Metro Ethernet Forum OAM

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The Problem

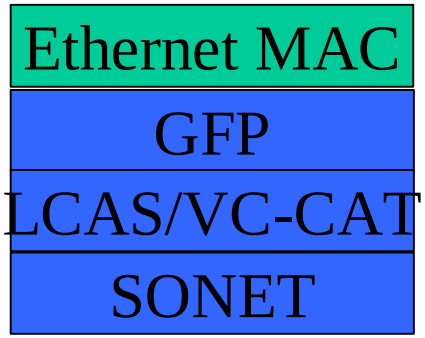
- Significant inhibitor of large scale Ethernet deployments is lack of OAM capabilities
  - Compared with SONET, ATM, etc.
- These other technologies have OAM capabilities within data link layer
  - SONET overhead/framing structures, performance reports, etc.
  - ATM ILMI, VC monitoring, etc.
- Traditional Ethernet OAM philosophy: use IP
  - Requires Ethernet be “up” for IP to manage it
  - Often out-of-band
- Works because Enterprise networks generally simple

Hierarchical Layered Networks

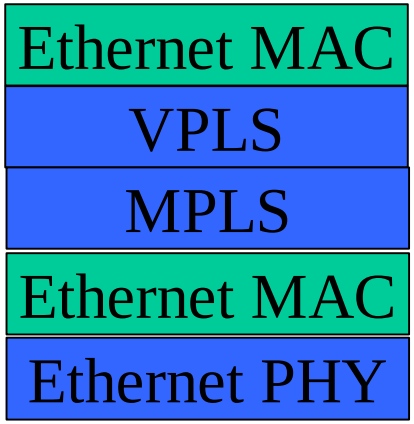
- Carrier networks not so simple when delivering Ethernet services
  - Switched Ethernet
  - Ethernet over SONET
  - Ethernet over ATM
  - Ethernet over RPR
  - Ethernet over MPLS
  - Ethernet over IP
- “Just plug it in and it works” no longer applicable
- Today’s networks are layered, hierarchical, and complicated
  - Leads to many potential layers of OAM

Examples of Today's Layering

Standard Ethernet



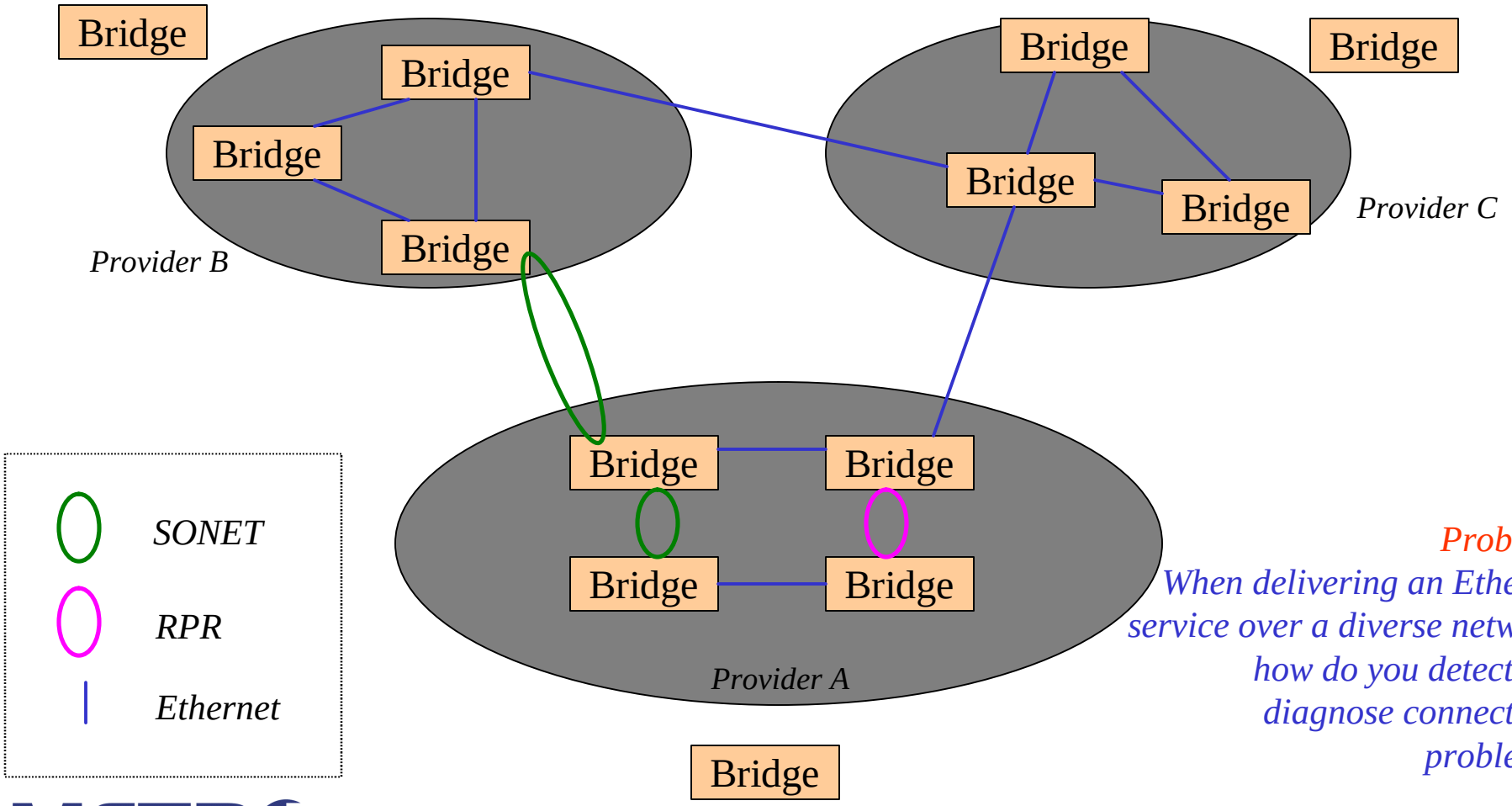
Ethernet over SONET



VPLS

1) Only commonality of service is the Ethernet frame.
2) OAM required at every layer in the hierarchy.

