Introducing the Specifications of the Metro Ethernet Forum
<table>
<thead>
<tr>
<th>MEF</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Requirements and Framework for Ethernet Service Protection</td>
</tr>
<tr>
<td>3</td>
<td>Circuit Emulation Service Definitions, Framework and Requirements in Metro Ethernet Networks</td>
</tr>
<tr>
<td>6</td>
<td>Metro Ethernet Services Definitions Phase I</td>
</tr>
<tr>
<td>7</td>
<td>EMS-NMS Information Model</td>
</tr>
<tr>
<td>8</td>
<td>Implementation Agreement for the Emulation of PDH Circuits over Metro Ethernet Networks</td>
</tr>
<tr>
<td>9</td>
<td>Abstract Test Suite for Ethernet Services at the UNI</td>
</tr>
<tr>
<td>10</td>
<td>Ethernet Services Attributes Phase I</td>
</tr>
<tr>
<td>11</td>
<td>User Network Interface (UNI) Requirements and Framework</td>
</tr>
<tr>
<td>12</td>
<td>Metro Ethernet Network Architecture Framework Part 2: Ethernet Services Layer</td>
</tr>
<tr>
<td>13</td>
<td>User Network Interface (UNI) Type 1 Implementation Agreement</td>
</tr>
<tr>
<td>14</td>
<td>Abstract Test Suite for Ethernet Services at the UNI</td>
</tr>
<tr>
<td>15</td>
<td>Requirements for Management of Metro Ethernet Phase 1 Network Elements</td>
</tr>
<tr>
<td>16</td>
<td>Ethernet Local Management Interface</td>
</tr>
</tbody>
</table>

* MEF 10 * replaced MEF 1 and MEF 5
### MEF 7

**EMS-NMS* Information Model**  
*Element Management System–Network Management System*

<table>
<thead>
<tr>
<th><strong>Purpose</strong></th>
<th>Provides a standard for carrier management systems to enable configuration and fault management of Metro Ethernet services.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Audience</strong></td>
<td>Equipment Manufacturers building devices that will carry Carrier Ethernet Services. Useful for Service Providers architecting their systems.</td>
</tr>
</tbody>
</table>
MEF 7: EMS - NMS Information Model

• **A specification**
  – Enable consistent definition of the management information required to manage Carrier Ethernet.

• **A Model**
  – defines the specific EMS-NMS management interface using a well-defined method such as Common Object Request Broker Object (CORBA) IDL, Simple Network Management Protocol (SNMP), JAVA, XML, etc.

• **Scope**
  – Ethernet (ETH) layer UNI configuration provisioning
  – ETH layer configuration and provisioning
  – ETH layer network connection and fault management (including setup/modification, notification, testing)
• **MEF 7 defines a Means to provide OAM at the Ethernet Services layer**
  – Does not define OAM at the transport link/ network layers
  – Compliments/relies on the work done in the ITU, IEEE and IETF at the Transport data link and Network layers

• **Provides a frame work and concepts for managing and monitoring flows across a connectionless network**
  – from end to end

• **Provides mechanism to perform:**
  – Node Discovery, Establish connectivity, monitor CoS, and detect service impairments
Key Assumptions behind MEF OAM

- Assumes Ethernet is only common denominator
  - E.g. 802.3 Ethernet, Ethernet over SONET, RPR, etc.
  - Must use Ethernet framing for OAM communications
- Ethernet segments interconnected with forwarding entities (bridge, switch, etc.)
  - Connectionless, like IP
  - Segment can be real or virtual
- Must measure “per service” and be with data plane
  - Out-of-band OAM not possible, not accurate with data plane
  - OAM mixes with user data within core
- Small initial focus on “SLA” metrics
  - Connectivity, latency, loss, jitter
- Other function may follow later
  - Traceroute, RDI/AIS, other
- Domain oriented
  - Domain may be intra-provider, inter-provider, customer-customer, etc.
Network Layering Concepts

- Flows, connections and resources can all be managed separately at each LND
- Each can remain independent
- Each in turn can pass information to upper management domains to isolate issues.
Network Mgmt Functions Addressed

- NMS Functional Model
- Node Discovery
- Service performance monitoring
- Ethernet (ETH) layer MEN topology configuration and provisioning
- ETH layer UNI configuration and provisioning
- ETH layer network flow (EVC) management
- ETH layer fault management
NMS Functional Model

- NMS Monitors/controls service end to end across separate EMS monitored/controlled flow domains
• **MEF 7 relies closely on the concepts defined by the ITU in G.809**
  – Ethernet services are inherently connectionless
  – Services are supported over Flows
  – Flow Domains can be set up within a provider's network and interconnected
    • Useful for connection of separate underlying transport networks (SONET, vs. Switched etc..)
  – Flow Domains can also be connected between carrier networks
Flow Domain Partitioning Concept

- **Flow Domains are sub networks** – interconnected by network links
- **Flow domains can be partitioned and nested within other larger flow domains**
  - E.g. each can be managed by separate EMS and/or NOCs
  - NMS systems can manage across multiple domains at the service layer
Terminations of links between flow domains are called Flow Point Pools (FPPs) or Link Ends

- FPPs can be associated with trail ends within a sub network topology (Fig. 1)
- A subnetwork connection is terminated by Connection Termination Points (CTPs)
- Multiple subnetworks can make up a flow domain link as depicted in Fig. 2
• Information is provided in the specifications with respect to the relationship to the concepts defined.

