MEF

Introducing the Specifications of the Metro Ethernet Forum

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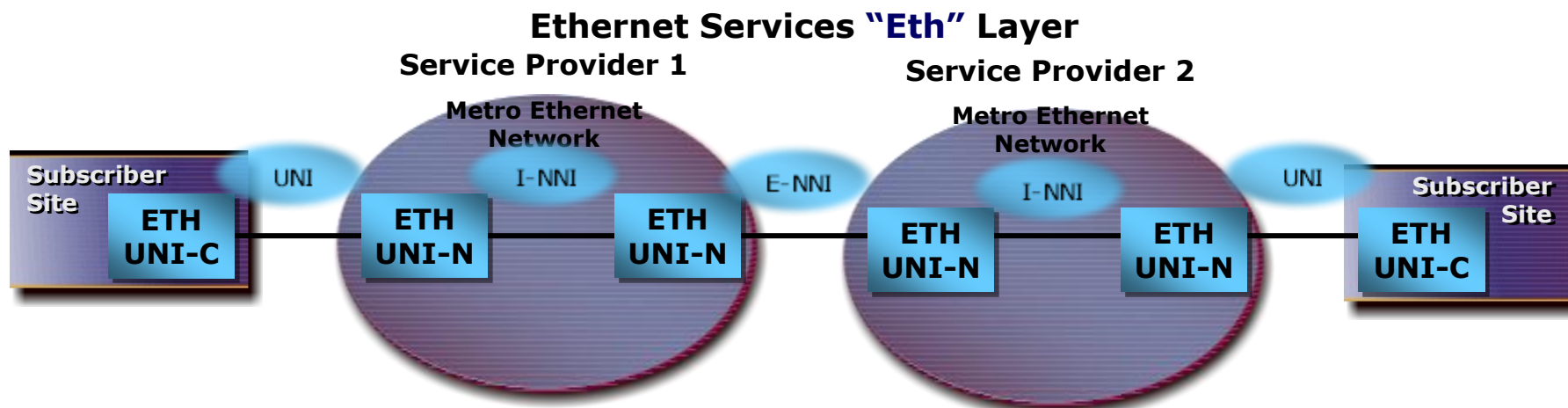|	
MEF 2	**Requirements and Framework for Ethernet Service Protection**
MEF 3	**Circuit Emulation Service Definitions, Framework and Requirements in Metro Ethernet Networks**
MEF 4	**Metro Ethernet Network Architecture Framework Part 1: Generic Framework**
MEF 6	**Metro Ethernet Services Definitions Phase I**
MEF 7	**EMS-NMS Information Model**
MEF 8	**Implementation Agreement for the Emulation of PDH Circuits over Metro Ethernet Networks**
MEF 9	**Abstract Test Suite for Ethernet Services at the UNI**
MEF 10	**Ethernet Services Attributes Phase I**
MEF 11	**User Network Interface (UNI) Requirements and Framework**
MEF 12	**Metro Ethernet Network Architecture Framework Part 2: Ethernet Services Layer**
MEF 13	**User Network Interface (UNI) Type 1 Implementation Agreement**
MEF 14	**Abstract Test Suite for Traffic Management Phase 1**
MEF 15	**Requirements for Management of Metro Ethernet Phase 1 Network Elements**
MEF 16	**Ethernet Local Management Interface**

* MEF 10 * replaced MEF 1 and MEF 5

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Introduction

- **This presentation is an introduction to both MEF 6 and MEF 10**
- **MEF 6 defines the Ethernet service types**
- **MEF 10 Defines the service attributes and parameters required to offer the services defined in MEF 6**

Ethernet Services "Eth" Layer

Service Provider 1   Service Provider 2

Metro Ethernet Network   Metro Ethernet Network

Subscriber Site   UNI   I-NNI   E-NNI   I-NNI   UNI   Subscriber Site

ETH UNI-C   ETH UNI-N   ETH UNI-N   ETH UNI-N   ETH UNI-N   ETH UNI-C

UNI: User Network Interface, UNI-C: UNI-customer side, UNI-N network side
NNI: Network to Network Interface, E-NNI: External NNI; I-NNI Internal NNI

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Introduction

| MEF 6	Ethernet Services Definitions – Phase I
Purpose	Defines the Ethernet Services (EPL, EVPL, E-Line, ELAN, etc)
Audience	All, since it provides the fundamentals required to build devices and services that deliver Carrier Ethernet. For Enterprise users it gives the background to Service Level Specifications for Carrier Ethernet Services being offered by their Service Providers and helps to plan Ethernet Services as part of their overall network.

MEF 10	Ethernet Services Definitions – Phase I
Purpose	Defines the service attributes and parameters required to offer the services defined in MEF 6
Audience	All, since it provides the fundamentals required to build devices and services that deliver Carrier Ethernet. For Enterprise users it gives the background to Service Level Specifications for Carrier Ethernet Services being offered by their Service Providers and helps to plan Ethernet Services as part of their overall network.

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Contents

- **Services model and taxonomy**
- **Services type definitions**
- **Service type application examples**
- **SLA specifications**
- **Traffic classification**
- **Traffic profiles**
- **Service attributes and parameters**

Ethernet Service – Basic MEF Model Concepts

- **Customer Equipment (CE) attaches to the Metro Ethernet Network (MEN) at the UNI**
  - Using standard Ethernet frames.
- **CE can be**
  - Router or bridge/switch -IEEE 802.1 bridge
- **UNI (User Network Interface)**
  - Demarcation point between the customer and provider network
  - Demarcation point between host services and provider network
  - Standard IEEE 802.3 Ethernet PHY/MAC

Customer Edge (CE) User Network Interface (UNI) User Network Interface (UNI) Customer Edge (CE)

Metro Ethernet Network

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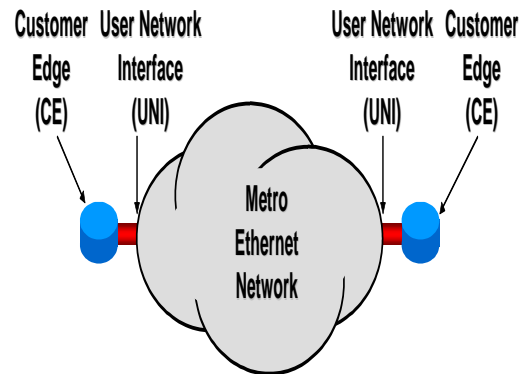
Ethernet Virtual Connection (EVC) defined …

- **An EVC is "an instance of an association of 2 or more UNIs"**
- **EVCs help visualize the Ethernet connections**
  - Like Frame Relay and ATM PVCs or SVCs
  - Cannot leak frame from one EVC to another
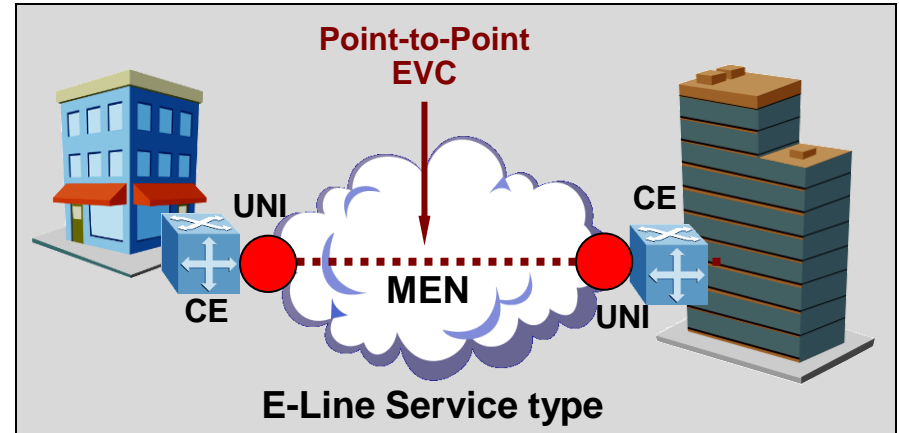- **MEF has defined 2 EVC types**
  - Point-to-Point

Point-to-Point EVC

MEN

UNI   **UNI**

MEN

Multipoint-to-Multipoint EVC
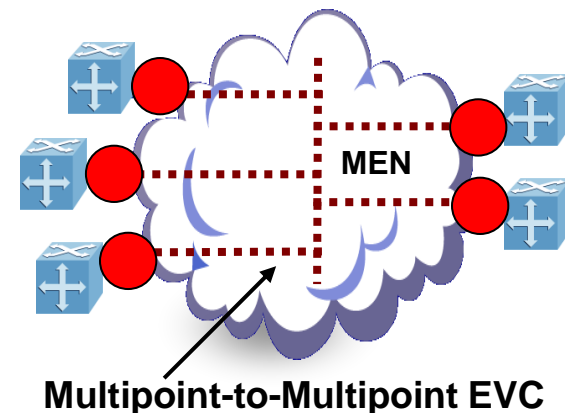
EVCs define the service connectivity

Service Types defined in MEF 6

- **E-Line Service used to create**
  - Ethernet Private Lines
  - Virtual Private Lines
  - Ethernet Internet Access
 - Point-to-Point upper layer services transport
    (IP-VPNs etc…)

- **E-LAN Service used to create**
  - Multipoint L2 VPNs
  - Transparent LAN Service
  - Multicast networks