Scoping the Problem



Problem:
When delivering an Ethernet service over a diverse network, how do you detect and diagnose connectivity problems?

Scoping the Problem

- When delivering an Ethernet service over a diverse network, how do you detect and diagnose connectivity problems?
  - Is this single Ethernet segment working?
  - Is this EoSONET segment working?
  - Is this VPLS segment working?
  - Is this RPR segment working?
  - Is spanning tree operating correctly?
  - Are two non-adjacent bridges communicating?
  - Is there connectivity across my network?
  - Is there connectivity across a multi-provider network?
  - Is there connectivity site-to-site for the user?
  - Is there multicast connectivity?
  - What is the latency across the network for a given service/VLAN?
  - Is there any packet loss for a given service/VLAN?
  - What is the jitter across the network for a given service/VLAN?

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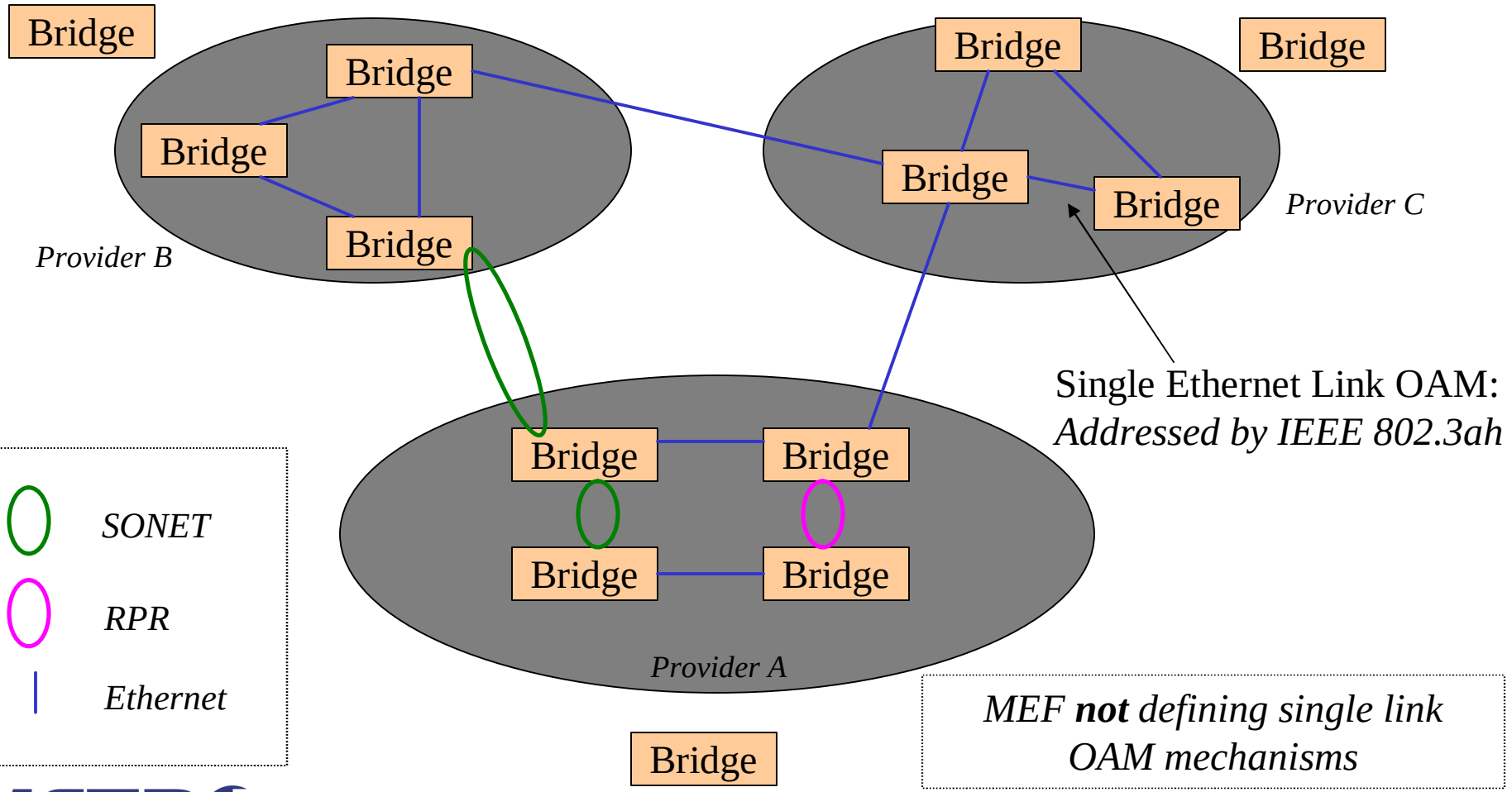

