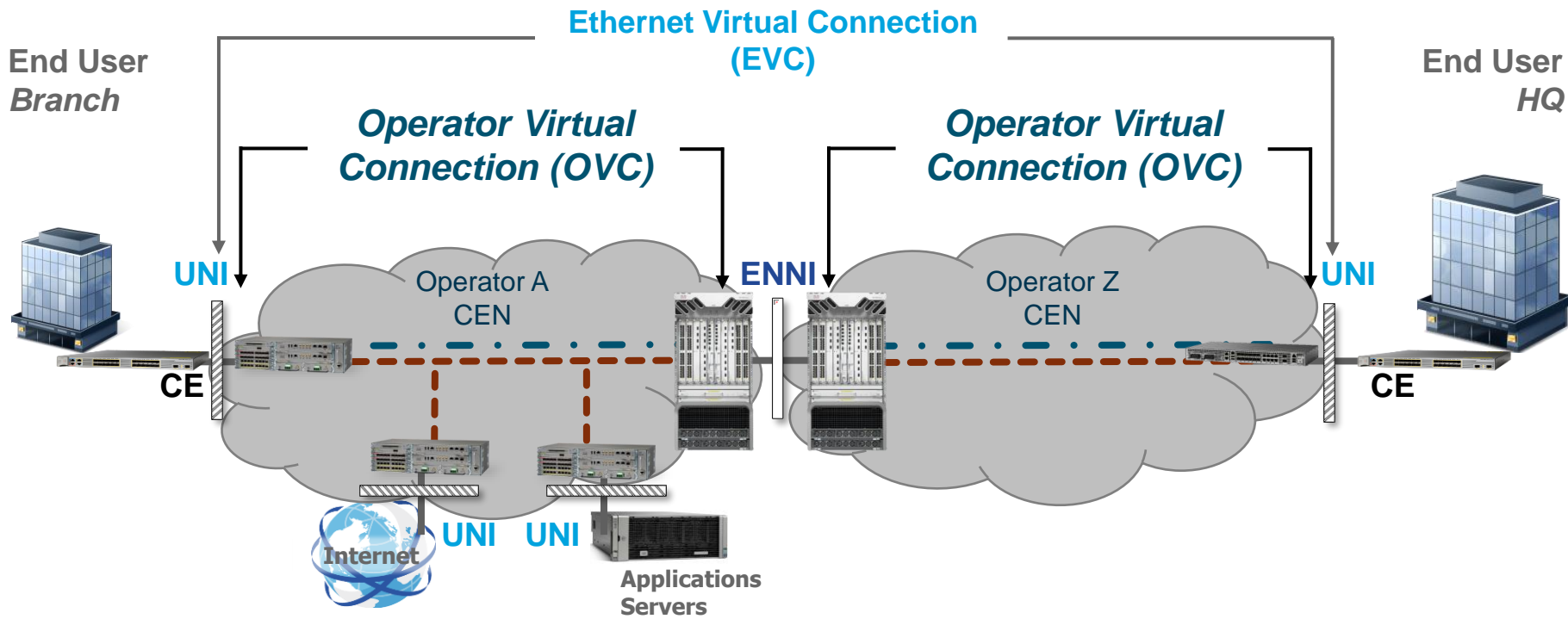
The First Generation of Carrier Ethernet Services

```
                        ┌─────────────┐
                        │     MEF     │
                        │   Services  │
                        └──────┬──────┘
               ┌───────────────┴───────────────┐
      ┌────────┴────────┐             ┌─────────┴────────┐
      │  Point to Point │             │    Multipoint    │
      │     E-Line      │             │      E-LAN        │
      └────────┬────────┘             └─────────┬────────┘
        ┌──────┴──────┐                   ┌──────┴──────┐
   ┌────┴────┐   ┌─────┴─────┐       ┌─────┴────┐  ┌─────┴─────┐
   │ EP-Line │   │ EVP-Line  │       │  EP-LAN  │  │  EVP-LAN  │
   │  (EPL)  │   │  (EVPL)   │       │          │  │           │
   └─────────┘   └───────────┘       └──────────┘  └───────────┘
```

E-Line = Point To Point Ethernet Connectivity

L2 Control Protocols Tunneling

UNI

Point-to-Point EVC

UNI

CE

CE

- EPL – Ethernet Private Line:
  - Port based;
  - Transparent;
  - Application: TDM Replacement.

- EVPL – Ethernet Virtual Private Line:
  - VLAN aware;
  - Allows Service multiplexing and bundling;
  - Application: ATM/FR Replacement.

E-Line Use Cases

* Note: Bandwidth granularity is transport technology dependent.

Carrier Ethernet Service	Application	Technical Benefits
EPL	Leased Line Services for: • LAN extension; • Data Center Interconnect; • Voice over IP; • Internet Access; • Business applications; • Collaboration services; • Backhaul services • Cloud services, and others… (TDM replacement)	• Higher interface speeds • Fine bandwidth granularity* • Interface flexibility* • Support for Multiple classes of service • Transparency
EVPL	Same as EPL, plus: • Service Multiplexing at Central Location (Frame Relay or ATM Replacement)	Similar to EPL, with some differences: • Adds scalable service multiplexing (4096 VLAN IDs) • Less transparent due VLAN processing at UNI.

E-LAN = Multipoint Ethernet Connectivity

L2 Control Protocols Tunneling

UNI

CE

UNI

CE

Multipoint EVC

UNI

CE
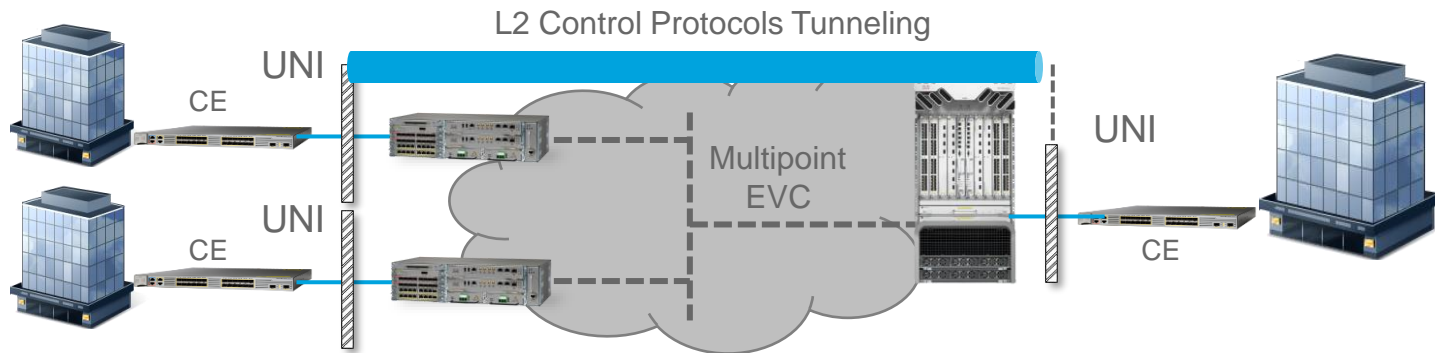
- EP-LAN – Ethernet Private LAN:
  - Port based;
  - Transparent;
  - Application: LAN emulation or extension.

- EVP-LAN – Ethernet Virtual Private LAN:
  - VLAN aware;
  - Service multiplexing and bundling;
  - Application: ATM/FR replacement.

E-LAN Use Cases

* Note: Bandwidth granularity is transport technology dependent.

Carrier Ethernet Service	Application	Technical Benefits
EP-LAN	Multipoint connectivity for: • LAN extension; • Data Center Interconnect; • Business applications; • Collaboration services; • Broadcast and Multicast traffic; • Backhaul services; • Cloud services, and others… (LAN Emulation replacement)	• Efficient packet-based multipoint connectivity; • Higher interface speeds • Fine bandwidth granularity* • Interface flexibility* • Multiple classes of service support • Transparency
EVP-LAN	Same as EP-LAN, plus: • Service multiplexing at central location; (Frame Relay or ATM Replacement)	• Higher interface speeds • Bandwidth granularity* • Interface flexibility* • Multiple classes of service support • Scalable service multiplexing (4096 VLAN IDs)

Services Behavior Also Depend On Other 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, …*		

*See MEF10.3, Section 8.8

L2 Control Processing

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

Chart provided only as illustration. It's not meant to represent the latest state of MEF specifications.
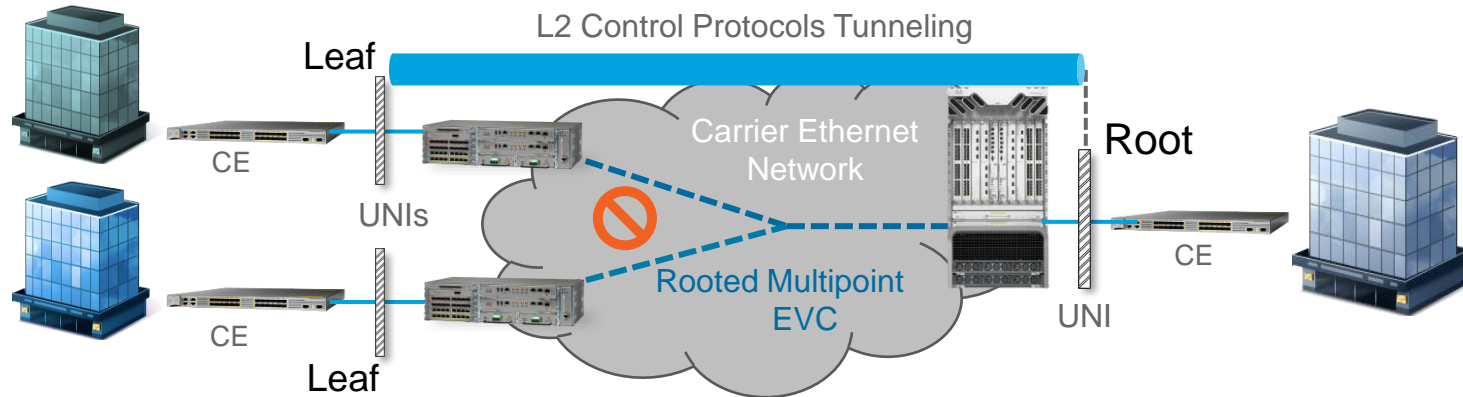
Agenda

- Introduction

- Carrier Ethernet Fundamentals

- Carrier Ethernet 2.0
  - Service Definitions and Enhancements
  - Service Design and Deployment

- Next Gen Carrier Ethernet Architecture

- Conclusion

Carrier Ethernet 2.0 Includes 8 Services
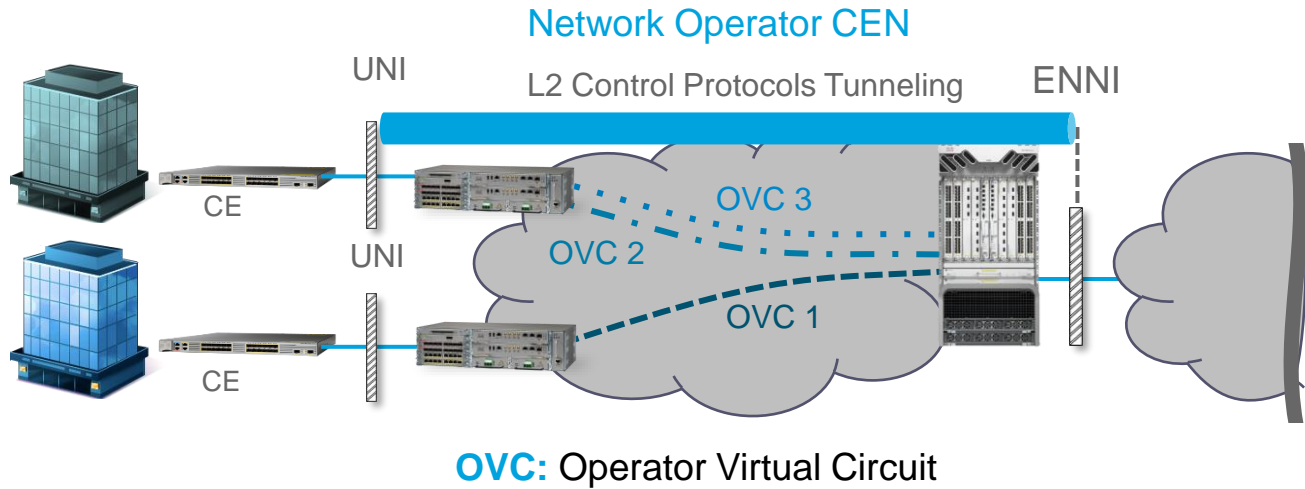