Point-to-Point EVC

UNI CE MEN UNI CE

E-Line Service type

Multipoint-to-Multipoint EVC

UNI CE MEN UNI CE
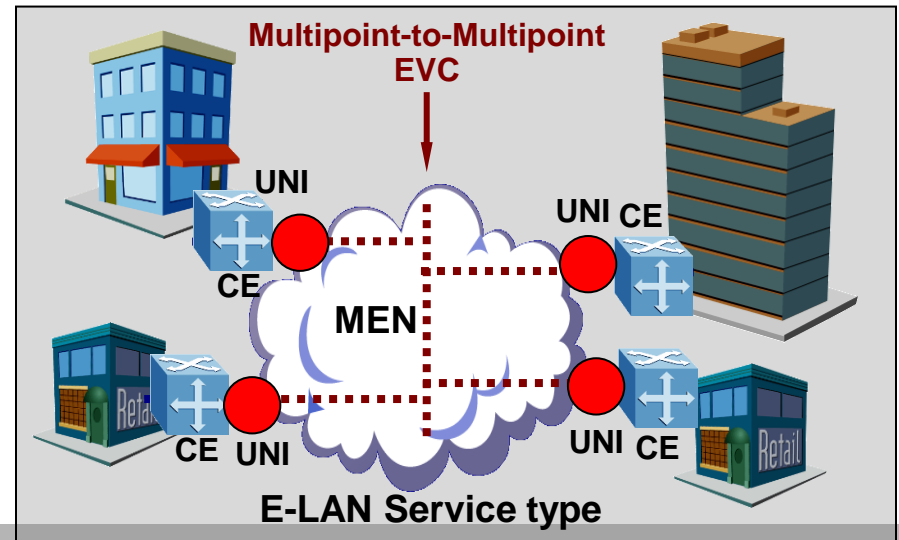
E-LAN Service type

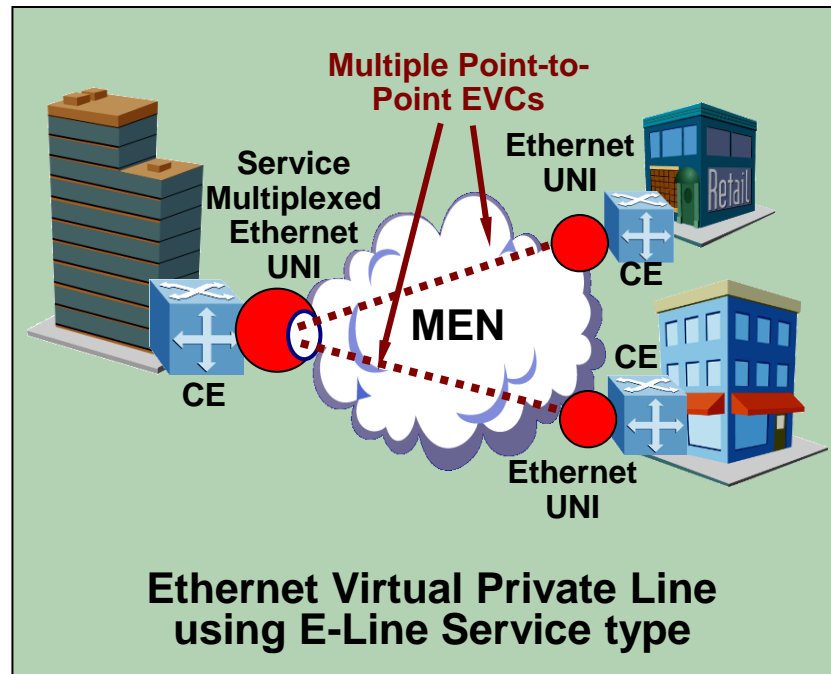# Example Service using E-Line Service Type

- **Ethernet Private Line**
    - Replaces a TDM Private line
    - Dedicated UNIs for Point-to-Point connections
    - Single Ethernet Virtual Connection (EVC) per UNI

Ethernet Private Line using E-Line Service type
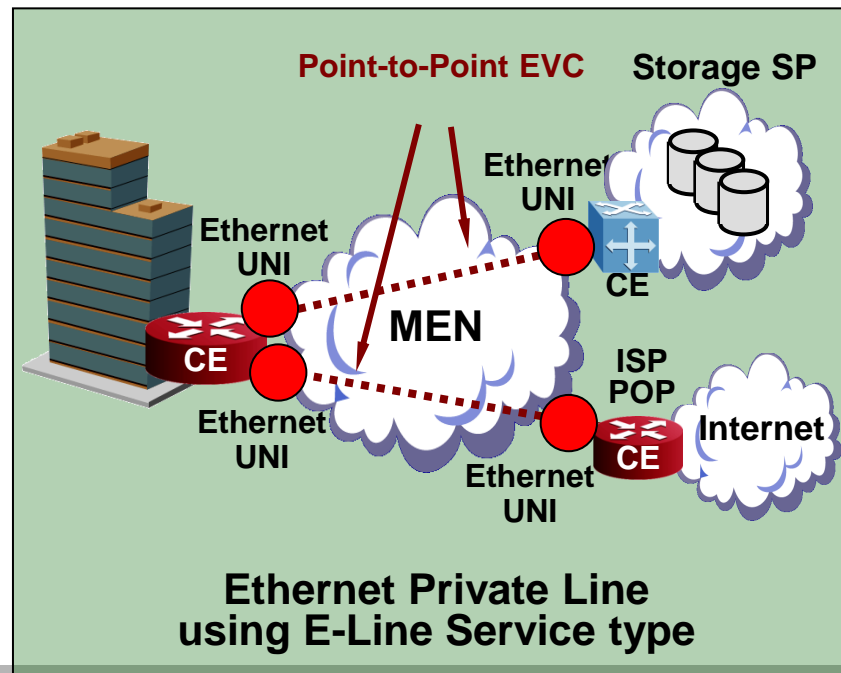
Example Service using E-Line Service Type

- **Ethernet Virtual Private Line**
  - Replaces Frame Relay or ATM services
  - Supports Service Multiplexed UNI*
  - Allows single physical connection to customer premise equipment for multiple virtual connections

* This is a UNI that must be configurable to support Multiple EVCs per UNI

Multiple Point-to-Point EVCs

Service Multiplexed Ethernet UNI

Ethernet UNI

CE

MEN

CE

CE

Ethernet UNI

Ethernet Virtual Private Line using E-Line Service type

Example Service using E-LAN Service Type

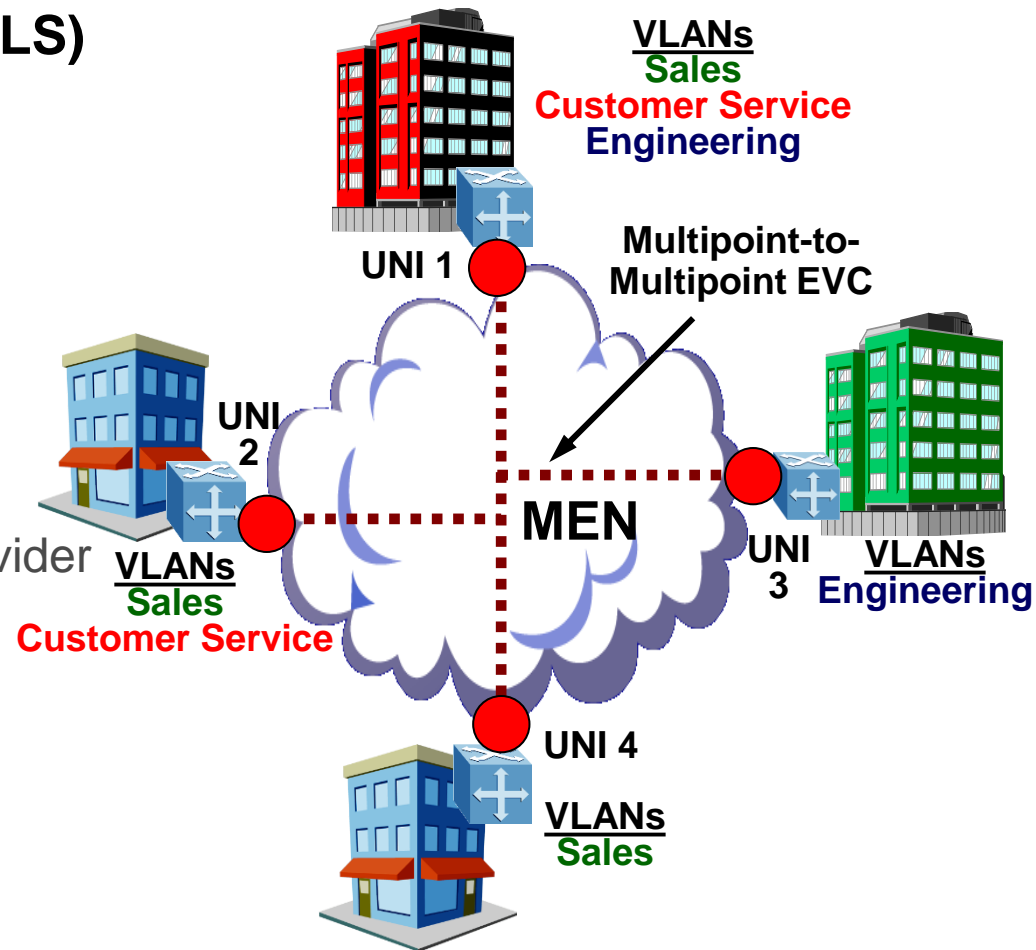- **Transparent LAN Service (TLS) provides**
  - Multipoint-multipoint
  - Intra-company Connectivity
  - Full transparency of control protocols (BPDUs)
- **New VLANs added**
  - without coordination with provider

TLS makes the MEN look like a LAN

Transparent LAN Service

VLANs
Sales
Customer Service
Engineering

UNI 1

Multipoint-to-Multipoint EVC

UNI 2

UNI 3

MEN

VLANs
Sales
Customer Service

VLANs
Engineering

UNI 4

VLANs
Sales

- **Ethernet Multicast**
  - Point to multipoint for broadcast applications (Video)
  - Supports Service Multiplexed UNI (to deliver multiple channels)