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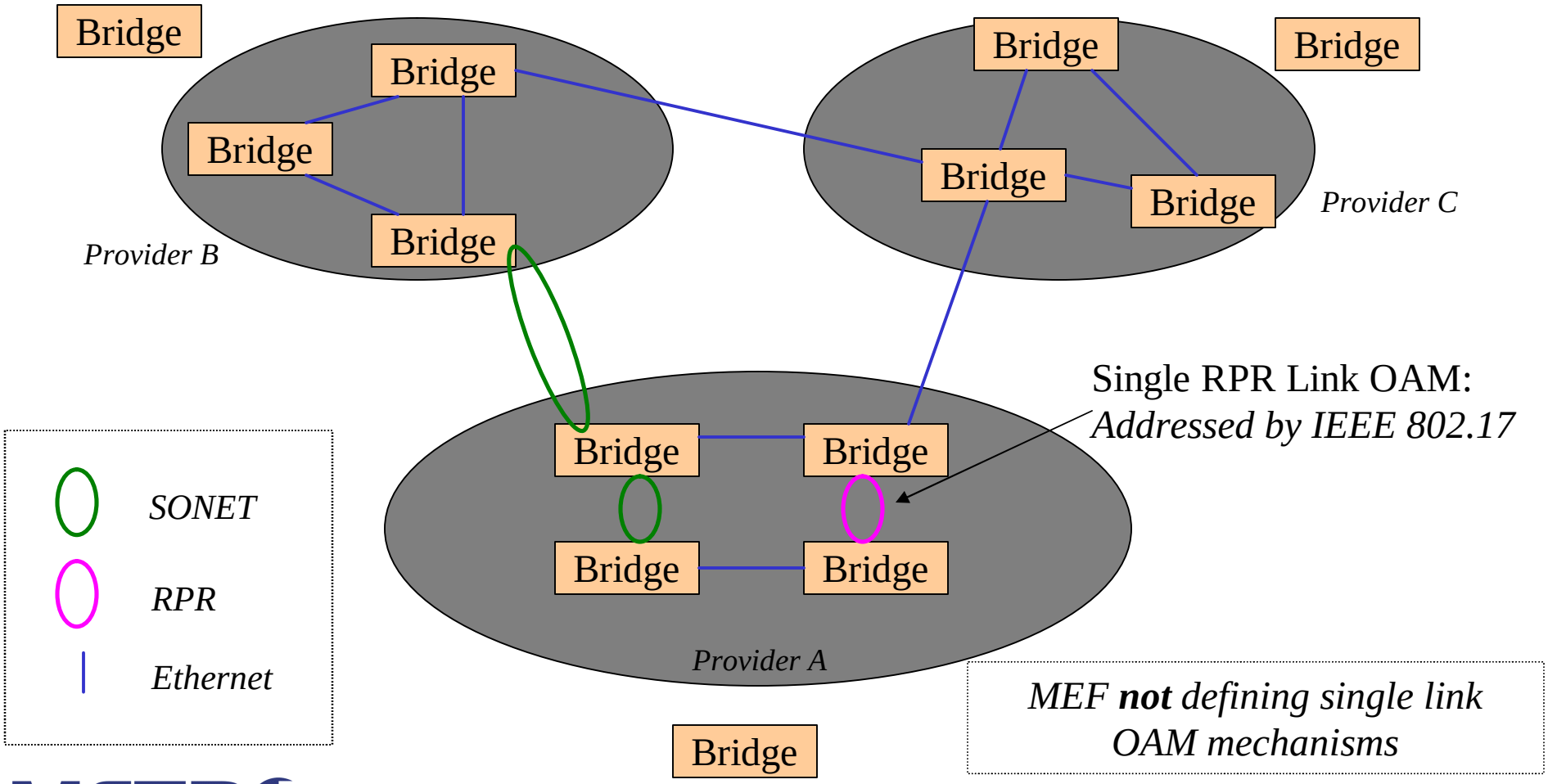