CE 2.0 Services

- Point to Point
  - E-Line
    - EP Line
    - EVP Line
- Multipoint
  - E-LAN
    - EP LAN
    - EVP LAN
  - E-Tree **New**
    - EP Tree
    - EVP Tree
- Wholesale **New**
  - E-Access
    - EP Access
    - EVP Access

E-Tree Service

L2 Control Protocols Tunneling

Leaf

UNIs

Carrier Ethernet Network

Root

CE

CE

Rooted Multipoint EVC

UNI

CE

Leaf
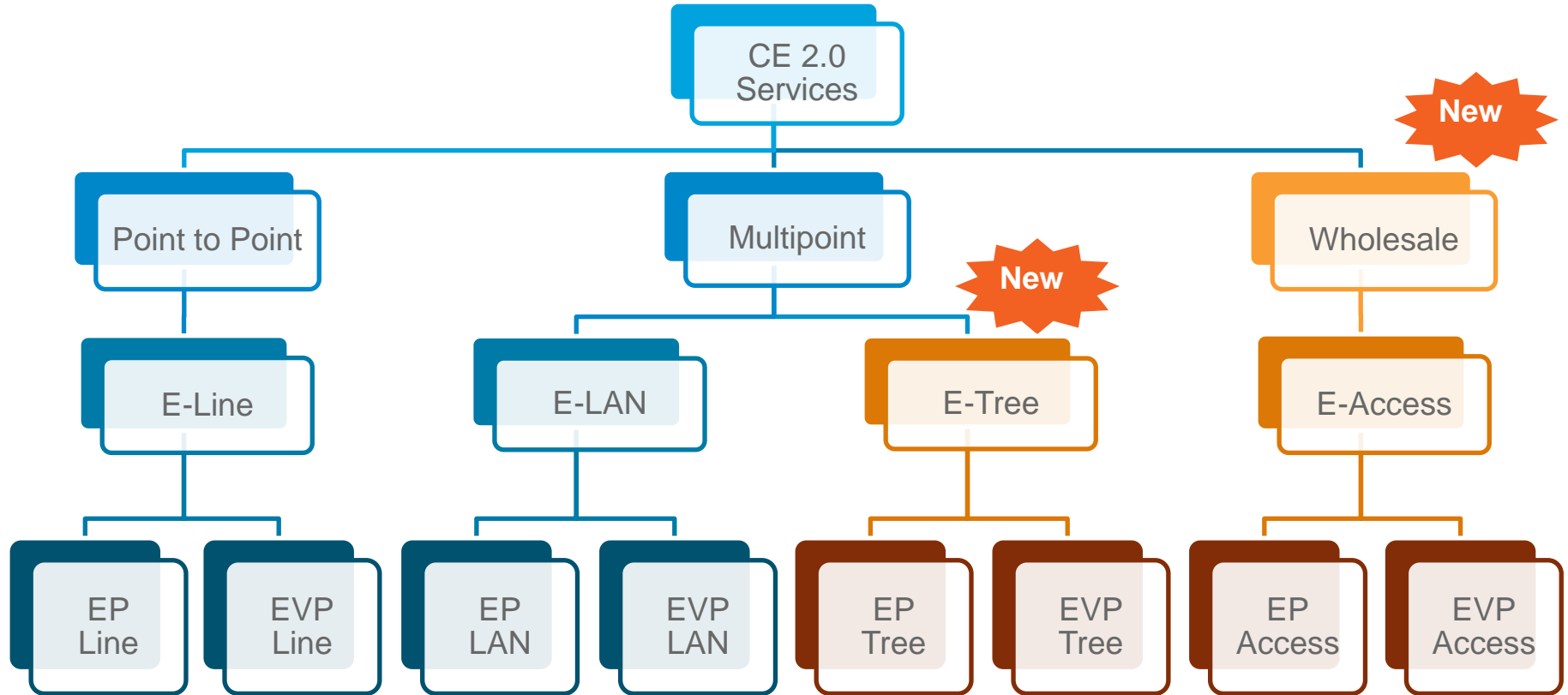
- **EP-Tree**:
  - Port-based at the UNI;
  - High-degree of transparency;

- **EVP-Tree**:
  - VLAN based service.
  - Service Multiplexing and Bundling at UNI;

E-Access Service

Network Operator CEN

UNI

L2 Control Protocols Tunneling

ENNI

CE

OVC 3

OVC 2

OVC 1

UNI

CE

OVC: Operator Virtual Circuit

- Access EPL:
  - Port-based at the UNI;
  - High-degree of transparency;

- Access EVPL:
  - VLAN based service.
  - Service Multiplexing and Bundling at UNI;

Interconnecting Carrier Ethernet Networks with E-NNI

E-NNI

CEN Operator A

CEN Operator B
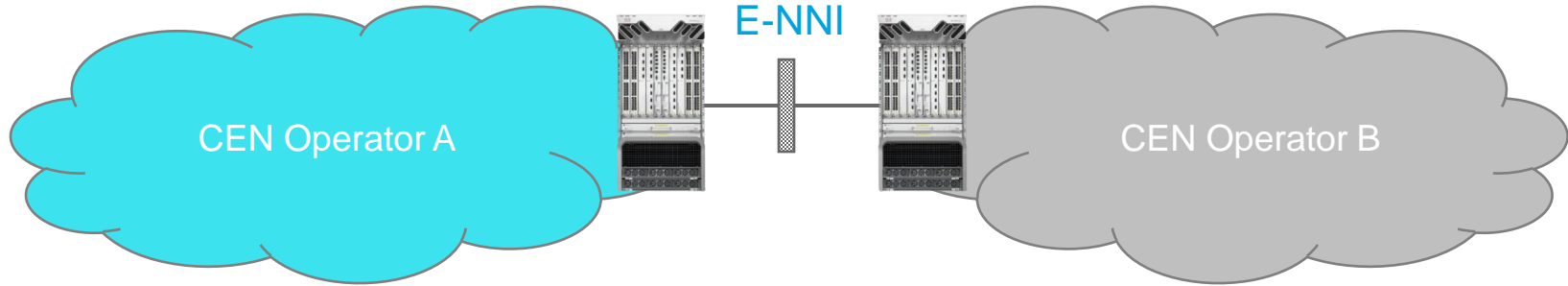
Key Characteristics

- 802.1ad Framing;
- LACP for protection

- Link OAM;
- MTU ≥ 1526 bytes
  (≥ 2000 bytes recommended).

EP-Line Option 2 Service

Destination MAC	Protocol	Ethertype Subtype	L2CP Action			
			EPL Option 1	EPL Option 2	EP-LAN	EP-Tree
01-80-C2-00-00-00	STP/RSTP/MSTP		MUST Tunnel	MUST Tunnel	MUST Tunnel	MUST Tunnel
01-80-C2-00-00-01	Pause	0x8808	MUST NOT Tunnel	Should Discard	MUST NOT Tunnel	MUST NOT Tunnel
01-80-C2-00-00-02	LACP/LAMP	0x8809/01/02	MUST NOT Tunnel	Should Tunnel	MUST NOT Tunnel	MUST NOT Tunnel
01-80-C2-00-00-02	Link OAM	0x8809/03	MUST NOT Tunnel	Should Tunnel	MUST NOT Tunnel	MUST NOT Tunnel
01-80-C2-00-00-02	ESMC	0x8809/0A	MUST NOT Tunnel	Should Tunnel	MUST NOT Tunnel	MUST NOT Tunnel
01-80-C2-00-00-03	802.1X	0x888E	MUST NOT Tunnel	Should Tunnel	MUST NOT Tunnel	MUST NOT Tunnel
01-80-C2-00-00-04	MAC Specific Control Protocols		MUST NOT Tunnel		MUST NOT Tunnel	MUST NOT Tunnel
01-80-C2-00-00-05	Reserved		MUST NOT Tunnel		MUST NOT Tunnel	MUST NOT Tunnel
01-80-C2-00-00-06	Reserved		MUST NOT Tunnel		MUST NOT Tunnel	MUST NOT Tunnel
01-80-C2-00-00-07	E-LMI	0x88EE	MUST NOT Tunnel	MUST Tunnel	MUST NOT Tunnel	MUST NOT Tunnel
01-80-C2-00-00-08	Provider Bridge Group Address		MUST NOT Tunnel		MUST NOT Tunnel	MUST NOT Tunnel
01-80-C2-00-00-09	Reserved		MUST NOT Tunnel		MUST NOT Tunnel	MUST NOT Tunnel
01-80-C2-00-00-0A	Reserved		MUST NOT Tunnel		MUST NOT Tunnel	MUST NOT Tunnel
01-80-C2-00-00-0B	Reserved		MUST Tunnel		MUST Tunnel	MUST Tunnel
01-80-C2-00-00-0C	Reserved		MUST Tunnel		MUST Tunnel	MUST Tunnel
01-80-C2-00-00-0D	Provider Bridge MVRP Address		MUST Tunnel		MUST Tunnel	MUST Tunnel
01-80-C2-00-00-0E	LLDP	0x88CC	MUST NOT Tunnel	MUST Tunnel	MUST NOT Tunnel	MUST NOT Tunnel
01-80-C2-00-00-0E	PTP Peer Delay	0x88F7	MUST NOT Tunnel	MUST Tunnel	MUST NOT Tunnel	MUST NOT Tunnel
01-80-C2-00-00-0F	Reserved		MUST Tunnel		MUST Tunnel	MUST Tunnel
01-80-C2-00-00-20 through 01-80-C2-00-00-2F	GARP/GMRP		MUST Tunnel	MUST Tunnel	MUST Tunnel	MUST Tunnel

Source: MEF 6.1.1 Specification

Carrier Ethernet 2.0 Features:
Standardized Multiple Classes Of Service

Why Deploy Multi-CoS for Carrier Ethernet?

- Allows improved network utilization;

- Allows improved network monetization;

- Provides better application performance;

- Enables service differentiation;

- Some customers demand it.

Why Deploy <u>Standardized</u> Multi-CoS Model?

- Industry expertise;

- Simple yet flexible model;

- Common terminology;

- Consistency;

- Reference values for Service-Level-Specifications (SLS).

MEF CE 2.0 Introduces a Simple 3 CoS Model

CoS Label	Bandwidth Profile Constraint	Example Application
H	CIR > 0 EIR ≥ 0	Voice over IP Synchronization
M	CIR > 0 EIR ≥ 0	Protocol Signaling Business Applications
L	CIR ≥ 0 EIR ≥ 0	Web Traffic

CIR: Committed Information Rate   EIR: Excess Information Rate

Traffic mapping based on one of the possible CoS IDs:

UNI, EVC/OVC EP, 802.1Q PCP or DSCP

Carrier Ethernet Service Performance Metrics

FD	Frame Delay, in milliseconds.
MFD	Mean Frame Delay, in milliseconds.
IFDV	Inter-frame Delay Variation, in milliseconds.
FDR	Frame Delay Range, in milliseconds.
FLR	Frame Loss Ratio, in percentile.

Classes of Services And Performance Tiers

- Performance Tiers (PT) and Service Level Specifications (SLS):
  - Performance Tiers provide pre-defined SLS metrics and values.

- There are 4 Performance Tiers*:
  - PT1: Metro (250 km / 155 mi)
  - PT2: Regional (1,200 km / 745 mi)
  - PT3: Continental (7,000 km / 4,350 mi)
  - PT4: Global (27,500 km / 17,090 mi)

- May be applied to an EVC or OVC.