Ethernet Delivery of Multicast IPTV Traffic
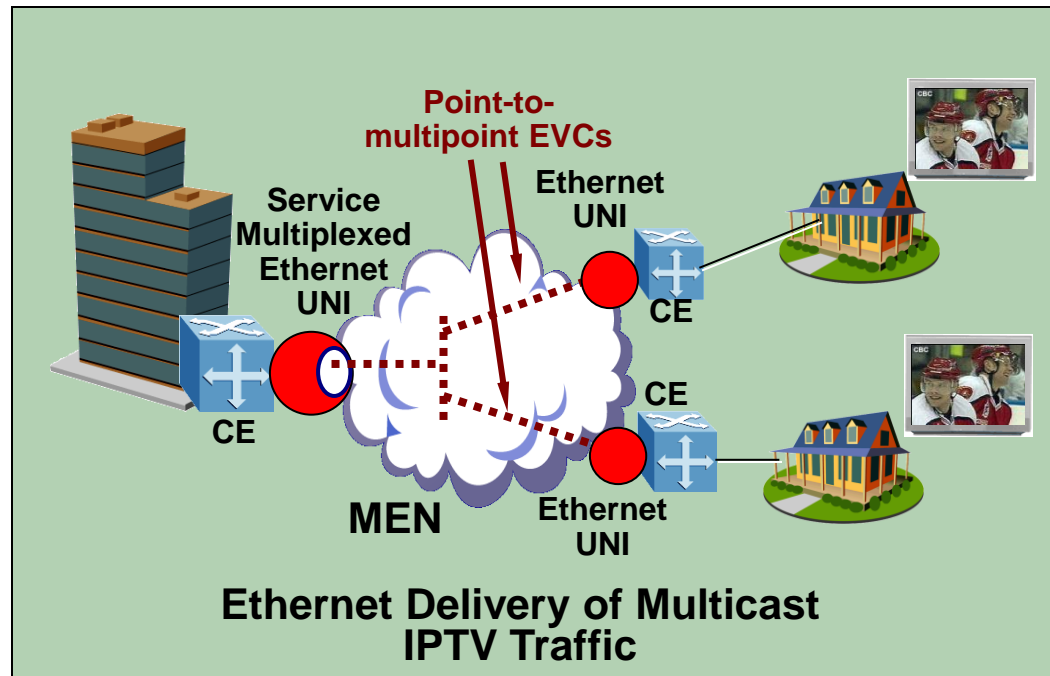
- **MEF 10 Defines how the services should handle customer generated frames**
  - Service frames
  - Customer VLANs
- **MEF 10 defines how to establish traffic classes**
 - and the required traffic management

Delivery of Service Frames

- **Broadcast**
  - Deliver to all UNIs in the EVC but the ingress UNI
- **Multicast**
  - Typically delivered to all UNIs in the EVC but the ingress UNI
- **Unicast (unlearned and learned)**
  - Typically delivered to all UNIs in the EVC but the ingress UNI if not learned
  - Otherwise, deliver to the UNI learned for the destination MAC address
  - Learning is important for Multipoint-to-Multipoint EVCs
- **Layer 2 Control (e.g., BPDU)**
  - Discard, peer, or tunnel

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- **Discard**
  - PDU from CE discarded by MEN
  - PDU never egresses from MEN

- **Peer**
  - MEN peers with CE to run protocol

- **Tunnel**
  - PDUs carried across MEN as if they were normal data
  - EVC is that associated with the Customer Edge VLAN ID (CE-VLAN ID) of the PDU, e.g., the Untagged CE-VLAN ID for most standard Layer 2 Control Protocols defined by IEEE 802
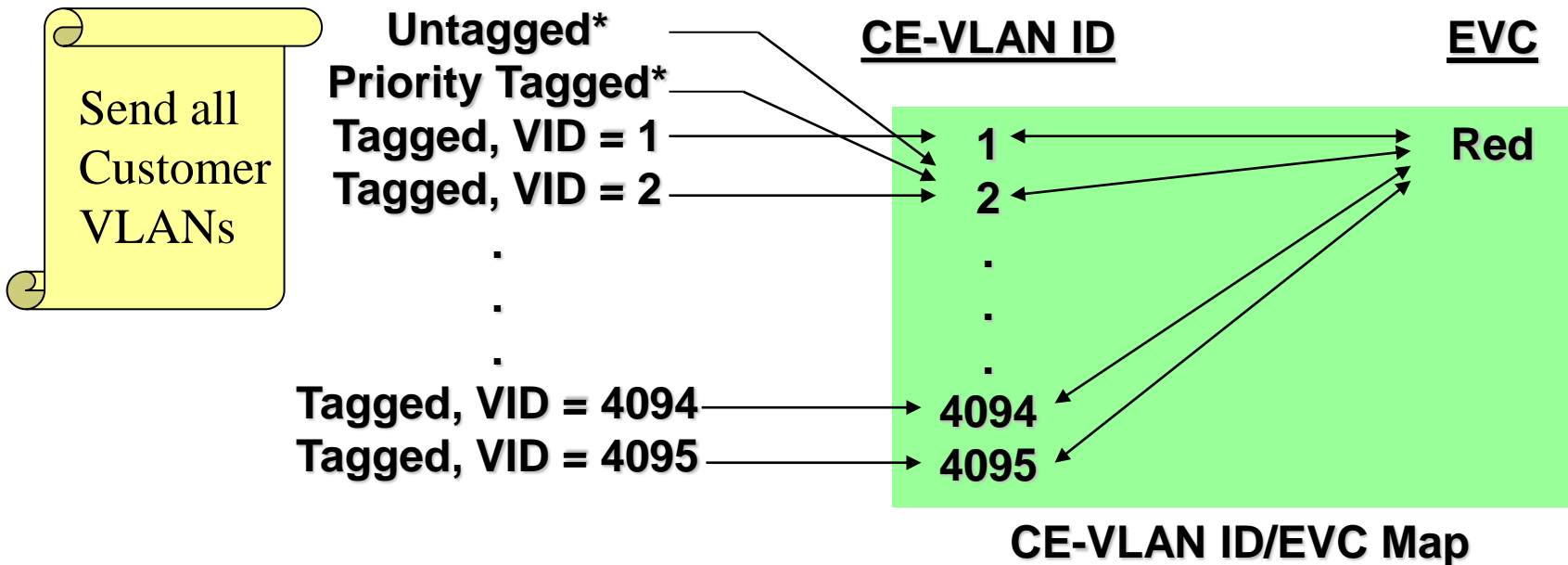
CE-VLAN ID Preservation/Mapping

CE-VLAN ID	EVC
37	Blue

EVC	CE-VLAN ID
Blue	37
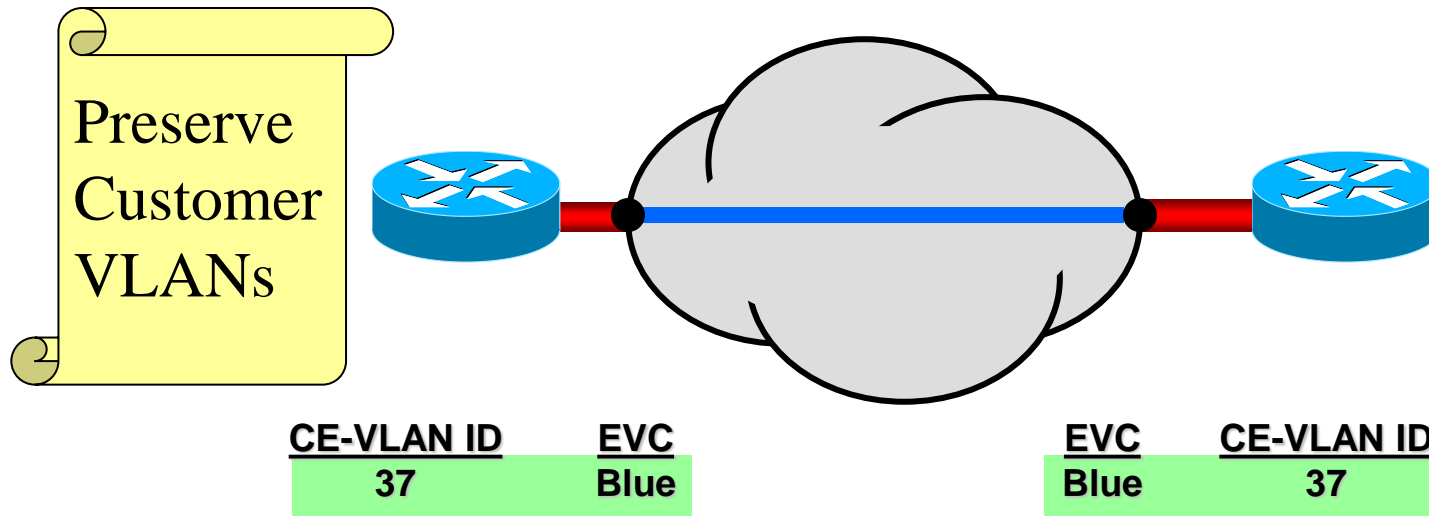
CE-VLAN ID/EVC Map must be identical at all UNIs in the EVC and

- **Priority Tagged in must be priority tagged out**
- **Untagged in must be untagged out**

All to One Bundling (Map)

Send all Customer VLANs

Untagged*
Priority Tagged*
Tagged, VID = 1
Tagged, VID = 2
.
.
.
Tagged, VID = 4094
Tagged, VID = 4095