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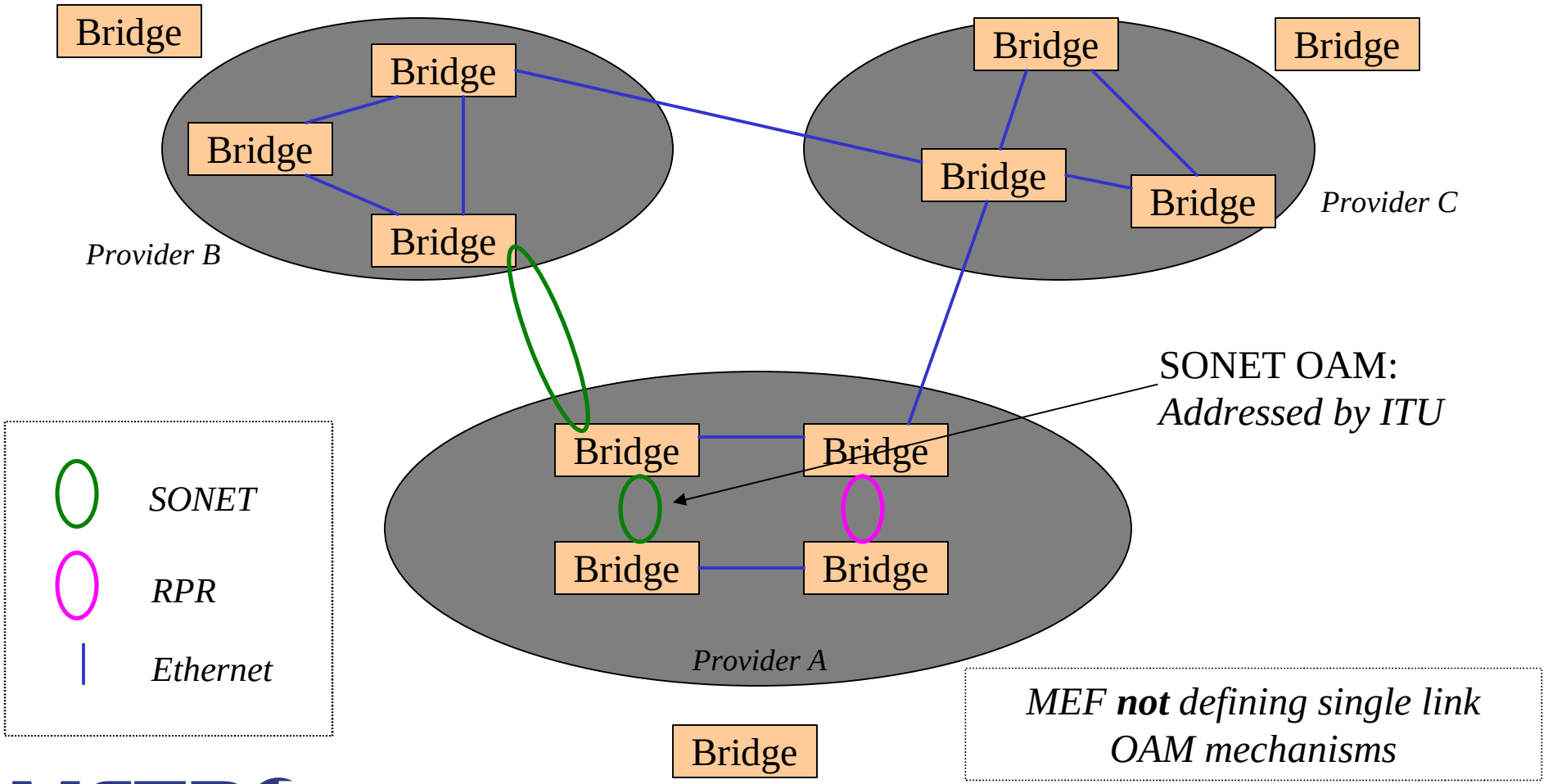