*Note: *Distances are provide as reference.*

Carrier Ethernet 2.0 Features: Service Management

The Need for Service level OAM

- Native tools available for IP level monitoring and troubleshooting

- Service level tools are not natively available

- Service OAM Provided Operational efficiency (OpEx);
  - Faster and easier troubleshooting;
  - Pro-active vs reactive operations;

- Provides SLS compliance;
  - Monitoring;
  - Reporting;

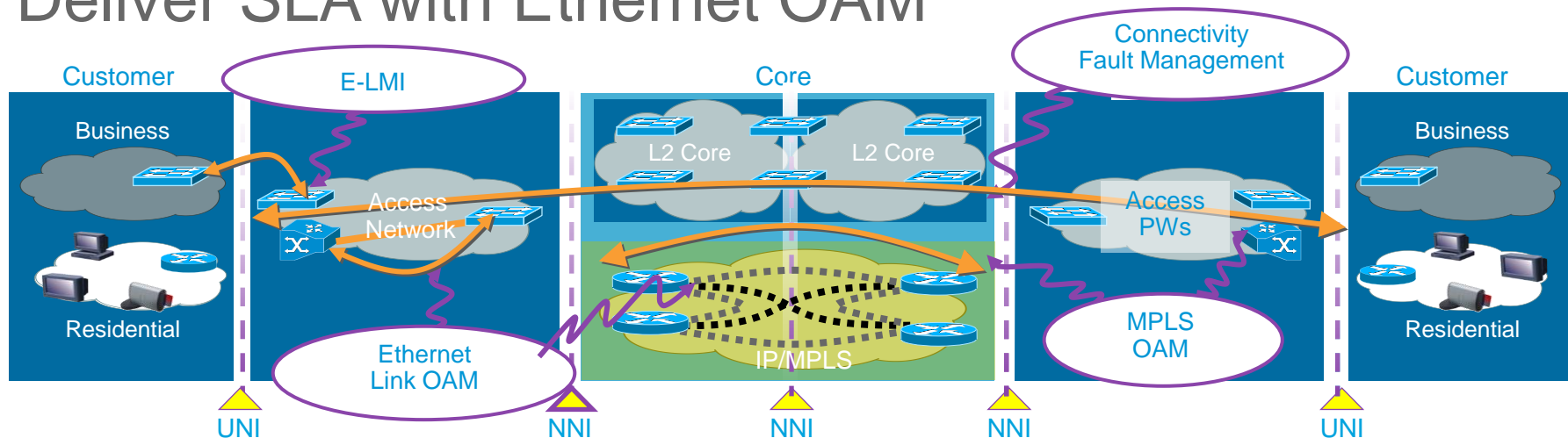# Mapping Ethernet OAM Building Blocks To Functional Layers

End to End Performance Monitoring

End to End Fault Monitoring

Point to Point *Link* Fault Management
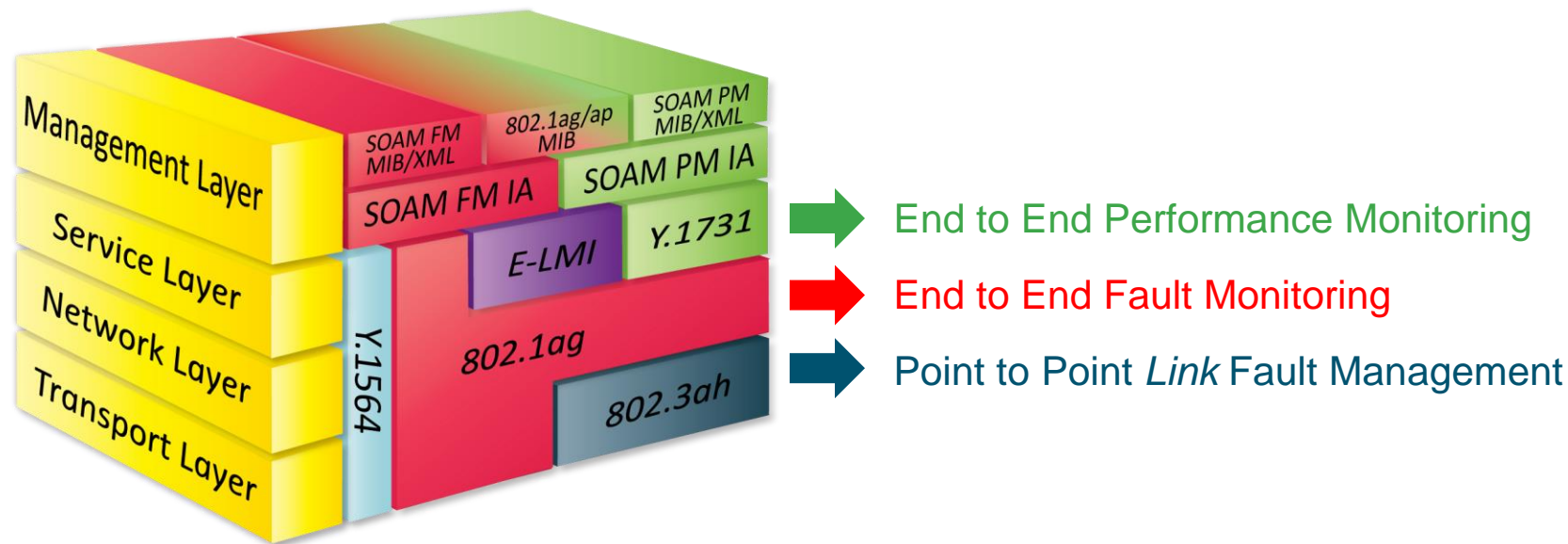
Note: Y.156sam (Y.1564) is not an OAM layer, but assessment that a Service is delivered to specification.

Deliver SLA with Ethernet OAM

Ethernet OAM
802.3ah Link OAM
ELMI
CFM 802.1ag /w Ethernet Fault Detection
Y.1731 Fault Management

Performance Monitoring
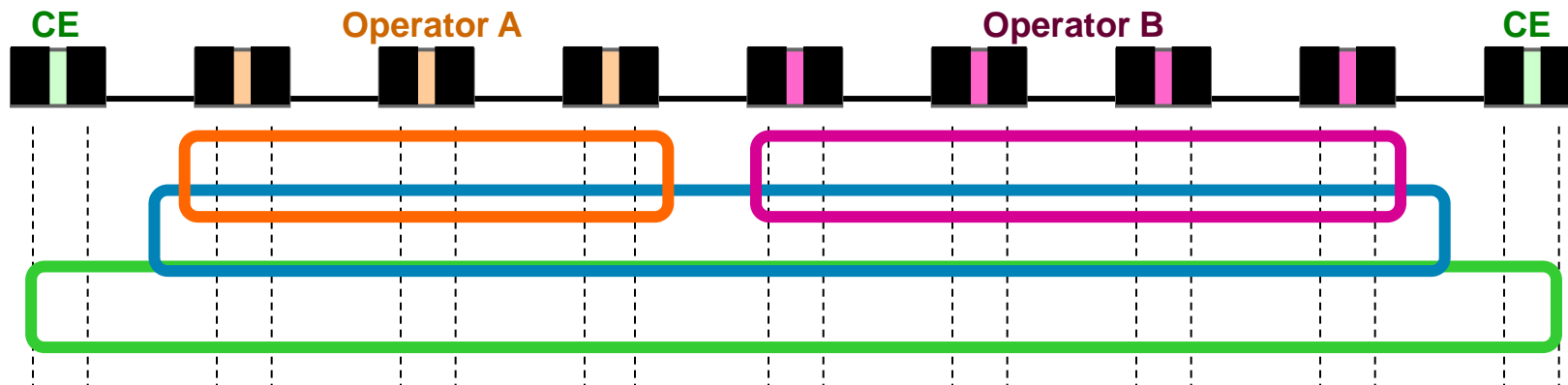Y.1731 Delay Measurement
Y.1731 SLM and LMM
IP SLA

Interworking
CFM-ELMI
802.3ah-CFM

Integrated Service Management with SLA Reporting
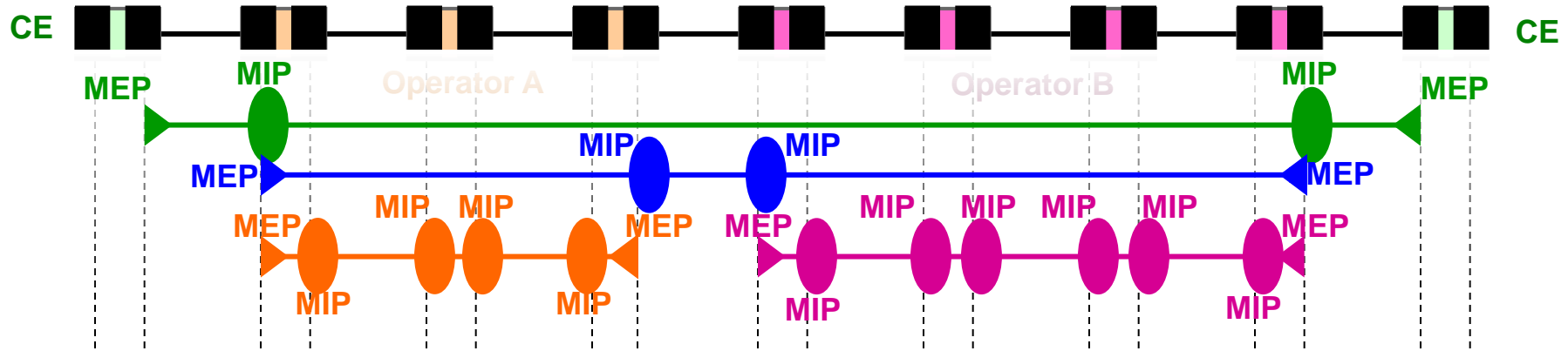
OAM Concepts

Management Entity Group

- Defined by Operational/Contractual Boundaries
  - e.g. Customer / Service Provider / Operator
- MEG may nest and touch
- Up to eight levels of "nesting": MEG Level (0..7)
  - The higher the level, the broader its reach

OAM Concepts

Maintenance End Points, Maintenance Intermediate Point

CE — MEP — MIP — Operator A — MIP — MIP — Operator B — MIP — MEP — CE

MEP · MIP · MEP · MIP · MIP · MEP · MEP · MIP · MIP · MIP · MIP · MEP · MIP

- **M**aintenance Association **E**nd **P**oint (**MEP**)

- Define the boundaries of a MD

- Support the detection of connectivity failures between any pair of MEPs

- Can initiate and respond to PDUs

- **M**aintenance Domain **I**ntermediate **P**oint (**MIP**)

- Support the discovery of paths among MEPs and location of faults along those paths