CE-VLAN ID

1
2
.
.
.
4094
4095

EVC
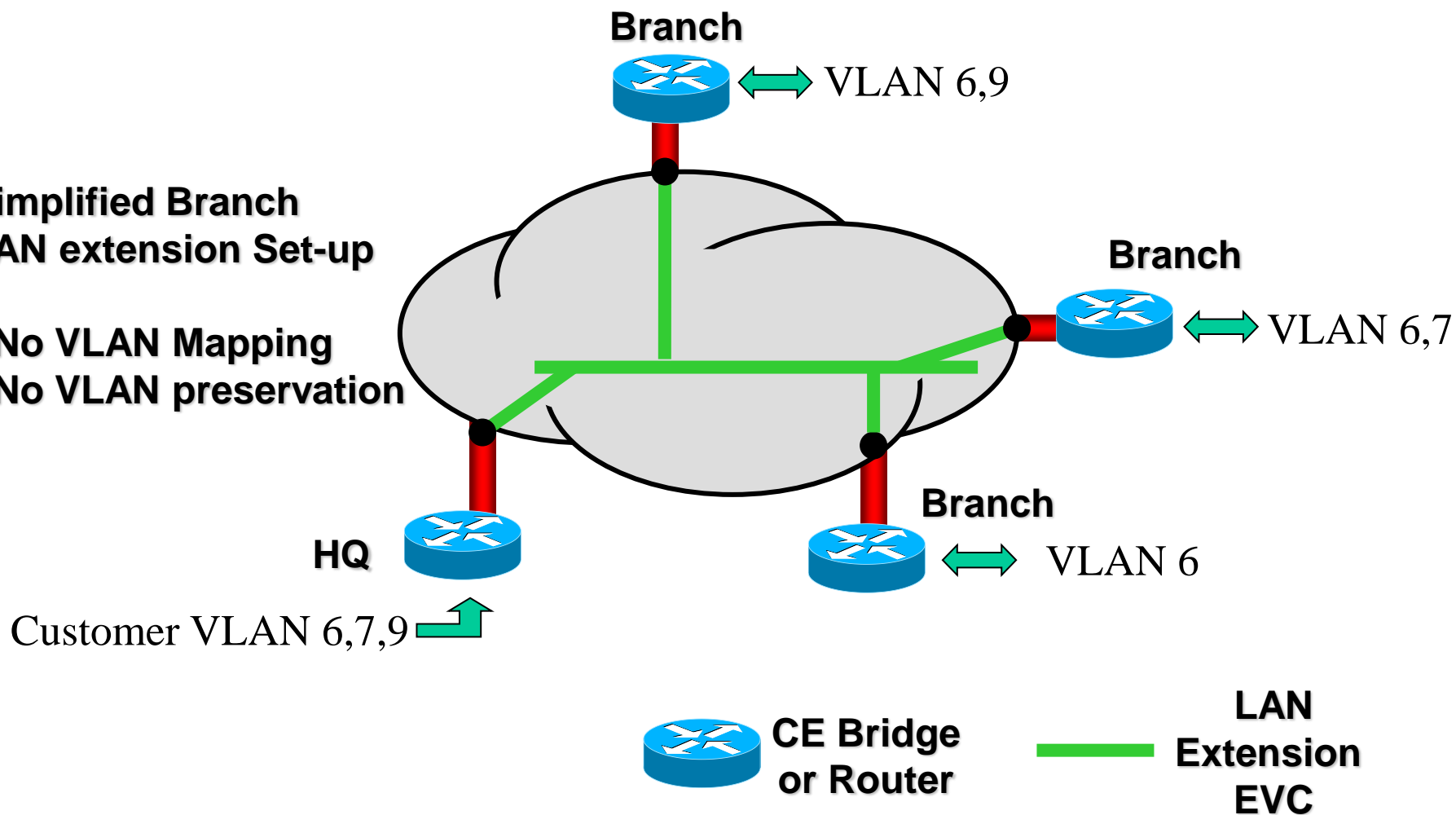
Red

CE-VLAN ID/EVC Map

- **Only one EVC at the UNI (no service multiplexing)**
- **All CE-VLAN IDs map to this EVC – no need for coordination of CE-VLAN ID/EVC Map between Subscriber and Service Provider**
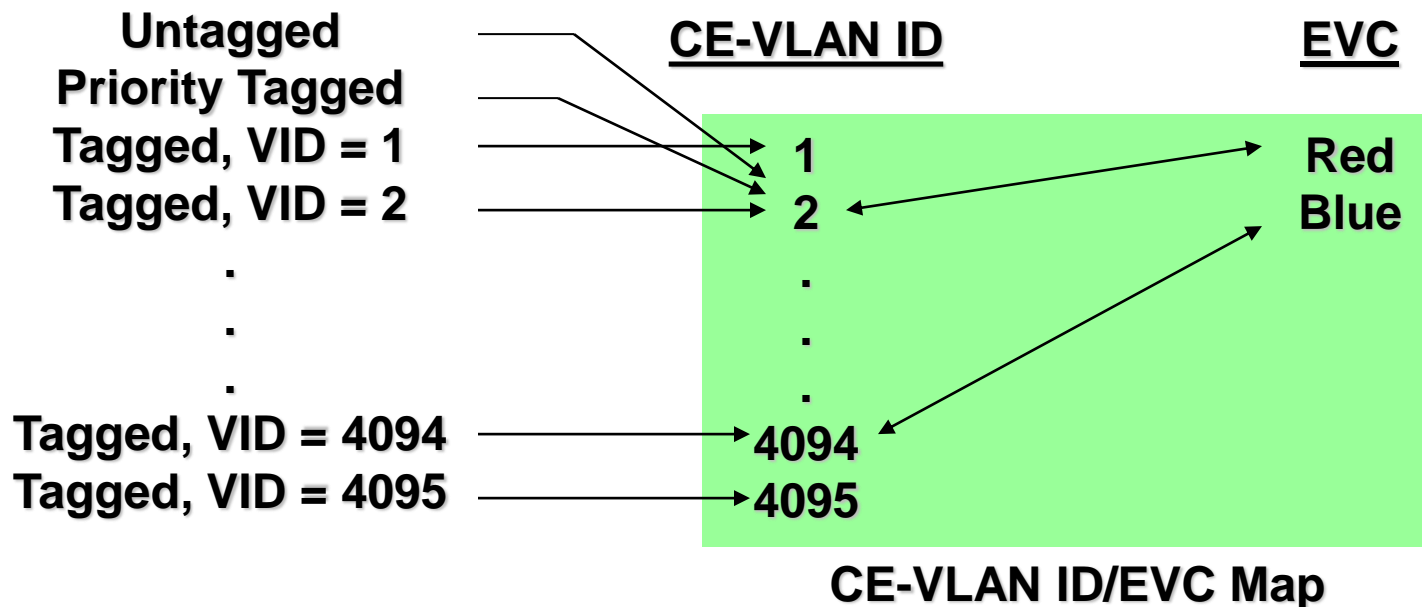- **EVC must have CE-VLAN ID Preservation**

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Using All to One Bundling

Branch

VLAN 6,9

Simplified Branch LAN extension Set-up

- **No VLAN Mapping**
- **No VLAN preservation**

Branch

VLAN 6,7

HQ

Customer VLAN 6,7,9

Branch

VLAN 6

CE Bridge or Router

LAN Extension EVC

One to One Map

Untagged
Priority Tagged
Tagged, VID = 1
Tagged, VID = 2

CE-VLAN ID

EVC

1
2
.
.
.
.

Red
Blue

Tagged, VID = 4094
Tagged, VID = 4095

4094
4095

CE-VLAN ID/EVC Map

- **No more than one CE-VLAN ID is mapped to each EVC at the UNI**
- **If CE-VLAN ID not mapped to EVC, ingress Service Frames with that CE-VLAN ID are discarded**
- **Service Multiplexing possible**
- **CE-VLAN ID Preservation <u>not</u> required**
- **Subscriber and Service Provider must coordinate CE-VLAN ID/EVC Map**
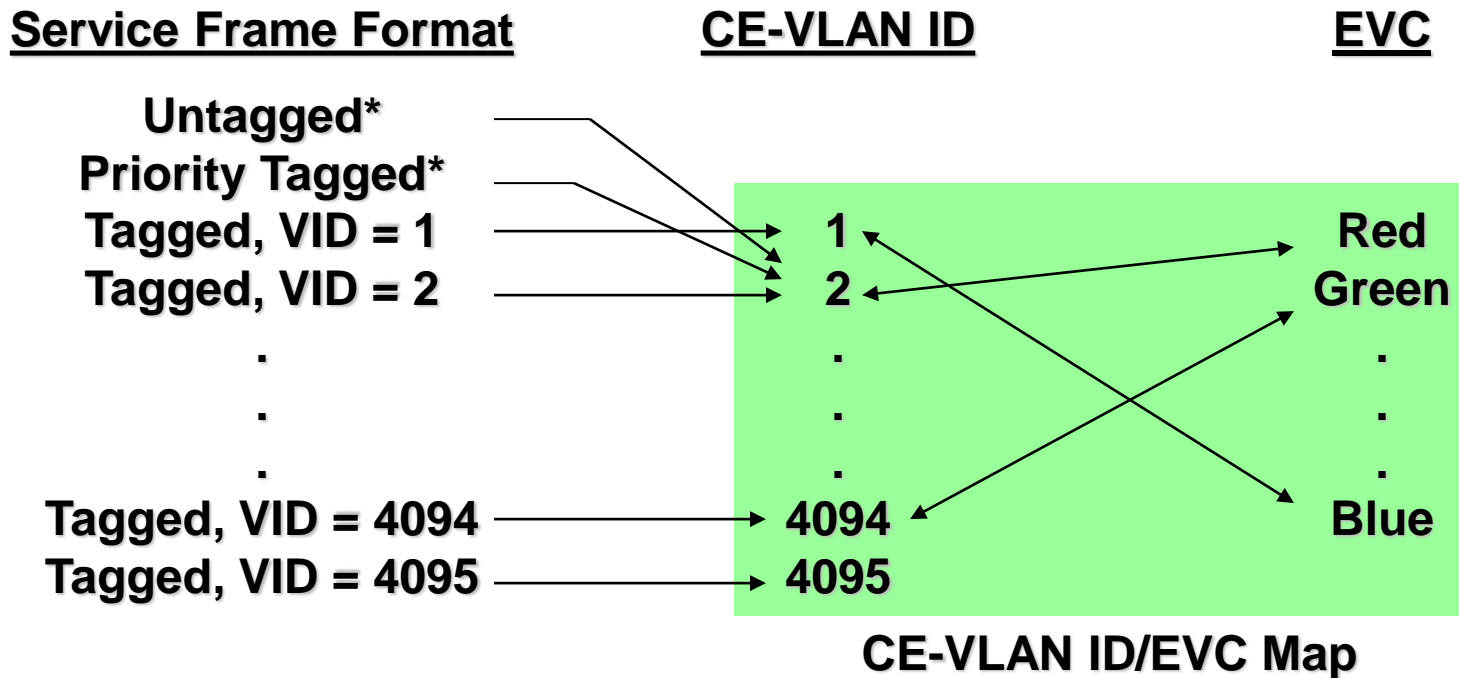
CE-VLAN ID Translation

