Carrier Ethernet Standards Progress

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Agenda

- History
- Metro Ethernet Forum work
- IETF work
- IEEE work
- Conclusion

Ethernet Evolution

- What do we like about Ethernet?
  - Data plane
    - Speeds
    - Flexible frame size
    - Native broadcast & multicast
  - Low cost
- What do we dislike about Ethernet?
  - Control plane (i.e. STP)
  - Management plane (i.e. OAM)
  - Flat addressing scheme

Carrier Ethernet History

- Early Ethernet based services based upon
  - Standard Ethernet Switches
  - QinQ Switches (now 802.1ad)
- Challenges
  - Lack of scalability (4K VLANs / MAC learning)
  - Limited Traffic Engineering (STP/MSTP)
  - Limited QoS (802.1p)
  - Limited Protection (STP/RSTP)

Carrier Ethernet Market

- Carrier Ethernet market was around USD155M in 2004, and has potential to pass USD1B in 2007
- Carrier Ethernet switch/routers is the set of products showing the greatest amount of activity
- Operators worldwide are using Carrier Ethernet to support Ethernet enterprise services and residential triple play services

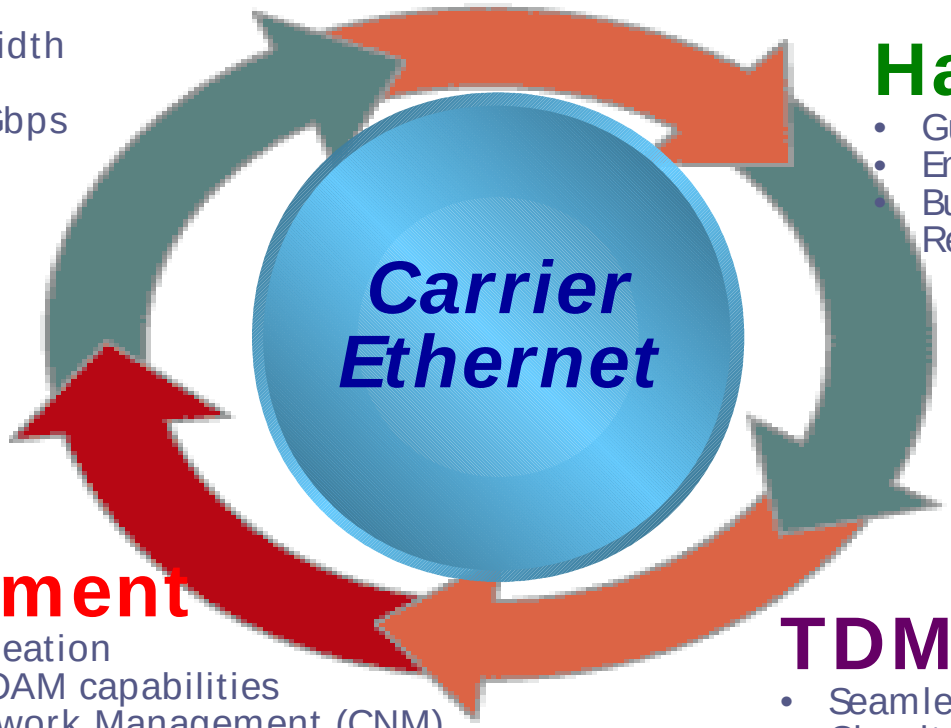
Source: Heavy Reading – Carrier Ethernet Equipment Market Outlook (Aug/2005)

Metro Ethernet Forum Work

What is Carrier Ethernet?

Protection
- 50ms Protection
- End to End Path Protection
- Aggregated Line & Node Protection