- Can be associated per MD and VLAN/EVC

- Can add, check and respond to received PDUs

Cisco *live!*

An End-to-End Ethernet OAM Example

E-LMI

Carrier Ethernet Network

E-LMI

Link OAM   Link OAM   Link OAM   Link OAM   Link OAM

MIP   MIP

Down MEP   Down MEP

Customer Domain

Up MEP   Up MEP

SP Domain
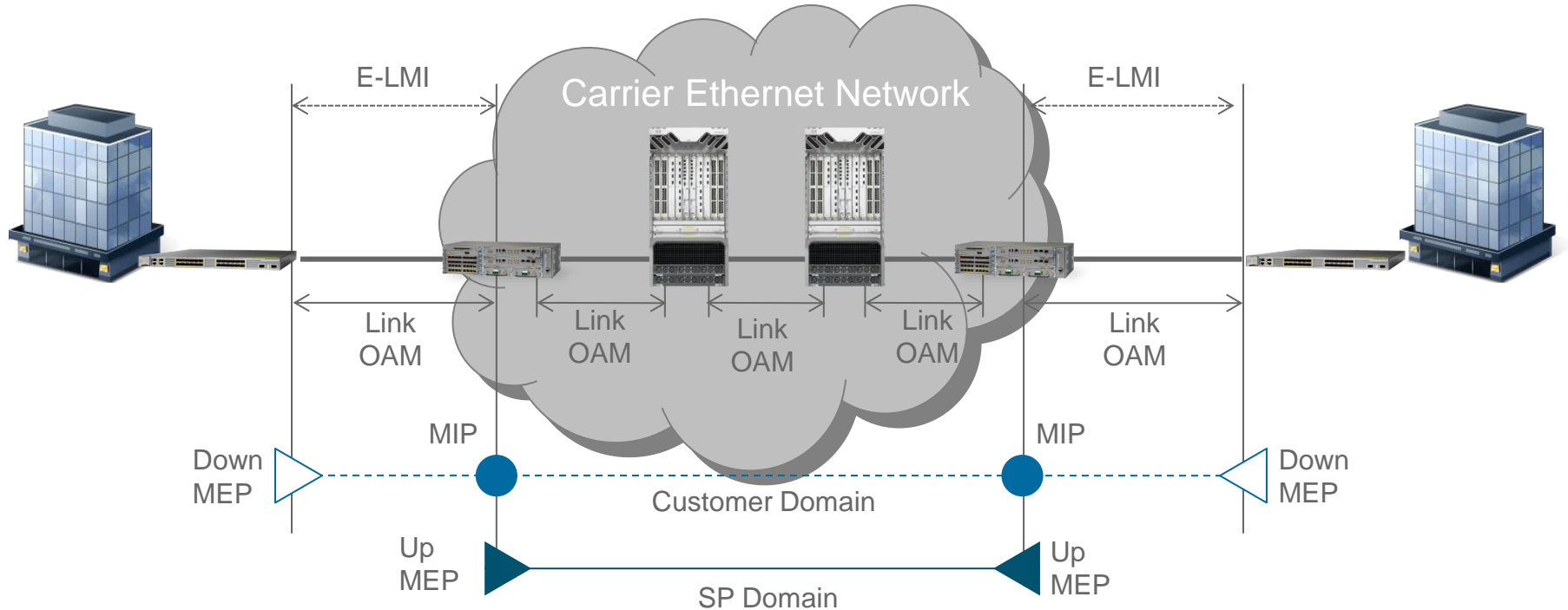
MEP: Maintenance End Point   **MIP:** Maintenance Intermediate Point   **E-LMI:** Ethernet Local Management Interface

CE 2.0 Fault Management Functions

ETH-CC	Ethernet Continuity Check.
ETH-LB	Ethernet Loopback.
ETH-LT	Ethernet Linktrace.
ETH-RDI	Ethernet Remote Defect Indication.
ETH-AIS	Ethernet Alarm Indication Signal.
ETH-LCK	Ethernet Locked Signal.

CE 2.0 Fault Management: Ethernet Continuity Check
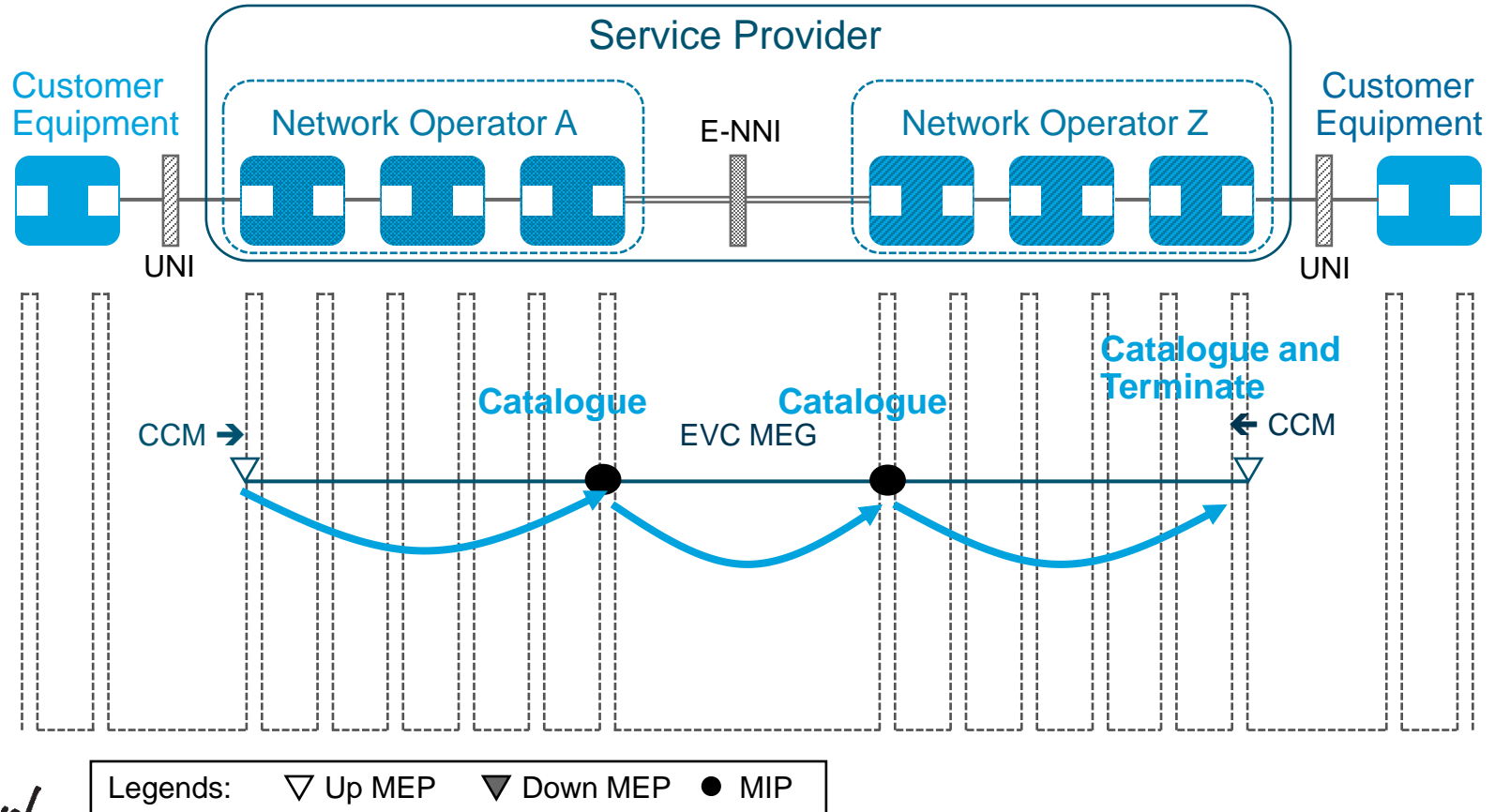
Ethernet Continuity Check In Action

Service Provider

Customer Equipment

Network Operator A

E-NNI

Network Operator Z

Customer Equipment

UNI

UNI

(3) Alarm is raised

CCM ➜

EVC MEG

(2) MEP misses

3 consecutive CCMs

(1) Fault

Single direction shown

Legends: ▽ Up MEP ▼ Down MEP ● MIP
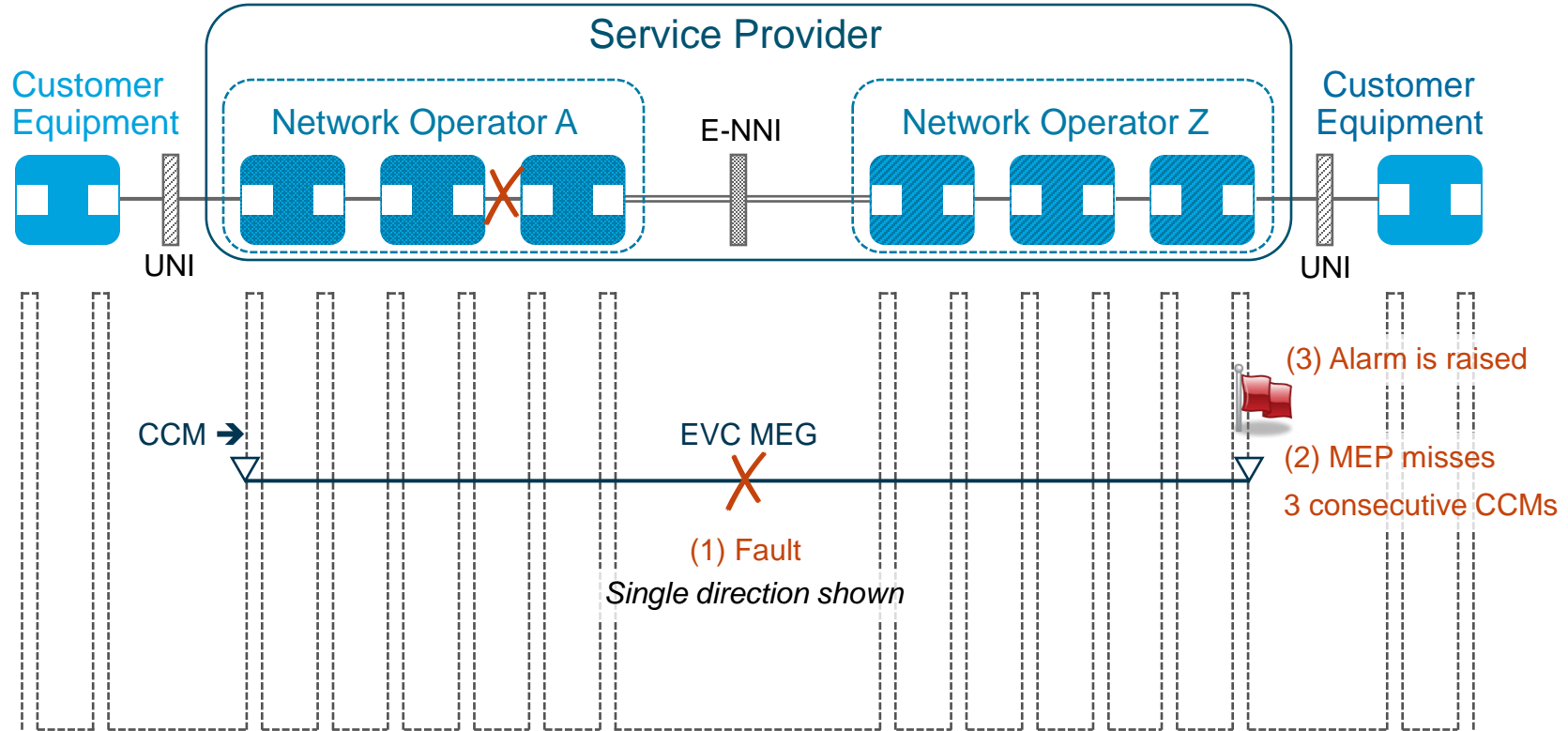
Ethernet Alarm Indication Signal (AIS) In Action
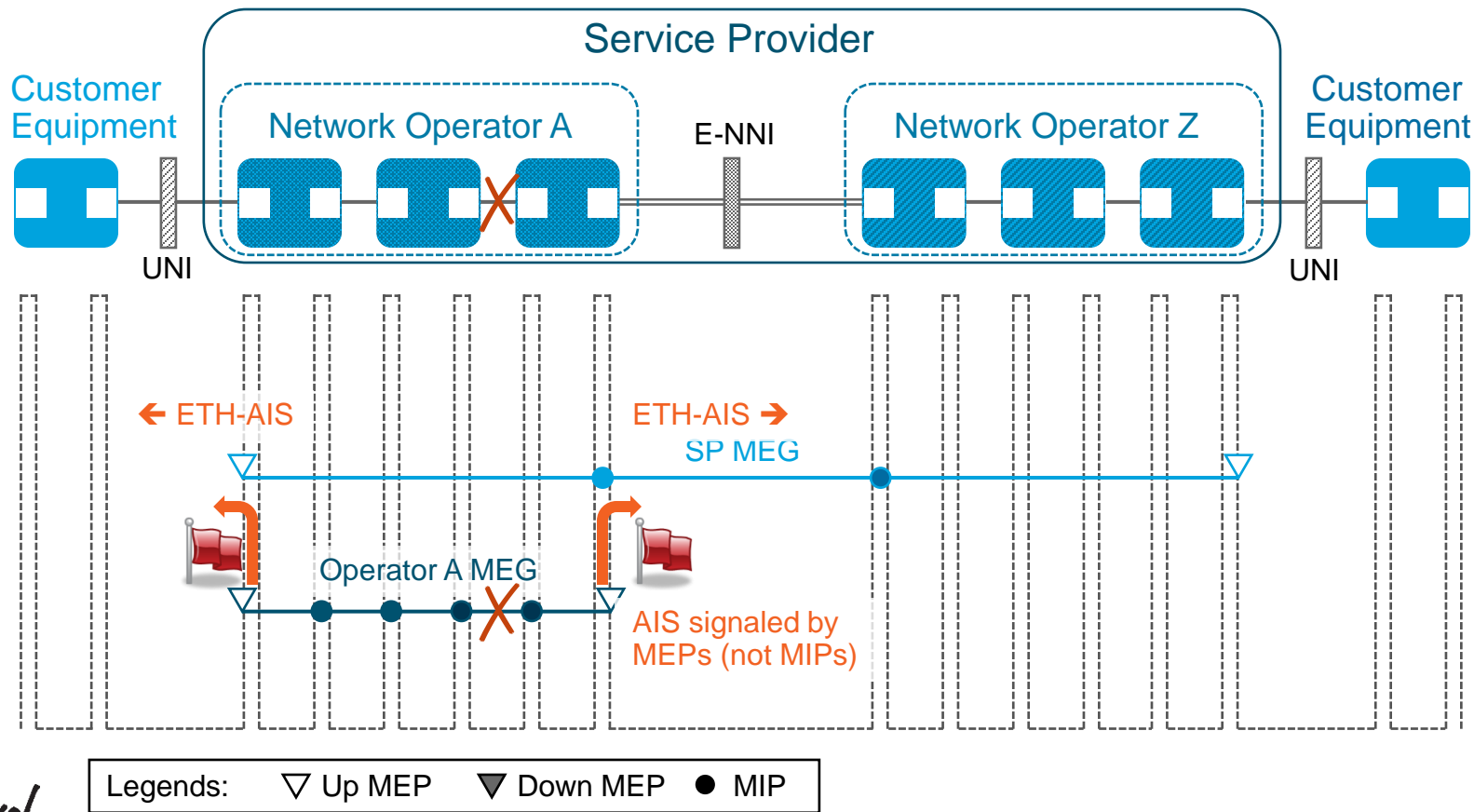
Service Provider