CE-VLAN ID	EVC
37	Blue

EVC	CE-VLAN ID
Blue	156
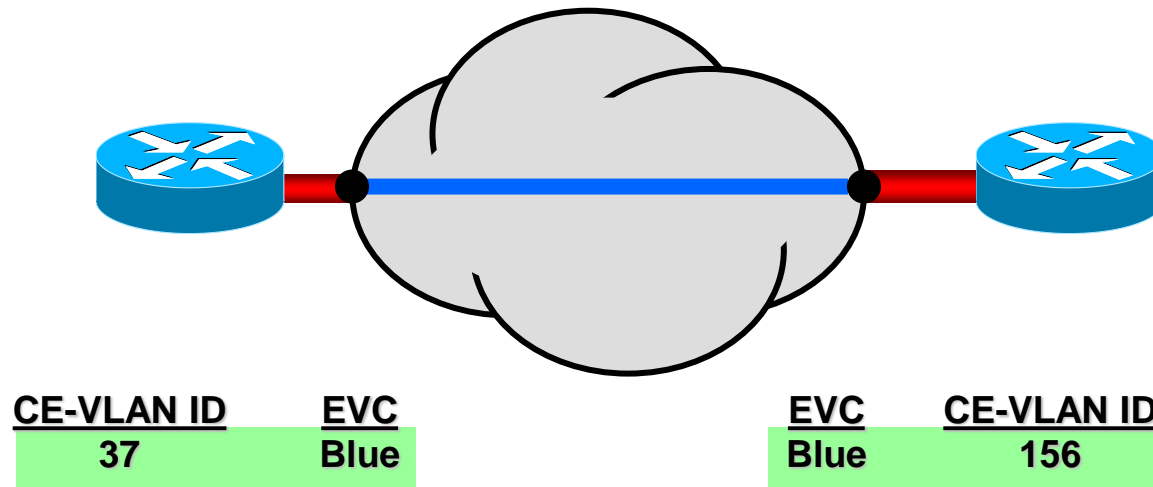
CE-VLAN ID/EVC Map can be different at different UNIs in an EVC

- **Fine for CE routers**

- **Problematic for CE bridges**

CE-VLAN ID/EVC Map

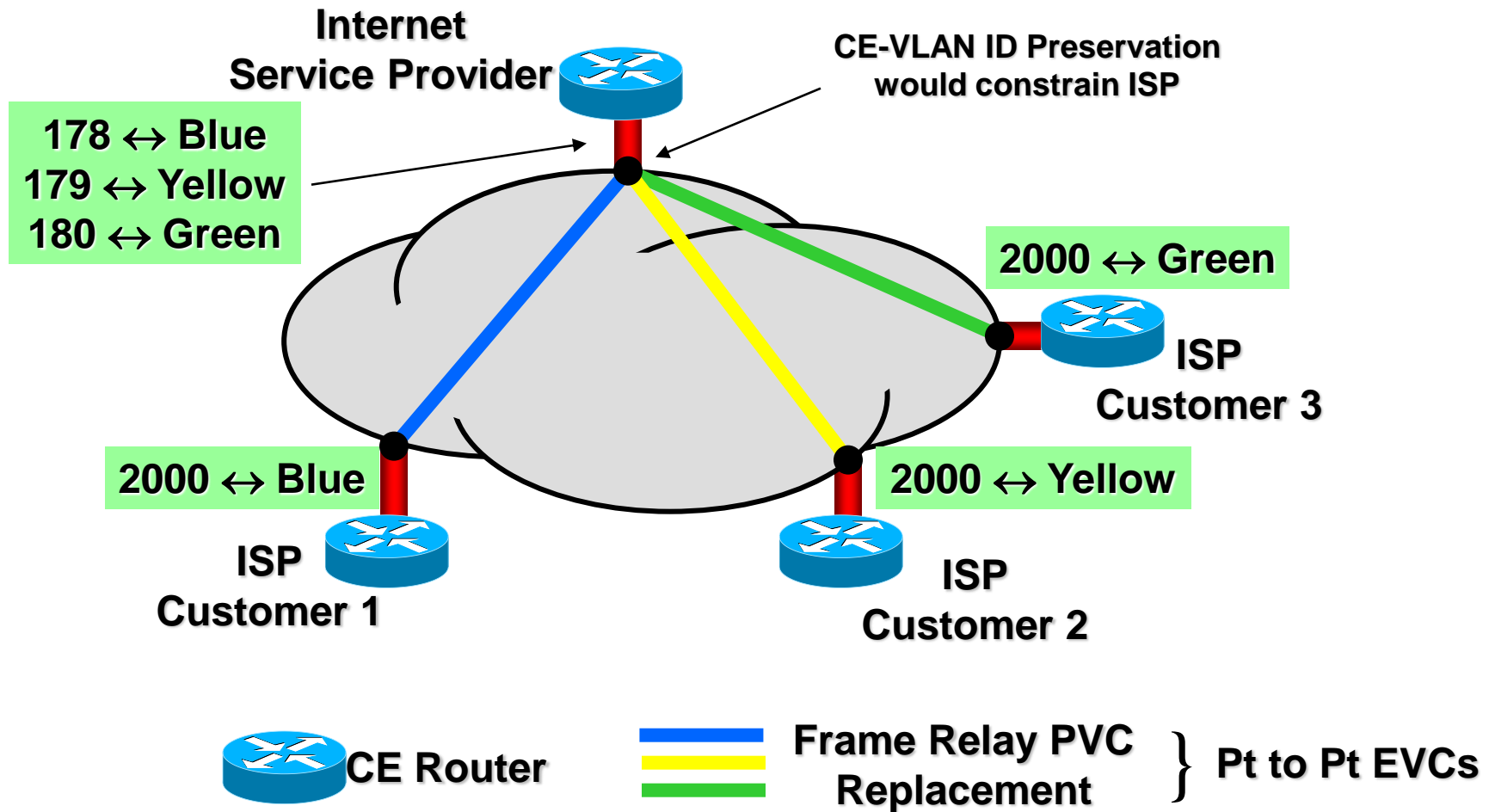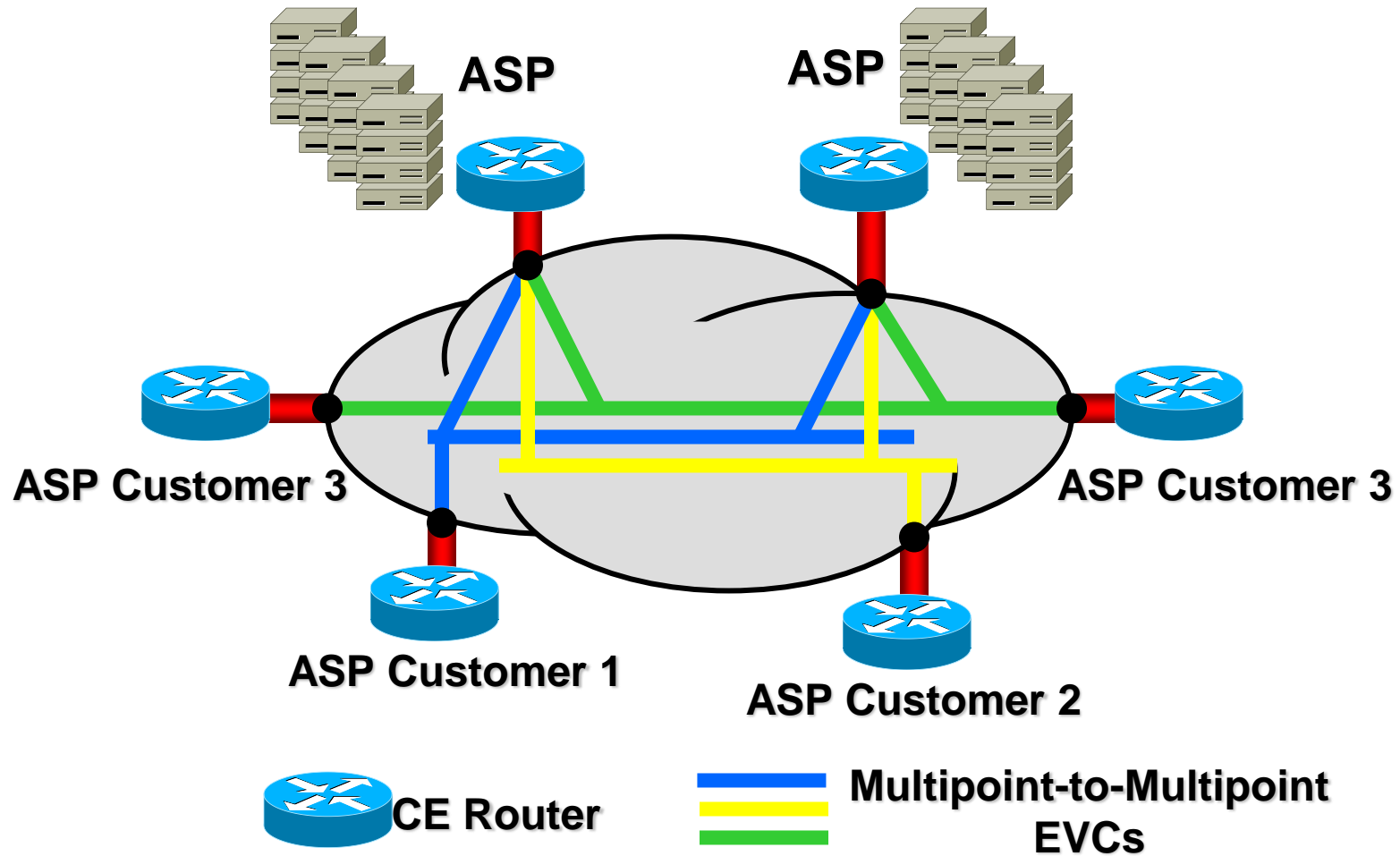| Service Frame Format	CE-VLAN ID	EVC
Untagged*		
Priority Tagged*		
Tagged, VID = 1	1	Red
Tagged, VID = 2	2	Green
.	.	.
.	.	.
.	.	.
Tagged, VID = 4094	4094	Blue
Tagged, VID = 4095	4095	

