Introducing the Specifications of the Metro Ethernet Forum
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* MEF 10 * replaced MEF 1 and MEF 5
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.

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
### Introduction

#### MEF 6 Ethernet Services Definitions – Phase I

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<th>Purpose</th>
<th>Defines the Ethernet Services (EPL, EVPL, E-Line, ELAN, etc)</th>
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<td>Audience</td>
<td>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.</td>
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#### MEF 10 Ethernet Services Definitions – Phase I

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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
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
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

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
• **Ethernet Private Line**
  - Replaces a TDM Private line
  - Dedicated UNIs for Point-to-Point connections
  - Single Ethernet Virtual Connection (EVC) per UNI
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
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
Example Service using E-LAN Service Type

• **Ethernet Multicast**
  – Point to multipoint for broadcast applications (Video)
  – Supports Service Multiplexed UNI (to deliver multiple channels)
Ethernet Frame handling

• 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
Options for Layer 2 Control Protocols

- **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 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)

- 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

Send all Customer VLANs

CE-VLAN ID/EVC Map

- U ntagged*
- Priority Tagged*
- Tagged, VID = 1
- Tagged, VID = 2
- Tagged, VID = 4094
- Tagged, VID = 4095

CE-VLAN ID

EVC

Red

1
2
4094
4095
Using All to One Bundling

Simplified Branch LAN extension Set-up
- No VLAN Mapping
- No VLAN preservation

Customer VLAN 6,7,9

LAN Extension EVC
One to One 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 not required
- Subscriber and Service Provider must coordinate CE-VLAN ID/EVC Map
CE-VLAN ID Translation

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

- Fine for CE routers
- Problematic for CE bridges
Identifying an EVC at a UNI

CE-VLAN ID/EVC Map

Service Frame Format
- Untagged*
- Priority Tagged*
- Tagged, VID = 1
- Tagged, VID = 2
- ...
- Tagged, VID = 4094
- Tagged, VID = 4095

CE-VLAN ID
- Red
- Green
- Blue

*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.
Using One to One Map w/ Translation – 1

Internet Service Provider

CE-VLAN ID Preservation would constrain ISP

178 ↔ Blue
179 ↔ Yellow
180 ↔ Green

2000 ↔ Green

ISP Customer 1

2000 ↔ Blue

ISP Customer 2

2000 ↔ Yellow

ISP Customer 3

CE Router

Frame Relay PVC Replacement

Pt to Pt EVCs
Using One to One Map – 2

![Diagram showing the connectivity between ASP customers and the CE router. The diagram illustrates the use of 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
How to classify the traffic

• **Apply ingress bandwidth profiles**
  – At the UNI (MEF 10) or other NNI handoffs (future)
  – Traffic that 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 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.
• **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
• **Conceptual Example**
  – 3 EVCs share fixed UNI bandwidth
  – 3 CIRs can always be met
  – 3 EIRs can not always be assured (simultaneously)

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
Bandwidth Profile Defined by Token Bucket Algorithm (2 rates, 3 colors)

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

2) At the EVC level

3) At the CE-VLAN level

UNI

EVC\(_1\)

EVC\(_2\)

EVC\(_3\)

Ingress Bandwidth Profile Per Ingress UNI

Ingress Bandwidth Profile Per EVC\(_1\)

Ingress Bandwidth Profile Per EVC\(_2\)

Ingress Bandwidth Profile Per EVC\(_3\)

UNI

EVC\(_1\)

EVC\(_2\)

EVC\(_3\)

CE-VLAN CoS 6

CE-VLAN CoS 4

CE-VLAN CoS 2

Ingress Bandwidth Profile Per CoS ID 6

Ingress Bandwidth Profile Per CoS ID 4

Ingress Bandwidth Profile Per CoS ID 2
Two Ways to Identify CoS Instance

• **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 and Delay Variation

- **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 Defined

- Frame loss is a measure of the number of lost service frames inside the MEN.
  - Frame loss ratio is $\% = \frac{\text{# frames lost}}{\text{# frames sent}}$

![Diagram showing frame loss example](image)

5000 frames in

Metro Ethernet Network

UNI to UNI

CE

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

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

... visit [www.metroethernetforum.org](http://www.metroethernetforum.org) to access the full specification.