Customer Equipment

Network Operator A

E-NNI

Network Operator Z

Customer Equipment

UNI

UNI

← ETH-AIS

ETH-AIS →
SP MEG

Operator A MEG

AIS signaled by MEPs (not MIPs)

Legends: ▽ Up MEP ▼ Down MEP ● MIP

Ethernet Loopback (a.k.a. L2 Ping) In Action

Service Provider

Customer Equipment

Network Operator A

E-NNI

Network Operator Z

Customer Equipment

UNI

UNI

✓ MEP to MEP

(1) LBM ➜

SP MEG

(2) LBM

(4) LBR

← (3) LBR

Legends: ▽ Up MEP   ▼ Down MEP   ● MIP
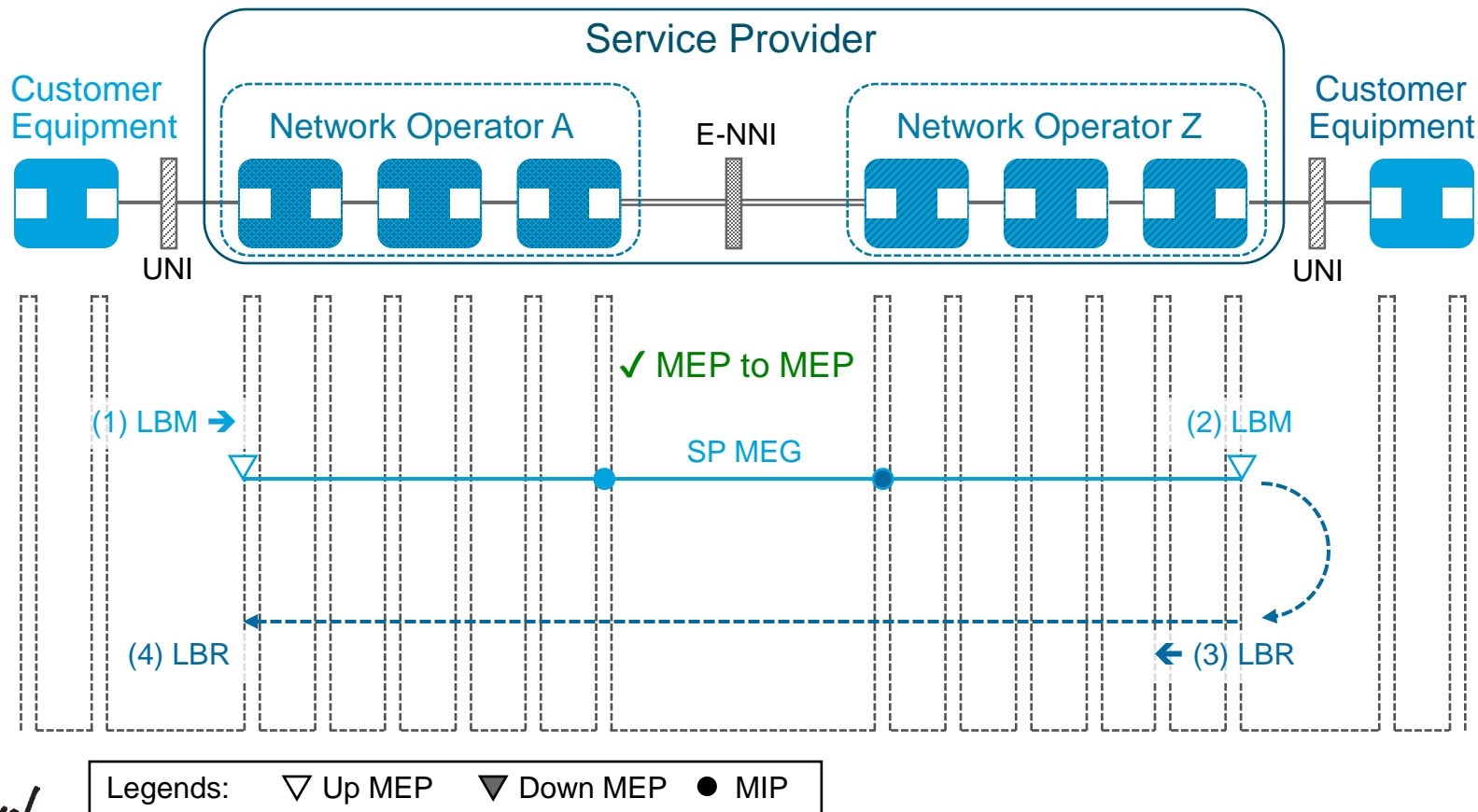
Ethernet Loopback (a.k.a. L2 Ping) In Action
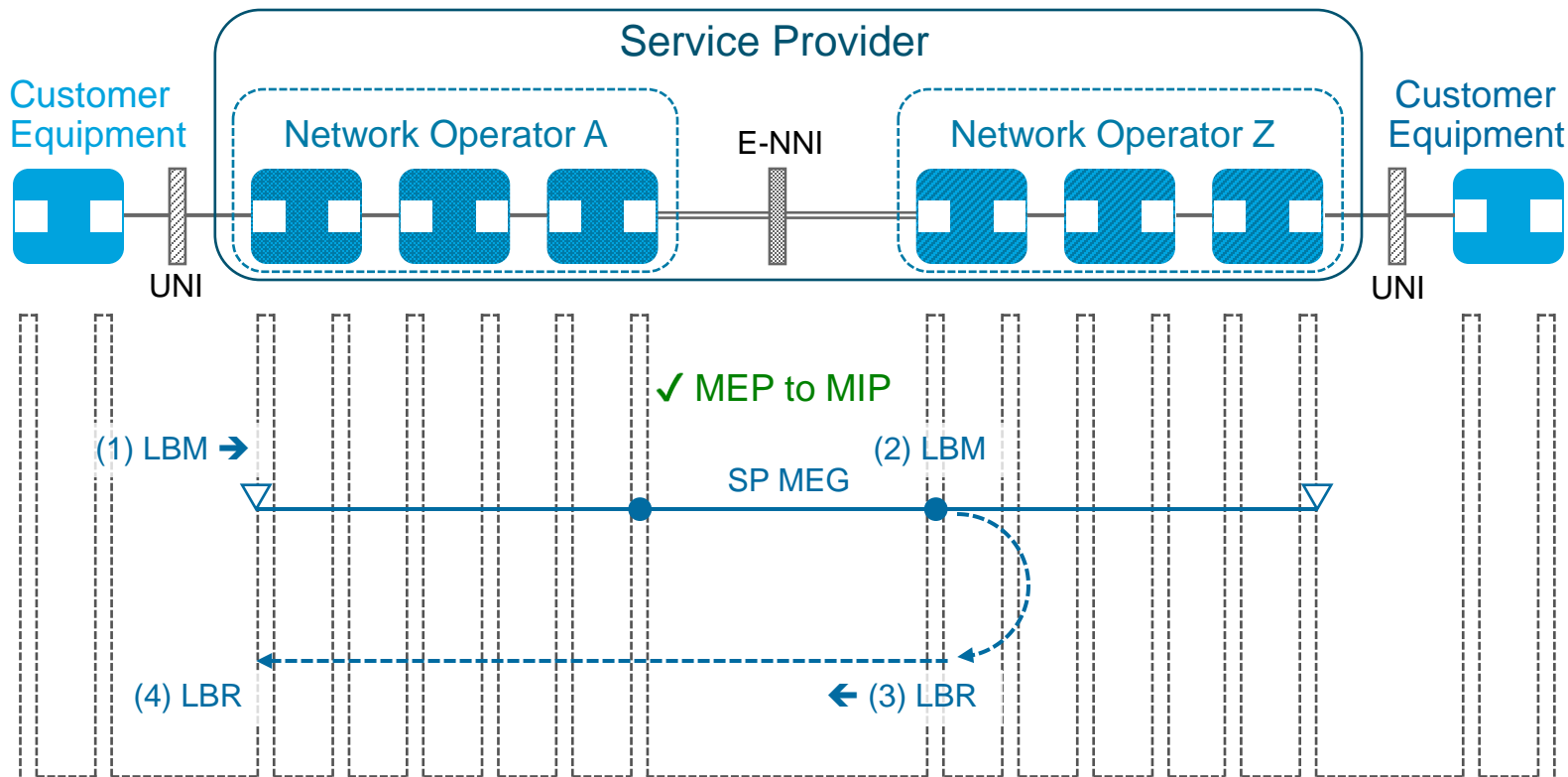
Ethernet Linktrace (a.k.a. L2 Traceroute) In Action
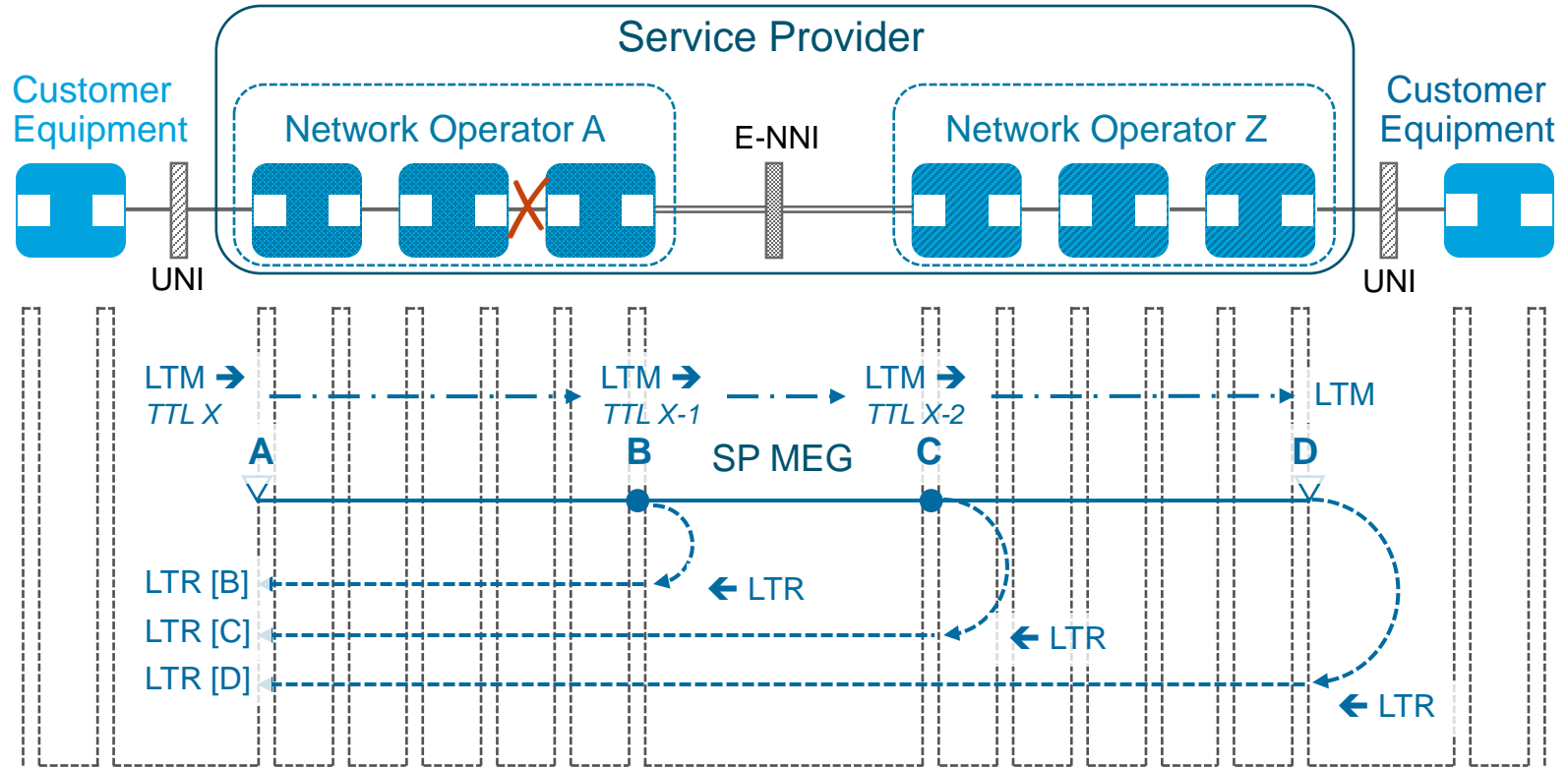
Service Provider