CE-VLAN ID/EVC Map

*Untagged and Priority Tagged Service Frames have the same CE-VLAN ID and that value is configurable at each UNI. This is the behavior expected by an IEEE 802.1Q CE.
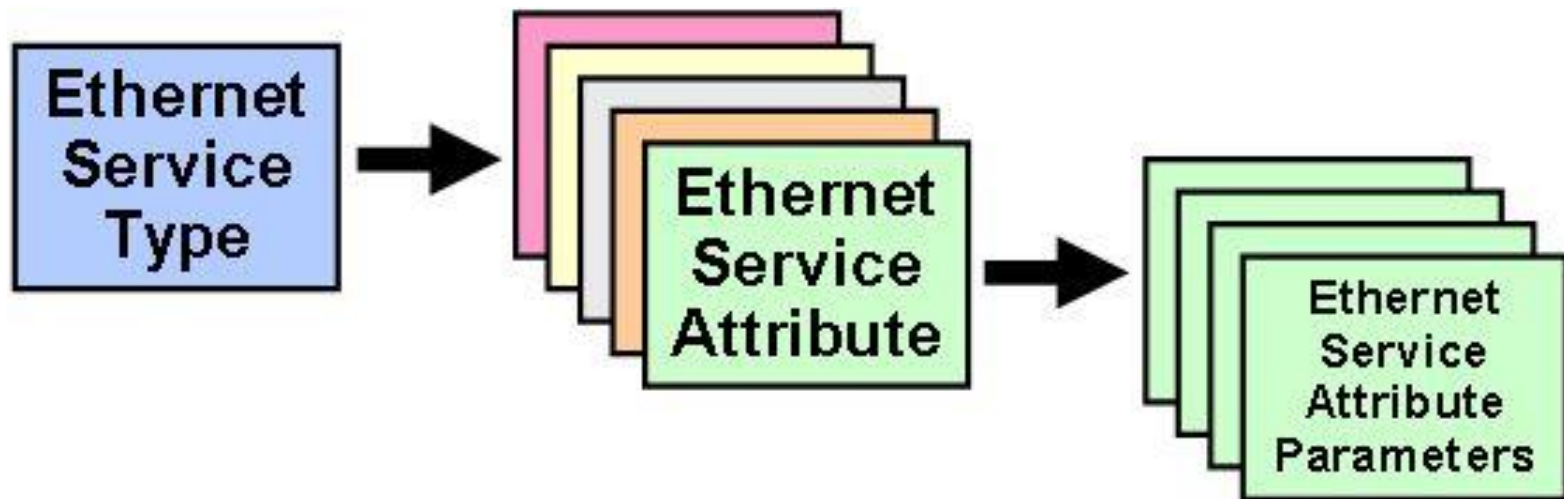
MEF

Using One to One Map w/ Translation – 1

ASP

ASP

ASP Customer 3

ASP Customer 3

ASP Customer 1

ASP Customer 2

CE Router

Multipoint-to-Multipoint EVCs

Industry Service Requirements

- **If the services are to be adopted in the market:**
  - They require strong service attributes
  - With meaningful and measurable parameters on which to base the SLA Specification

The best of all worlds

- **Offer a mix of SLA "ensured" and non SLA traffic**
  - over the same "shared" MEN access/backbone links.
  - Allow certain traffic be delivered with strict SLAs,
  - Allow other traffic to be delivered best efforts.
- **Critical SLA Service Attributes**
  - Bandwidth Profile
  - Service Performance

Allows bandwidth to exceed commitments… but does not apply SLA conformance measures to that traffic

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- **Apply ingress bandwidth profiles**
    - At the UNI (MEF 10) or other NNI handoffs (future)
    - Traffic the meets the profile is marked (colored) in accordance with the SLA commitments.
    - Traffic that meets the profile is marked (colored) subject to the SLA conformance measures
    - Traffic that does not meet the profile is not subject to the SLA commitments

MEF
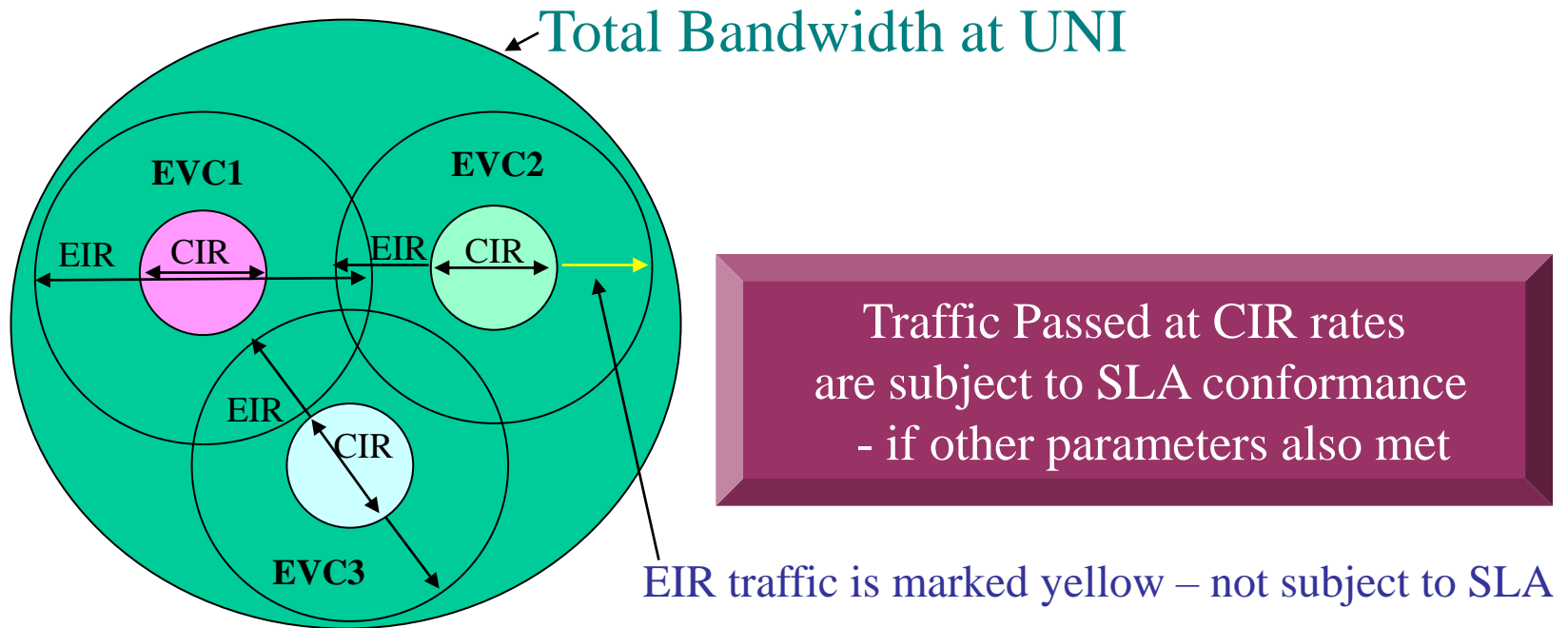
Coloring Classified Traffic

- MEF 10 Specifies coloring of traffic as an optional means to mark traffic as in or out of profile as it leaves the ingress UNI

- MEF 10 specifies three levels of Bandwidth Profile compliance
  - **Green: Service Frame subject to SLA**
  - **Yellow: Service Frame not subject to SLA**
  - **Red: Service Frame discarded.**