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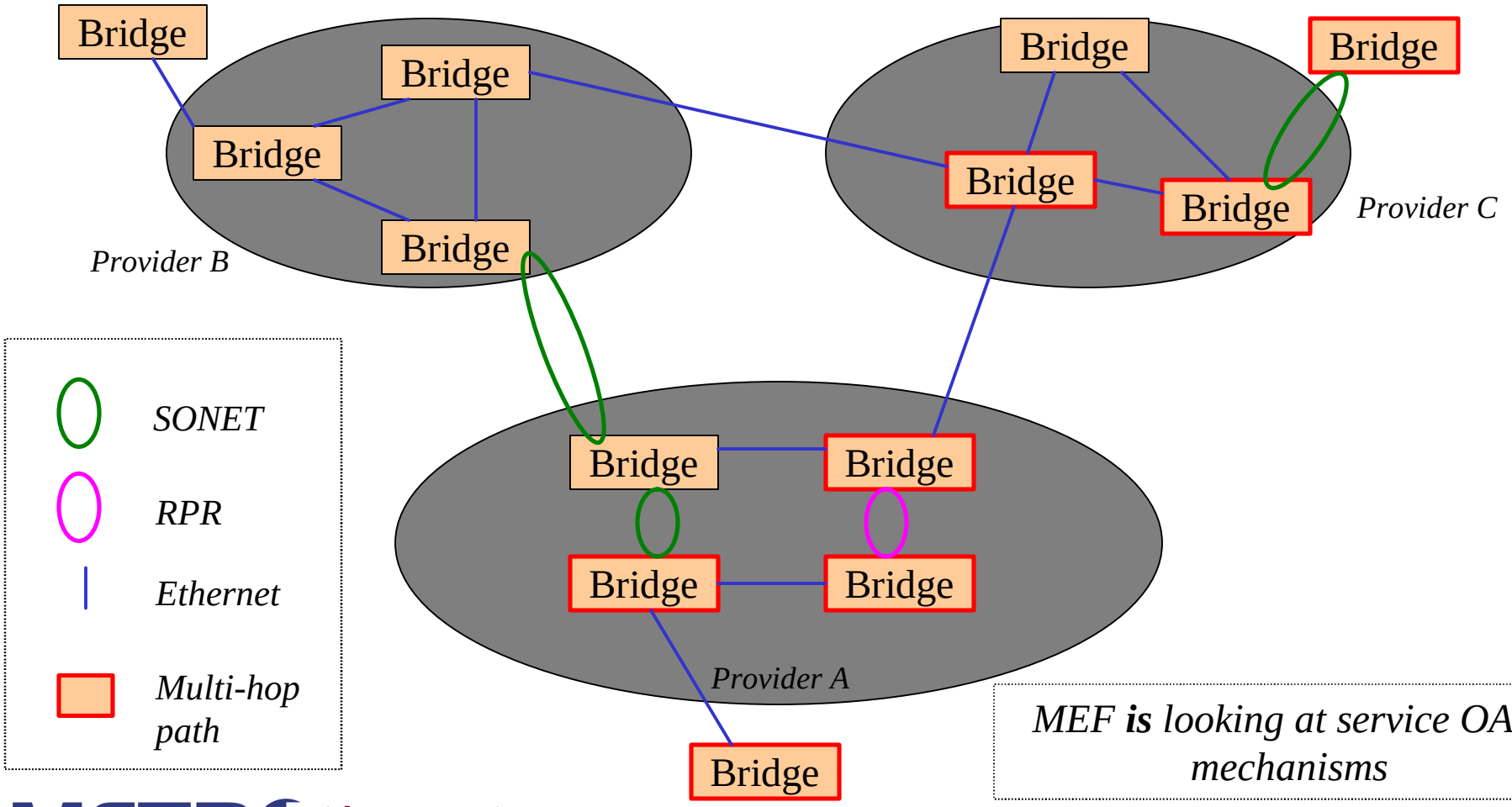
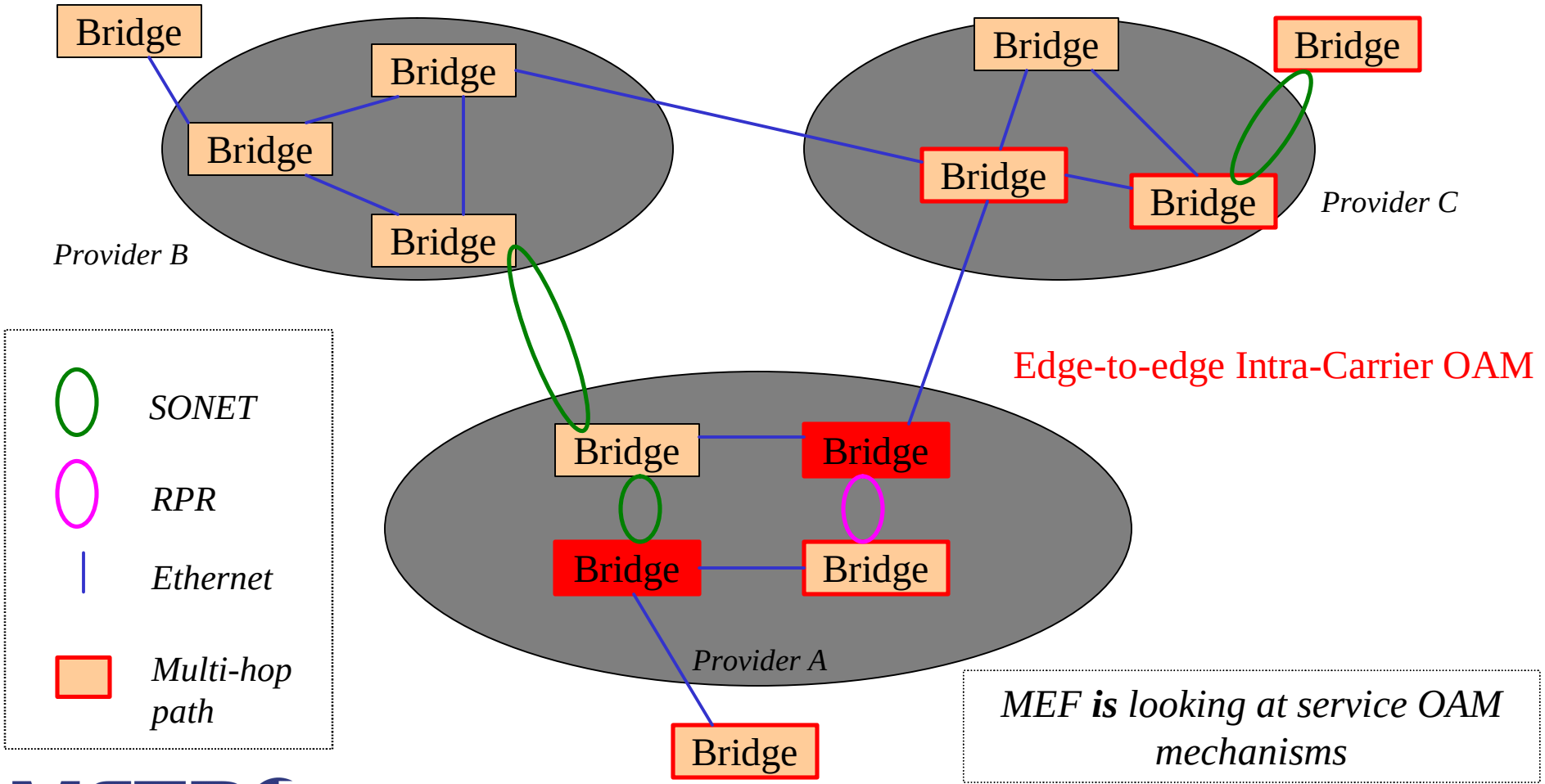