Customer Equipment

Network Operator A

E-NNI

Network Operator Z

Customer Equipment

UNI

UNI

LTM → TTL X

LTM → TTL X-1

LTM → TTL X-2

LTM

A

B

SP MEG

C

D

LTR [B]

← LTR

LTR [C]

← LTR

LTR [D]

← LTR

Legends: ▽ Up MEP ▼ Down MEP ● MIP

Agenda

- Introduction

- Carrier Ethernet Fundamentals

- Carrier Ethernet 2.0
  - Service Definitions and Enhancements
  - Service Design and Deployment

- Next Gen Carrier Ethernet Architectures

- Conclusion

E-Line with CE 2.0
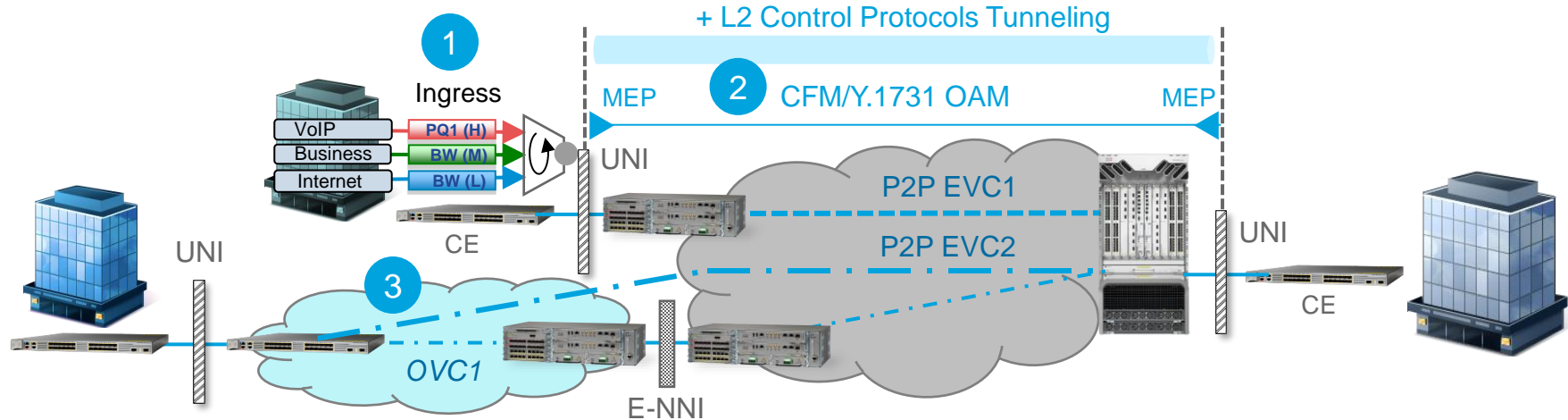
1. **Multiple Classes of Service:**
   - Up to 3 Classes of Services;
   - Reference values for SLS.

2. **Service OAM:**
   - Fault Management.

3. **Extended service coverage:**
   - E-NNIs;
   - E-Access.

E-LAN with CE 2.0
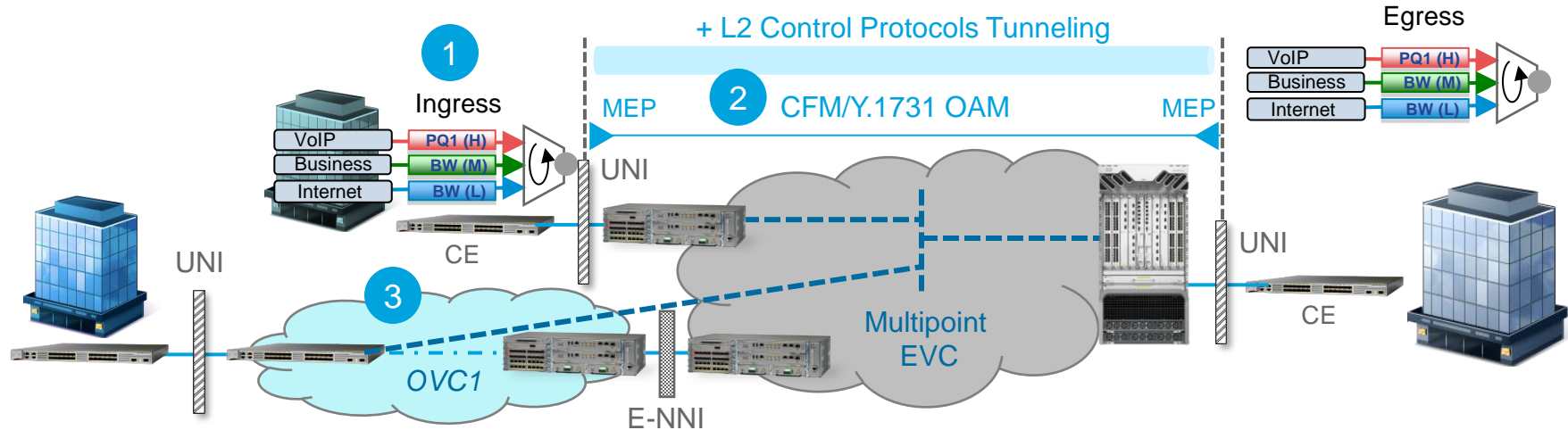
1. **Multiple Classes of Service:**
   - Up to 3 Classes of Services;
   - Reference values for SLS.
   - Egress traffic management.

2. **Service OAM:**
   - Fault Management.

3. **Extended service coverage:**
   - E-NNIs;
   - E-Access.

Many Technologies Support Carrier Ethernet

Transport Encapsulation

L0/L1 Transport
(EoSONET/SDH, OTN, DWDM)

L2 Bridging
(QinQ, 802.1ad, PBB)

MPLS Switching
(MPLS-TP, PW, VPLS, EVPN)

Control Plane

EMS/NMS + SNCP/MS-SPRing
ASON/WSON, GMPLS

xSTP, REP, others
G.8031, G.8032

IP/MPLS (IGP, LDP, RSVP, BGP)
SR, GMPLS, EMS/NMS

+ various access (wireless, wireline, cable) and tunneling technologies.

Cisco EPN Framework

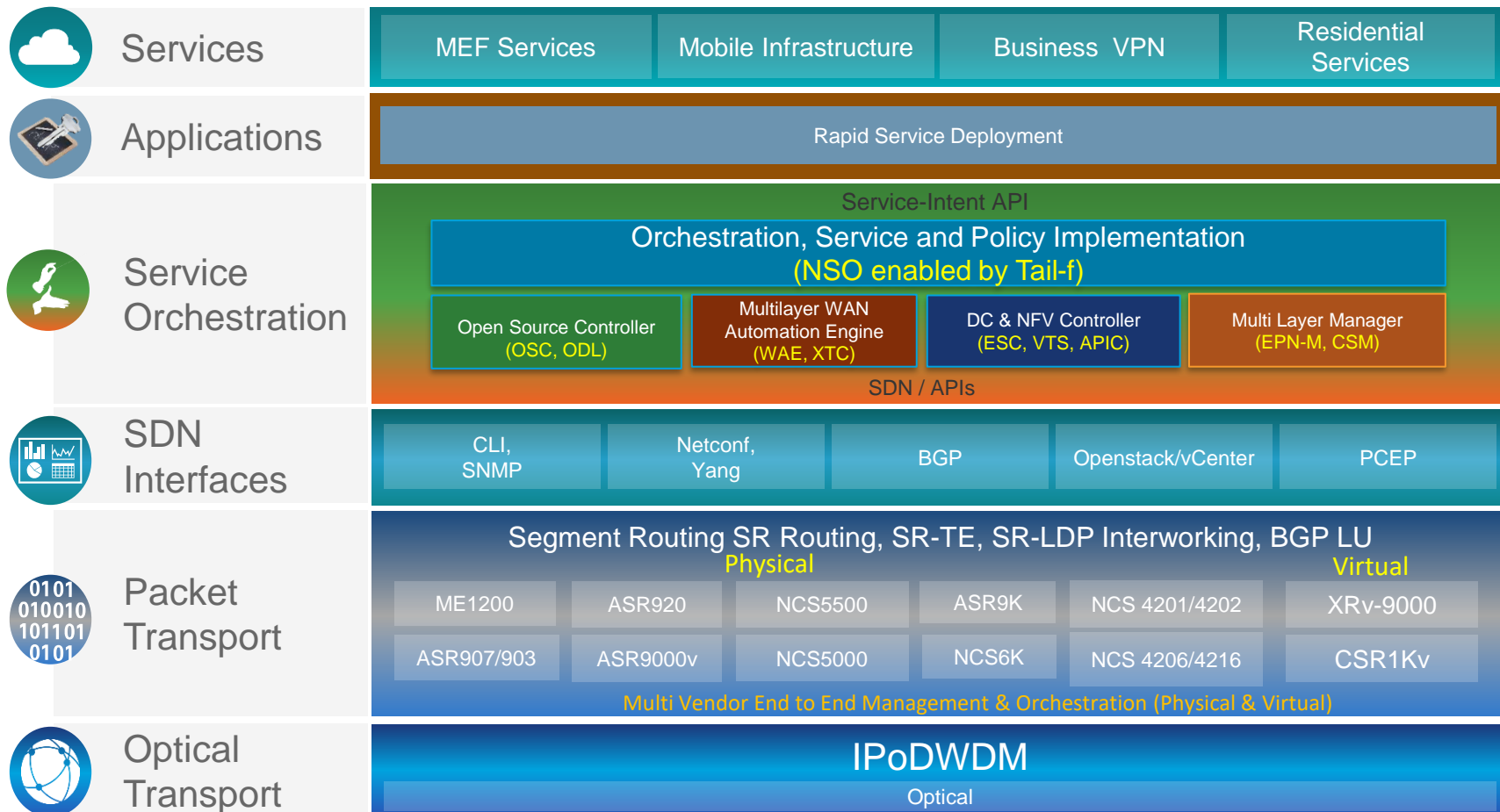| Services	MEF Services	Mobile Infrastructure	Business VPN	Residential Services