Bandwidth Profiles defined in MEF 10

- **MEF has defined three bandwidth profiles**

  - Ingress Bandwidth Profile Per Ingress UNI

  - Ingress Bandwidth Profile Per EVC

  - Ingress Bandwidth Profile Per CoS ID

- **4 main parameters <CIR, CBS, EIR, EBS>**

  - CIR/CBS determines frame delivery per service level objectives

  - EIR/EBS determines amount of excess frame delivery allowed

    - CIR/EIR is measure in bits per second , CBS/EBS in Bytes per second
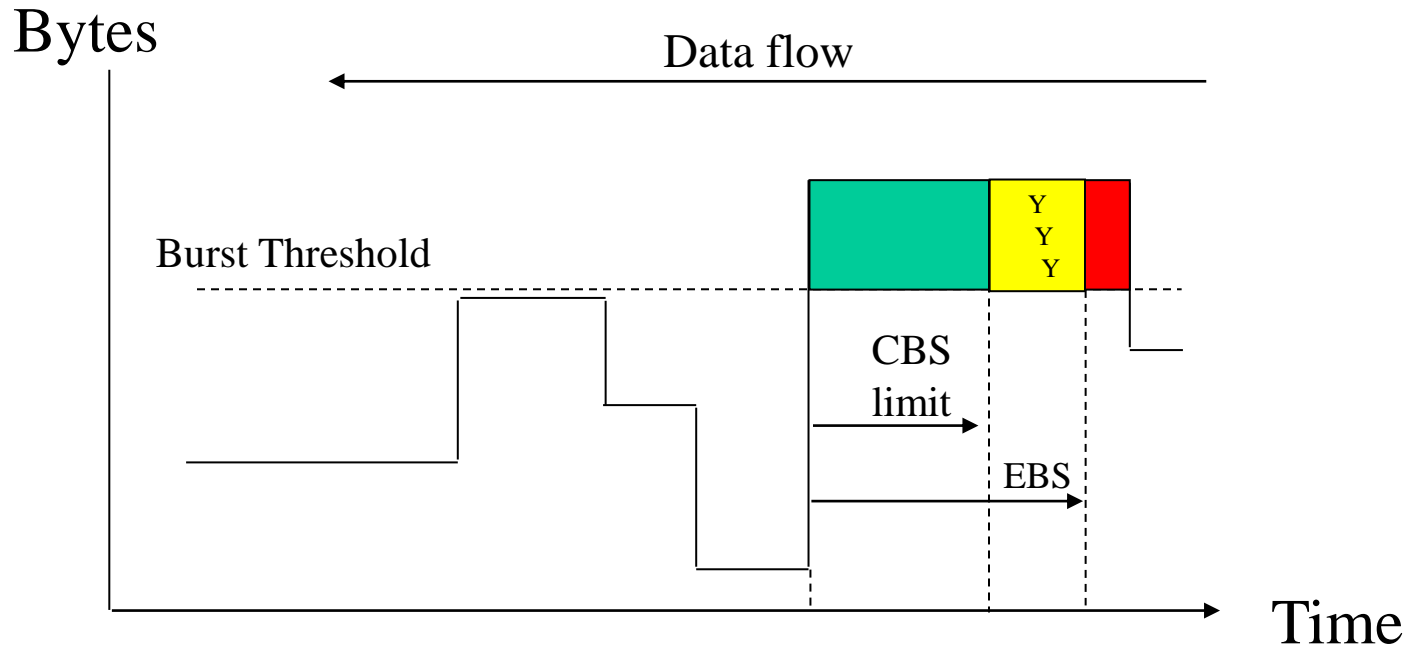
CIR vs. EIR service example

- **Conceptual Example**
  - 3 EVCs share fixed UNI bandwidth
  - 3 CIRs can always be met
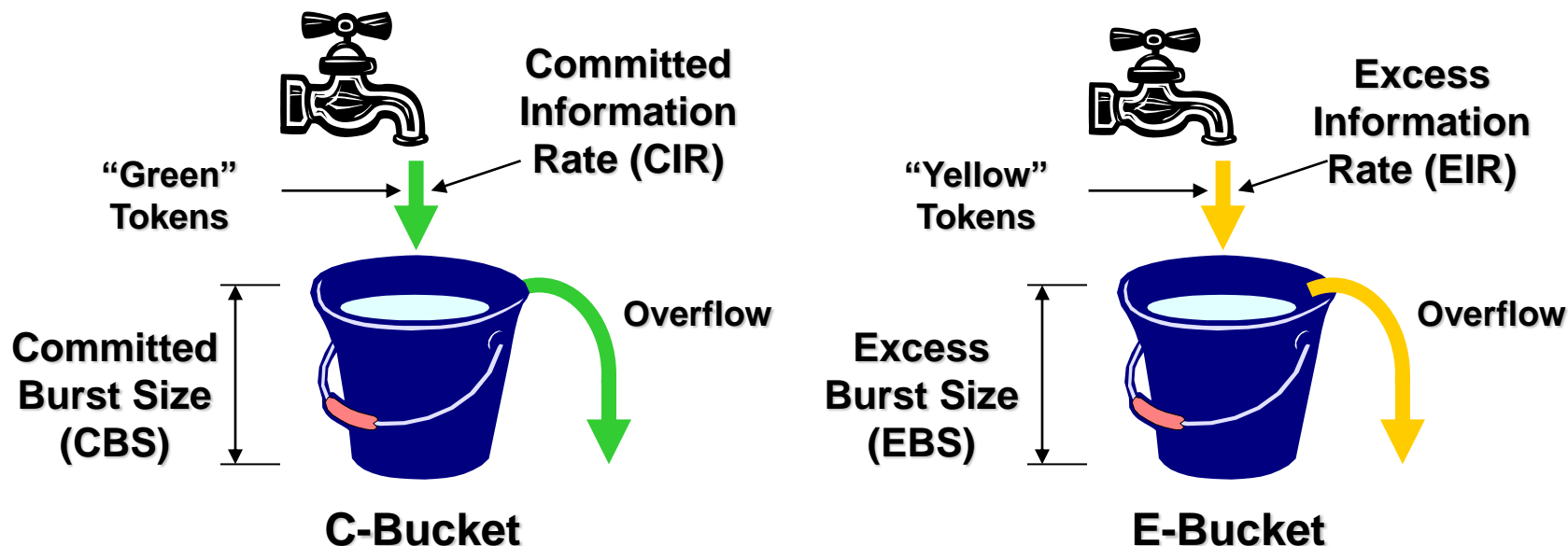 - 3 EIRs can not always be assured (simultaneously)

Total Bandwidth at UNI

EVC1 EVC2 EVC3

EIR CIR EIR CIR EIR CIR

Traffic Passed at CIR rates
are subject to SLA conformance
- if other parameters also met

EIR traffic is marked yellow – not subject to SLA

- **Burst size in Bytes per second allowed**
  - CBS marked Green, EBS is Yellow,
  - Bursts beyond EBS limit is discarded

"Green" Tokens → **Committed Information Rate (CIR)**

Committed Burst Size (CBS)

Overflow

C-Bucket

"Yellow" Tokens → **Excess Information Rate (EIR)**

Excess Burst Size (EBS)
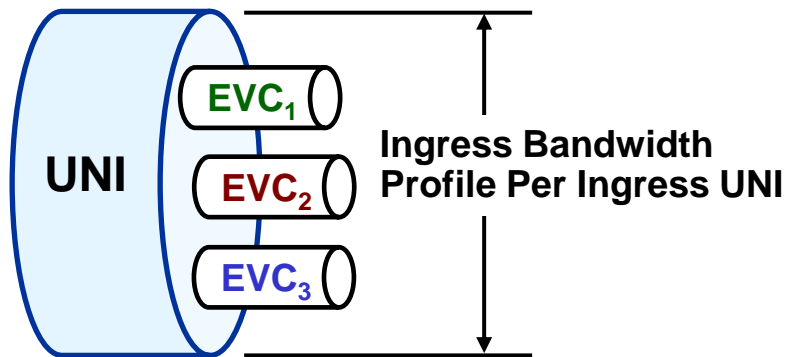
Overflow

E-Bucket
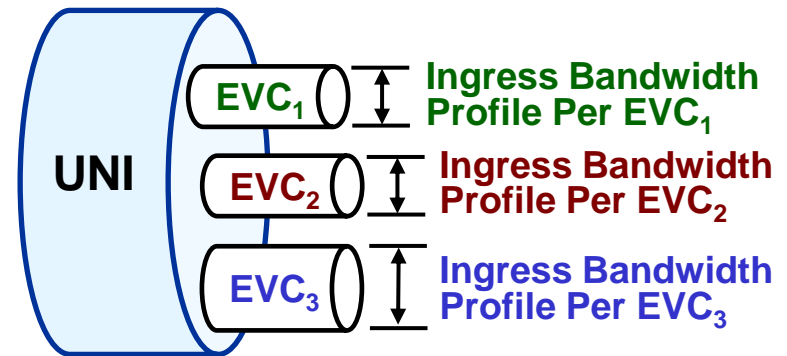
Color Blind Algorithm Skeleton:

If (Service Frame length is less than C-Bucket tokens)

 {declare green; remove tokens from C-Bucket}

else if (Service Frame length is less than E-Bucket tokens)

 {declare yellow; remove tokens from E-Bucket}

else declare red
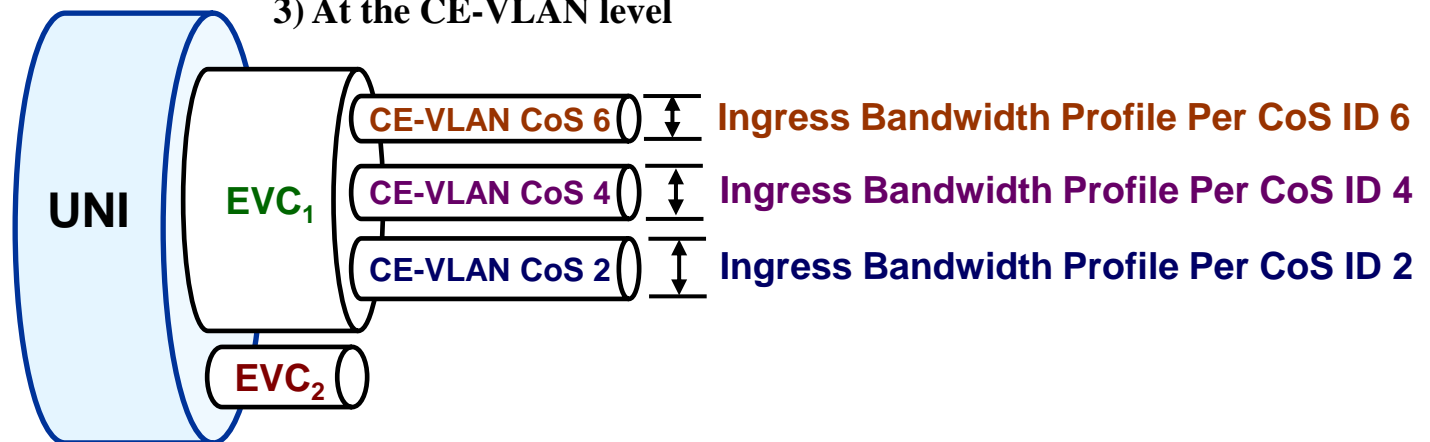
Three Types of Bandwidth Profiles defined in MEF 10