*MEF **is** looking at service OAM mechanisms*

Scoping the Problem



Edge-to-edge Intra-Carrier OAM

*MEF **is** looking at service OAM mechanisms*

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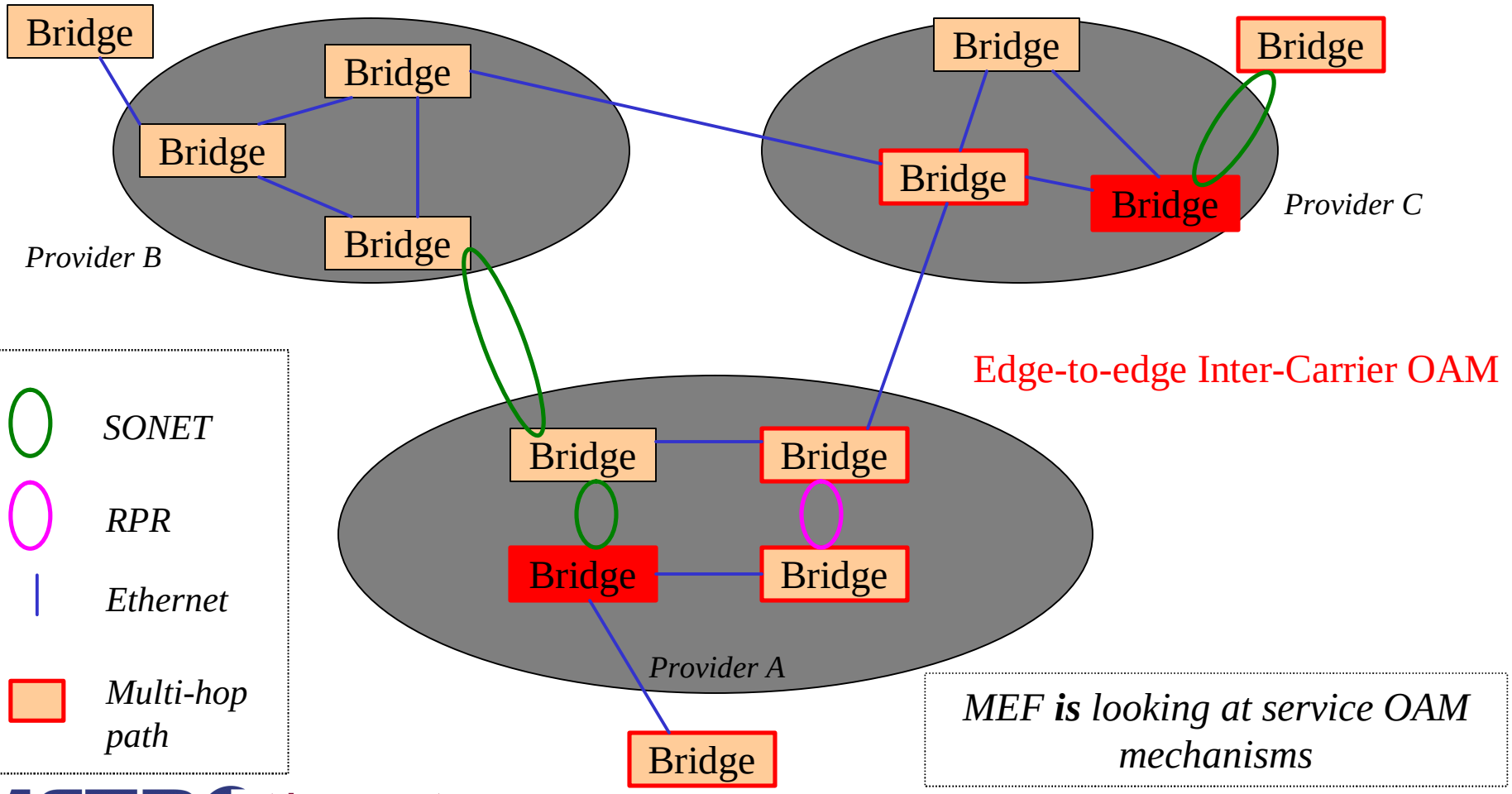