Applications

Rapid Service Deployment

Service Orchestration

Service-Intent API

Orchestration, Service and Policy Implementation
(NSO enabled by Tail-f)

Open Source Controller (OSC, ODL)	Multilayer WAN Automation Engine (WAE, XTC)	DC & NFV Controller (ESC, VTS, APIC)	Multi Layer Manager (EPN-M, CSM)

SDN / APIs

SDN Interfaces

CLI, SNMP	Netconf, Yang	BGP	Openstack/vCenter	PCEP

Packet Transport

Segment Routing SR Routing, SR-TE, SR-LDP Interworking, BGP LU

Physical   Virtual

ME1200	ASR920	NCS5500	ASR9K	NCS 4201/4202	XRv-9000
ASR907/903	ASR9000v	NCS5000	NCS6K	NCS 4206/4216	CSR1Kv

Multi Vendor End to End Management & Orchestration (Physical & Virtual)

Optical Transport

IPoDWDM

Optical

MEF Services in an EPN Environment

MPLS, Ethernet and/or nV Access Network
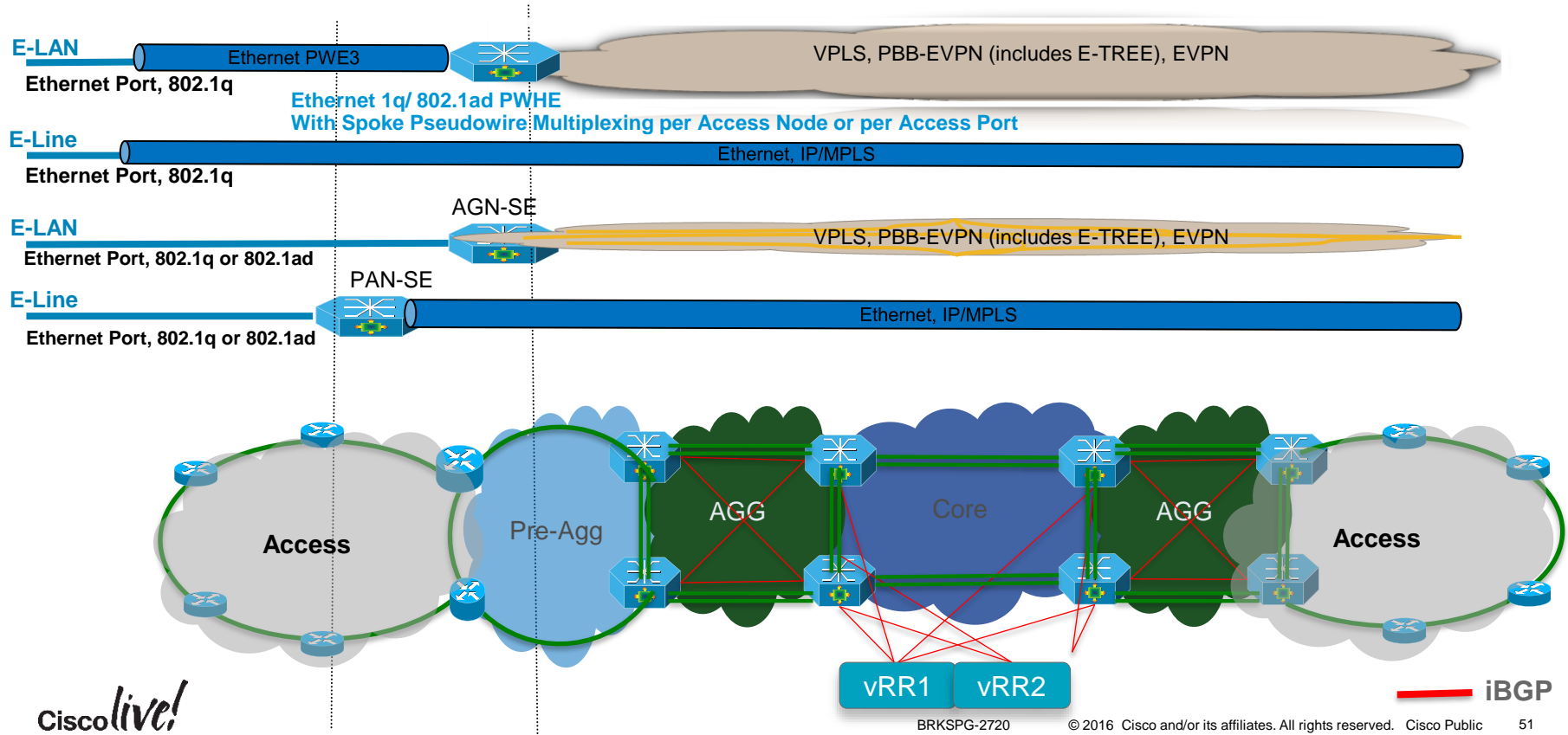
MEF Services: Activation and Monitoring

Monitoring

E-OAM,
Y.1731 (1DM,
2DM, SLM)
TWAMP

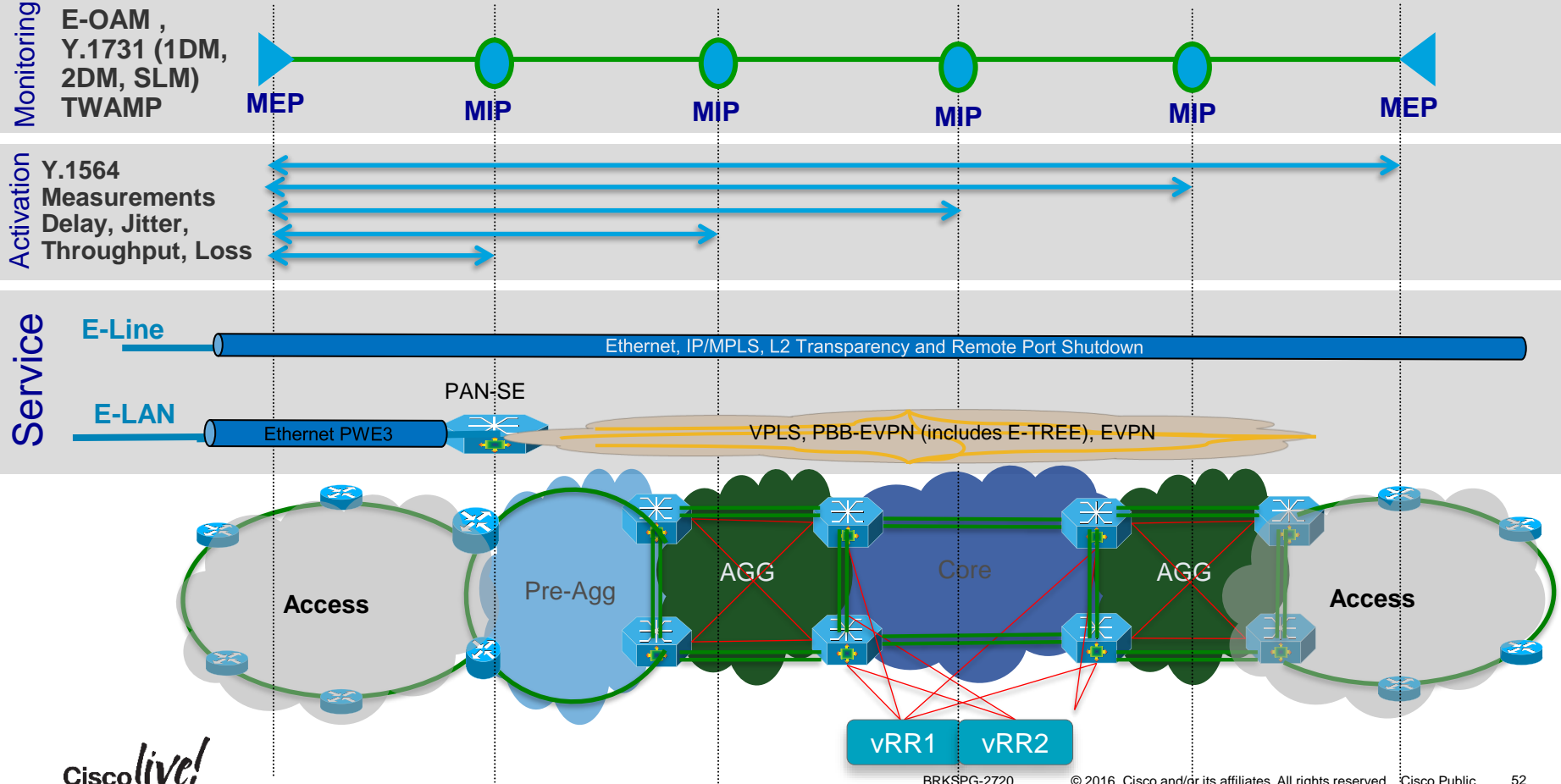MEP   MIP   MIP   MIP   MIP   MEP

Activation

Y.1564
Measurements
Delay, Jitter,
Throughput, Loss

Service

E-Line

Ethernet, IP/MPLS, L2 Transparency and Remote Port Shutdown

E-LAN

PAN-SE

Ethernet PWE3

VPLS, PBB-EVPN (includes E-TREE), EVPN

Access   Pre-Agg   AGG   Core   AGG   Access
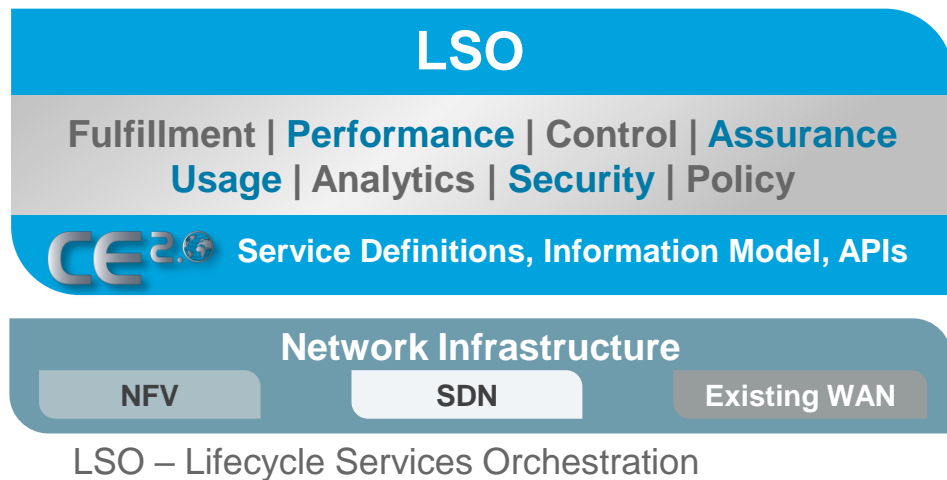
vRR1   vRR2

Agenda

- Introduction

- Carrier Ethernet Fundamentals

- Carrier Ethernet 2.0
  - Service Definitions and Enhancements
  - Service Design and Deployment

- Next Gen Carrier Ethernet Architectures

- Conclusion

The Future Of Carrier Ethernet

- Faster;

- Simpler;

- Dynamic;

- Programmable;

- Orchestrated;

The Future of Carrier Ethernet At MEF

- Agile
  - Rapidly introduce new, on-demand services
  - Leverage MEF API's for Orchestration
  - SDN and NFV helps, but SP operational transformation is key

- Assured
  - Subscribers expect consistent performance and security assurances also key
  - Require authentication and authorization as well as an audit trail

- Orchestrated
  - Dynamic and Automated services lifecycle
  - Use of API's and Models that provide technology abstraction

MEF
TheThirdNetwork
Agile, Assured, Orchestrated

Courtesy of MEF

LSO

Fulfillment | Performance | Control | Assurance Usage | Analytics | Security | Policy

CE2.0 **Service Definitions, Information Model, APIs**

Network Infrastructure

NFV   **SDN**   **Existing WAN**

LSO – Lifecycle Services Orchestration

Cisco live!