• These cover:
  – ETH Topology Information
  – ETH Connectivity Information
  – Association Relationship of ETH Topology Information
  – Association Relationship of ETH Connection Information
Applying the Model

The following are a selection of examples covering:

- Discovery
- Control
- Performance monitoring
On-Demand retrieval of Ethernet Flow Domains

• **TRIGGER:**
  – The NMS initiates this operation to inventory all Ethernet Flow Domains managed by the EMS, and retrieve certain attributes from each.

• **PRE-CONDITIONS:**
  – EMS-NMS Connectivity is established.
On-Demand retrieval of Ethernet UNIs

- **TRIGGER:**
  - The NMS initiate this operation to inventory all Ethernet UNIs managed by the EMS, and retrieve certain attributes from each.

- **PRE-CONDITIONS:**
  - EMS-NMS Connectivity is established.
  - The NMS is aware of or able to retrieve the names or identifiers for all Ethernet UNI instances.
Auto-discovery of Ethernet FPP UNIs

- **TRIGGER:**
  - Whenever a new Ethernet FPP is created, the EMS notifies the NMS and provides attribute information.

- **PRE-CONDITIONS:**
  - EMS-NMS Connectivity is established.
On-Demand retrieval of Ethernet EVCs

**TRIGGER:**

- The NMS initiate this operation to inventory all Ethernet EVCs and associated ETH_Flow_Points within a subnetwork managed by the EMS, and retrieve certain attributes from each.
• **TRIGGER:**
  - The NMS has provisioned an ETH_FPP_UNI representing an Ethernet UNI on a port, and is ready to create a EVC to support the customer’s service.
• **TRIGGER:**
  - The NMS has a need to revise the COS Profile on an Ethernet Flow Point due to a change order.
• **TRIGGER:**
  - An alarm notification is sent to the NMS whenever an alarmable event is detected by the EMS or NE
OAM Frame Requirements

• Requires its own in band OAM “data channel”
  – To perform operations
    • Service pings
  – Carry service provisioning and performance data
    • Like an ECC
  – Identifiable by Multicast Destination address and/or Ether Type field

```
01234567 89012345 67890123 45678901
+-----------------------------------------------+
 | Dest MAC |
+-----------------------------------------------+
 | Dest MAC | Source MAC |
+-----------------------------------------------+
 | Source MAC |
+-----------------------------------------------+
 | VLAN Ethertype | VLAN Tag |
+-----------------------------------------------+
 | (Optional) |
+-----------------------------------------------+
 | VLAN OAM | Version | OpCode |
+-----------------------------------------------+
 | EtherType |
+-----------------------------------------------+
 | Data (OpCode specific, N bytes)...
+-----------------------------------------------+
```
Discovery Requirements

- Ethernet service can be multi-point to multi-point
- It is valuable to automatically discover the other endpoints of an Ethernet service
  - Plug-n-play – can eliminate some provisioning
  - Diagnostic – can detect some misconfiguration
- Utilizes multicasts capability of Ethernet
  - Edge device sends out a multicast “ping” request
  - Other edge devices respond to ping
  - Repeated for more reliability
  - Source can construct list of other edge devices
Connectivity, Latency, Loss

- Discovery has learned MAC addresses of all other edge devices
- Can validate connectivity with unicast “ping” to other edge device
  - On demand for diagnostic
  - Regularly for monitoring
- Interior devices can’t tell ping from user data
  - Analogous to routers and ICMP ping
- Time from request sent to response received measures round-trip latency
  - Just like ICMP ping
- Can repeat multiple times for loss measurement
  - Ping N times, no response to M of the pings
  - Implies packet loss is M/N
  - Provides ICMP echo functionality at layer two
Delay Variation

- One-way delay variation an important SLA metric
  - Important for video, voice, and anything real-time
- OAM can measure delay variation by inclusion of timestamp in ping requests
  - Source of ping can include a (relative) timestamp in the request
  - Source can send pings repeatedly or periodically
  - Receiver can measure inter-transmit times via timestamps
  - Receiver can measure inter-receive times via actual time pings received
  - Receiver can measure delay variation by the difference in the receive times relative to the transmit times
    - Transmit timestamps say 0, 1000, 2000, 3000, 4000 (milliseconds)
    - Receive times are 3561, 4560, 5562, 6561, 7563 (milliseconds)
    - Says delay variation is around 1 millisecond
Summary

• MEF developing OAM for multi-hop networks utilizing Ethernet framing

• Focused on providing SLA measurements
  – Connectivity, Latency, Loss, Jitter

• Provides functionality using combination of
  – Automated discovery of edge devices
  – Ping like functionality at layer 2
  – Filtering mechanisms to protect a providers’ domain

• Needs to be used in combination with other OAM mechanisms
  (e.g. IEEE 802.3ah OAM) for a more complete OAM solution
For Full Details ...

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