Edge-to-edge Inter-Carrier OAM

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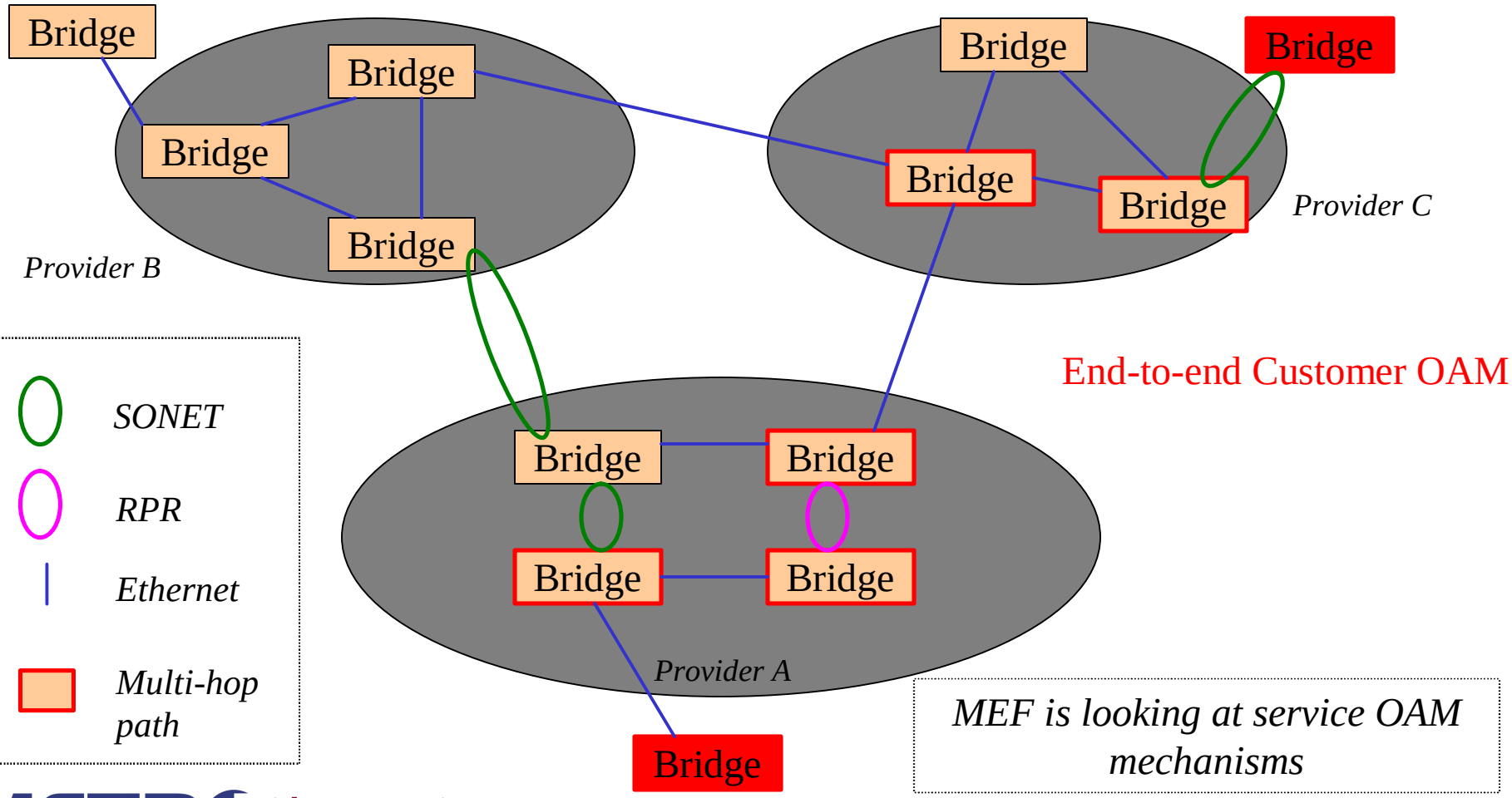


Ethernet OAM: Industry Focus

Services

Service and SLA OAM
MEF + ITU EthOAM

Networks

Bridged Network Fault Detection & Isolation
IEEE 802.1?? + MEF + ITU EthOAM

Links

Ethernet OAM	MPLS/VPLS OAM	EoSONET OAM	RPR OAM
IEEE 802.3ah	IETF MPLS	ITU	IEEE 802.17

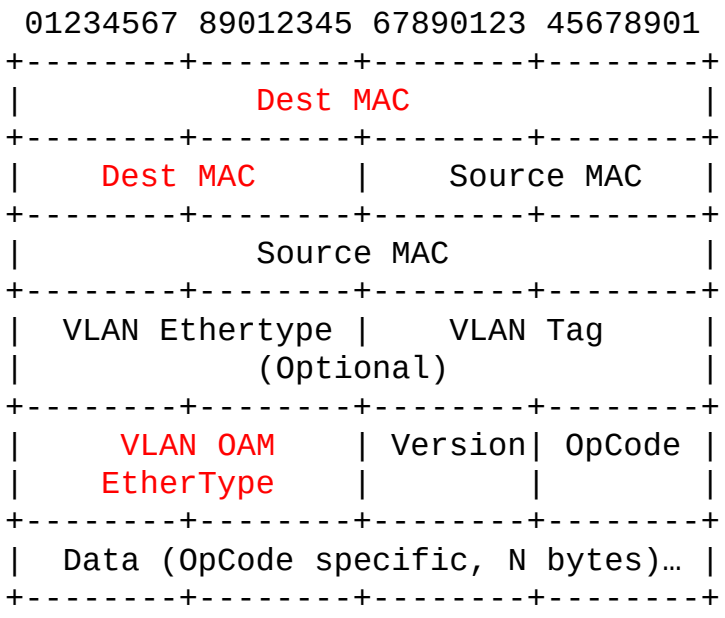
Disclaimer

- The remainder of this document discusses a draft within the Metro Ethernet Forum
  - It is subject to change
  - It does not represent the agreed consensus of the MEF
  - Do not run off and implement this (yet)

Key Aspects of 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.

OAM Frame



If OAM measuring VLAN 99, tagged with VLAN 99.

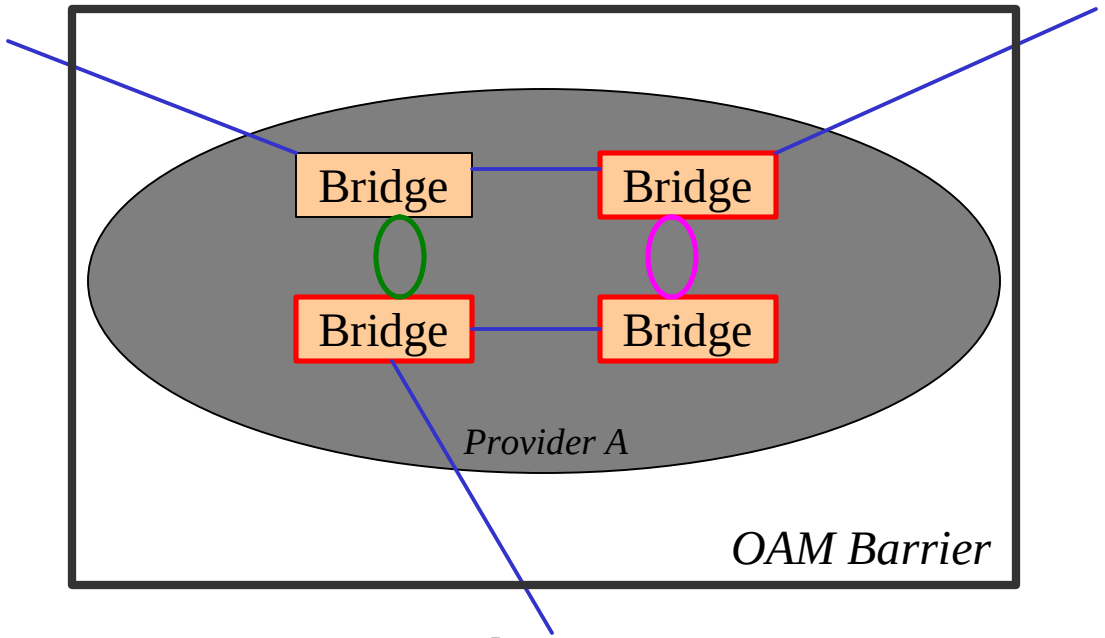
OAM Frames “look” like user data frames, but differentiated by