Protocols Evolution Impacting Carrier Ethernet
Autonomic, Simplified/Optimized and Self-protected SR Transport

Service protocols

BGP
T-LDP
RFC 3107 BGP (opt)

Transport protocols

RSVP-TE
MPLS LDP
IGP
IP

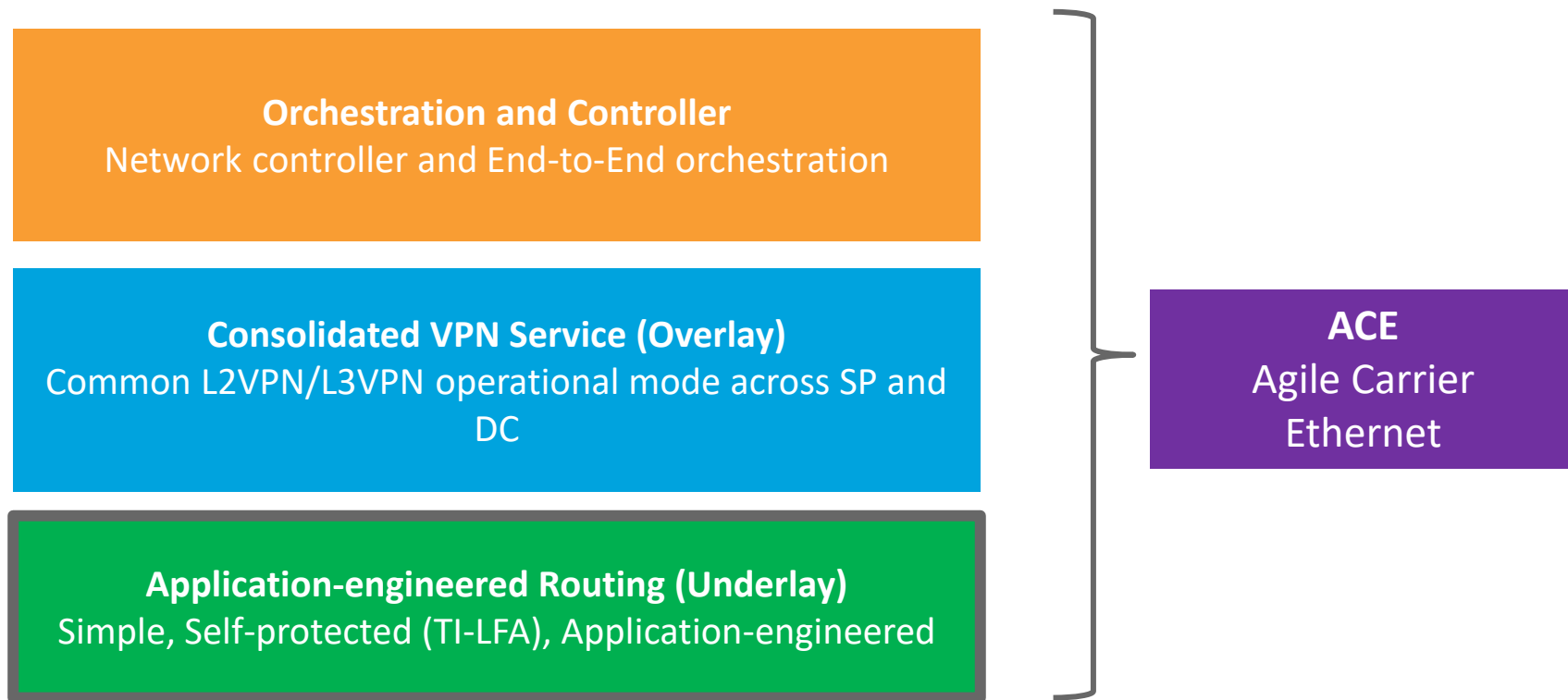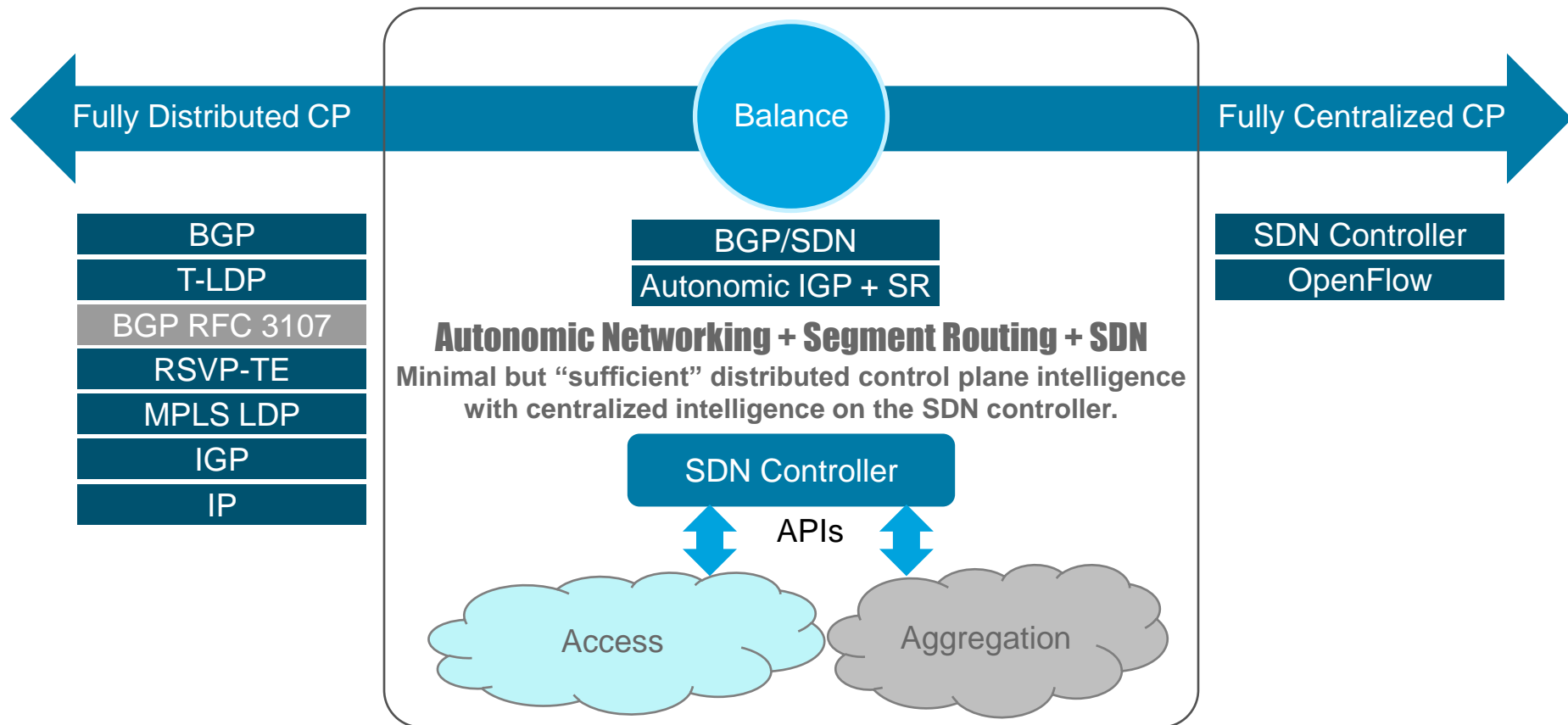| BGP	SDN
SR	
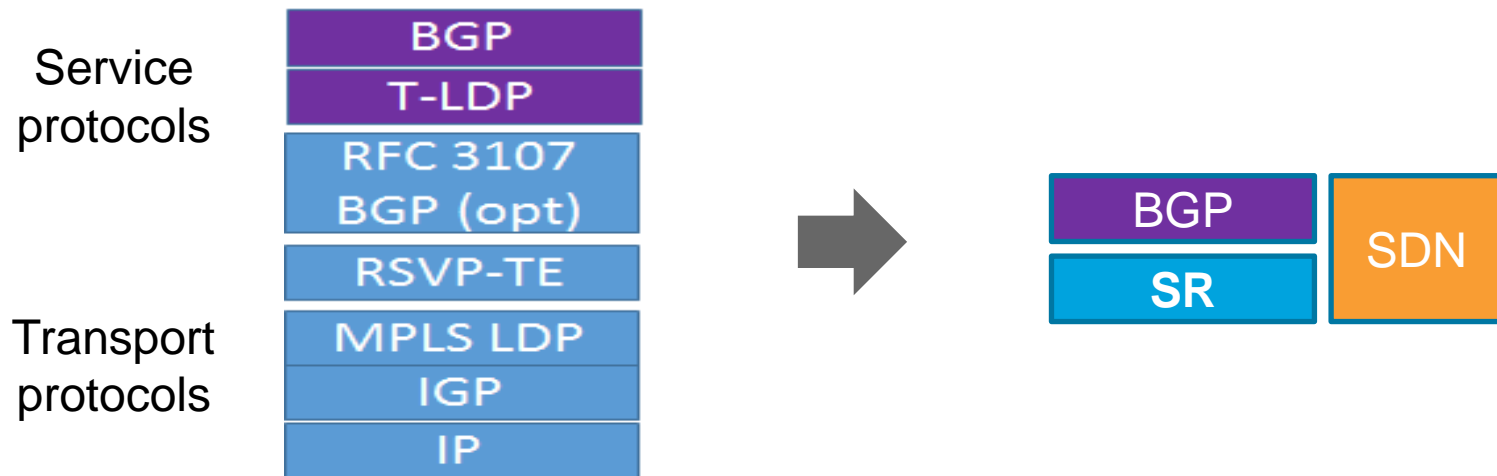
Keep the existing MPLS data plane and the forwarding features
→ support existing service and SLA
Simplify the control plane and optimize the routing path

The ACE Architecture Framework

Orchestration and Controller
Network controller and End-to-End orchestration

Consolidated VPN Service (Overlay)
Common L2VPN/L3VPN operational mode across SP and DC

Application-engineered Routing (Underlay)
Simple, Self-protected (TI-LFA), Application-engineered

ACE
Agile Carrier Ethernet

Agile Carrier Ethernet Networks

Fully Distributed CP ← → Fully Centralized CP

Balance

BGP	
T-LDP	
BGP RFC 3107	
RSVP-TE	
MPLS LDP	
IGP	
IP	

BGP/SDN
Autonomic IGP + SR

Autonomic Networking + Segment Routing + SDN
Minimal but "sufficient" distributed control plane intelligence with centralized intelligence on the SDN controller.

SDN Controller

APIs

Access   Aggregation

SDN Controller
OpenFlow

Summary

Key Takeaways

- Carrier Ethernet market growth brings new challenges;

- MEF CE 2.0 expands and enhances services, simplifies operations and extends services reach with:
  - New services with certification;
  - Interconnected Networks;
  - Standardized Multi-CoS;
  - Service Management;

- Future of Carrier Ethernet: Lifecycle Services Orchestration (MEF LSO - SDN, NFV, Orchestration).

Complete Your Online Session Evaluation

- Give us your feedback to be entered into a Daily Survey Drawing. A daily winner will receive a $750 Amazon gift card.

- Complete your session surveys through the Cisco Live mobile app or from the Session Catalog on CiscoLive.com/us.

Don't forget: Cisco Live sessions will be available for viewing on-demand after the event at CiscoLive.com/Online

Please join us for the Service Provider Innovation Talk featuring:

Yvette Kanouff | Senior Vice President and General Manager, SP Business

Joe Cozzolino | Senior Vice President, Cisco Services

Thursday, July 14th, 2016

11:30 am - 12:30pm, In the Oceanside A room

What to expect from this innovation talk
- Insights on market trends and forecasts
- Preview of key technologies and capabilities
- Innovative demonstrations of the latest and greatest products
- Better understanding of how Cisco can help you succeed

Register to attend the session live now or watch the broadcast on cisco.com

Continue Your Education

- Demos in the Cisco campus

- Walk-in Self-Paced Labs

- Lunch & Learn

- Meet the Engineer 1:1 meetings

- Related sessions

Thank you

Cisco *live!*

Cisco live!

July 10-14, 2016 · Las Vegas, NV