1) At the UNI level

UNI — EVC$_1$, EVC$_2$, EVC$_3$

Ingress Bandwidth Profile Per Ingress UNI

2) At the EVC level

UNI — EVC$_1$, EVC$_2$, EVC$_3$

Ingress Bandwidth Profile Per EVC$_1$

Ingress Bandwidth Profile Per EVC$_2$

Ingress Bandwidth Profile Per EVC$_3$

3) At the CE-VLAN level

UNI — EVC$_1$ — CE-VLAN CoS 6, CE-VLAN CoS 4, CE-VLAN CoS 2

EVC$_2$

Ingress Bandwidth Profile Per CoS ID 6

Ingress Bandwidth Profile Per CoS ID 4

Ingress Bandwidth Profile Per CoS ID 2

MEF

- **EVC**
  - All Service Frames mapped to the same EVC receive the same CoS

- **<EVC,set of user_priority values>**
  - All Service Frames mapped to an EVC with one of a set of user_priority values receive the same CoS

- **SLA Specification:
  Service performance parameters**
  - Frame delay (one-way delay)
  - Frame delay variation (jitter)
  - Frame loss
- **Service performance level to delivery determined via:**
  - Bandwidth profile conformance
    - UNI, EVC or CoS-ID

- **Frame Delay**
  - This is measured as the time taken for service frames across the network
  - Frame Delay is measured from the arrival of the first bit at the ingress UNI to the output of the last bit of the egress UNI. I.e. an end-to-end measurement as the customer views it.
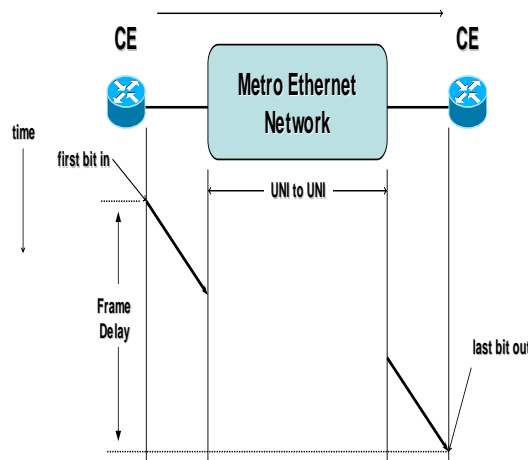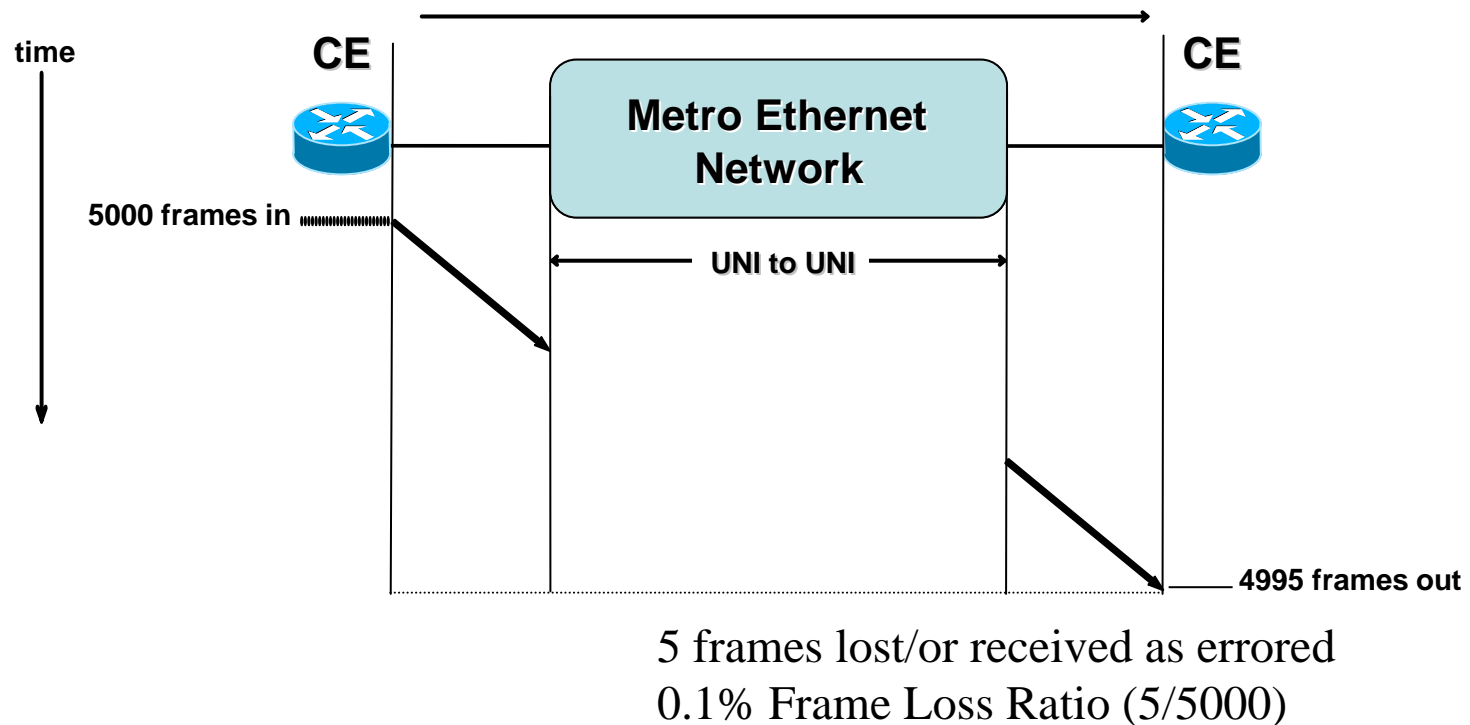

- **Frame Delay Variation**
  - Frame Delay Variation is therefore the variation in this delay for a number of frames. This delay is an important factor in the transmission of unbuffered video and where variation occurs in the millisecond range can affect voice quality. For data can cause a number of undesirable effects such as perceived frame loss, etc
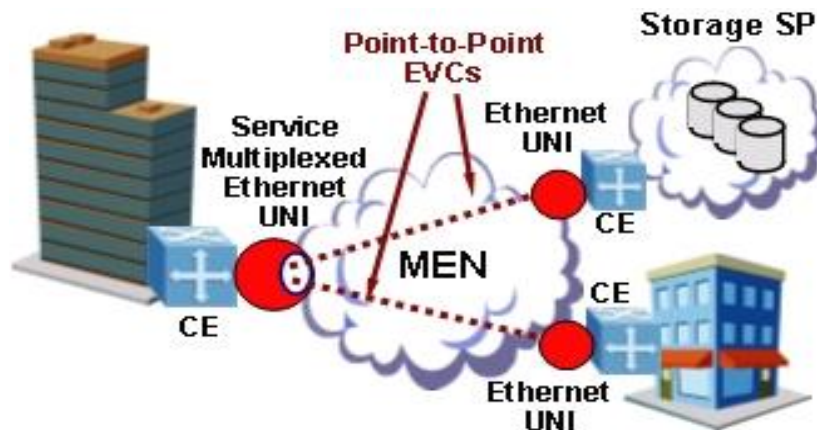- *Note: The term Jitter is not an appropriate term to be substituted from Frame Delay Variation*
- *Note: The MEF expresses performance of delay and delay variation in percentage terms*
- *Note: For most purposes one way delay (rather than round trip delay) is required to establish service quality*

- **Frame loss is a measure of the number of lost service frames inside the MEN.**

  - Frame loss ratio is % = # frames lost / # frames sent

time

CE

CE

Metro Ethernet Network

5000 frames in

UNI to UNI

4995 frames out

5 frames lost/or received as errored
0.1% Frame Loss Ratio (5/5000)

Example CoS-based Metro Ethernet SLA

- E-Line Virtual Private Line Service
- 4 Classes of Service
- CoS determined via 802.1p CoS ID
- Common type of SLA used with CoS-based IP VPNs

Service Class	Service Characteristics	CoS ID	Bandwidth Profile per EVC per CoS ID	Service Performance
Premium	Real-time IP telephony or IP video applications	6, 7	CIR > 0 EIR = 0	Delay < 5ms Jitter < 1ms Loss < 0.001%
Silver	Bursty mission critical data applications requiring low loss and delay (e.g., Storage)	4, 5	CIR > 0 EIR ≤ UNI Speed	Delay < 5ms Jitter = N/S Loss < 0.01%
Bronze	Bursty data applications requiring bandwidth assurances	3, 4	CIR > 0 EIR ≤ UNI Speed	Delay < 15ms Jitter = N/S Loss < 0.1%
Standard	Best effort service	0, 1, 2	CIR=0 EIR=UNI speed	Delay < 30ms Jitter = N/S Loss < 0.5%

Final Word

- ## Service Attributes & Parameters
  - Ethernet Private Line, Ethernet Virtual Private Line, Ethernet LAN attributes and parameters are covered in detail in the specifications

- ## Next Actions
  - After reading this document you should now be familiar with the main concepts of Ethernet Services and be in a position to follow the details contained in both the MEF and MEF 10 Specifications

MEF

For Full Details …

… visit **www.metroethernetforum.org**
to access the full specification