1) Use of well-known multicast address for OAM discovery
2) Use of well-known EtherTypes for OAM

A Security Wrinkle

- Ethernet has the unfortunate property that packets may be sent to places they don't need to go (e.g. MAC address is not known)
- With OAM for a service provider environment,
  - OAM must not "leak" out of the provider to other providers or the customer
  - Customers and other providers must not be able to interfere with the carrier's OAM
- To deal with this, multi-hop OAM must filter OAM at the edges of the domain

A Security Wrinkle



OAM is required to create an *OAM Barrier*

- No OAM in from the outside
- No OAM out from the inside

Protects carrier OAM from interference and leaking

- OAM is filtered by EtherType at all “external” ports

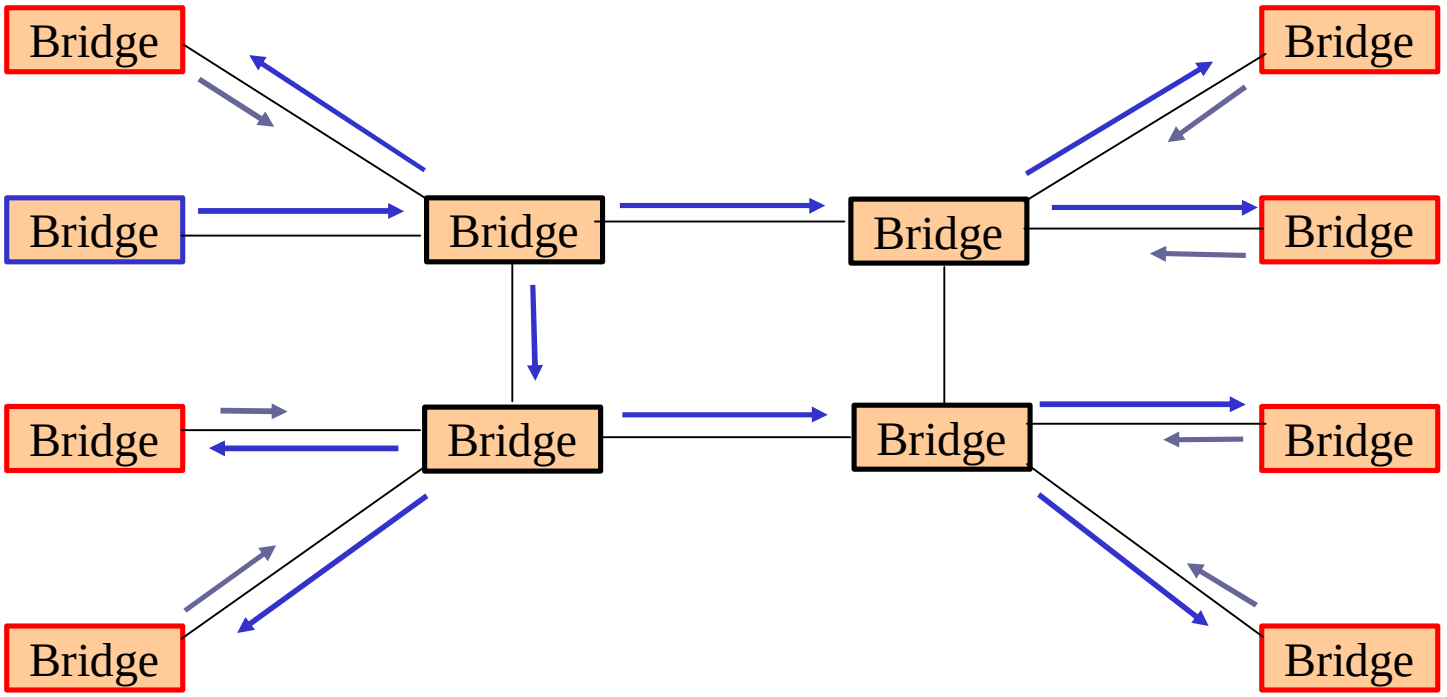
Operational Aspects

- Four basic functions
  - Discovery
  - Connectivity verification
  - Latency and loss measurement
  - Delay variation measurement
- Additional functionality may come later

Discovery

- 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

Discovery


Bridge
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Bridge
Multicast Ping Request
Unicast Ping Response

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
- Fixes the missing piece of OAM in the Carrier Grade Ethernet puzzle