Scalability
- Services and Bandwidth
- 100,000's of EVC's
- From Mbps to x10Gbps



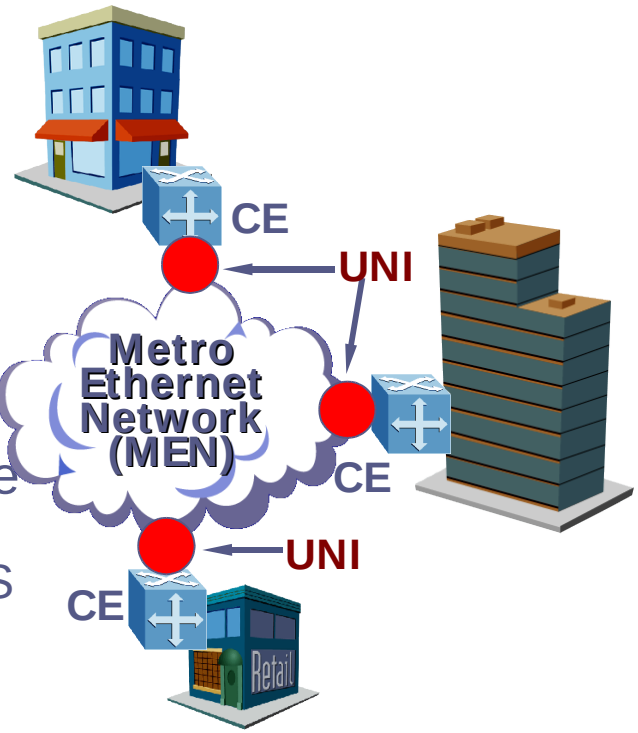
Hard QoS
- Guaranteed end to end SLA
- End to End CIR and EIR
- Business, Mobile, Residential

Service Management
- Fast service creation
- Carrier class OAM capabilities
- Customer Network Management (CNM)

TDM Support
- Seamless integration of TDM
- Circuit Emulation Services
- Support existing voice applications

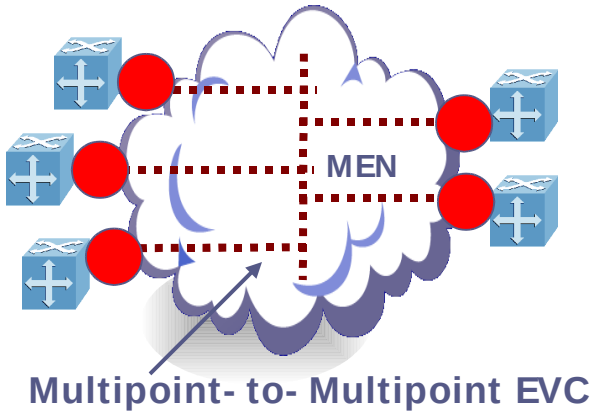
Ethernet Service
Basic Model

- Customer Equipment (CE) attaches to UNI
- CE can be
  - router
  - IEEE 802.1Q bridge (switch)
- UNI (User Network Interface)
  - Standard IEEE 802.3 Ethernet PHY and MAC
  - 10Mbps, 100Mbps, 1Gbps or 10Gbps
- Metro Ethernet Network (MEN)
  - May use different transport and service delivery technologies
    - SONET/SDH, WDM, RPR, MiM, QiQ, MPLS



Ethernet Virtual Connection (EVC)

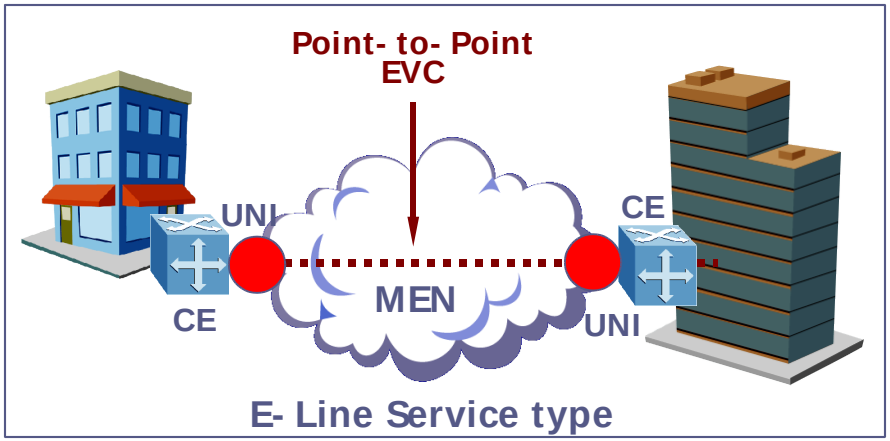
- An EVC is “an instance of an association of 2 or more UNIs”
- EVCs help visualize the Ethernet connections
  - Like Frame Relay and ATM PVCs
- MEF has defined 2 EVC types
  - Point-to-Point
  - Multipoint-to-Multipoint

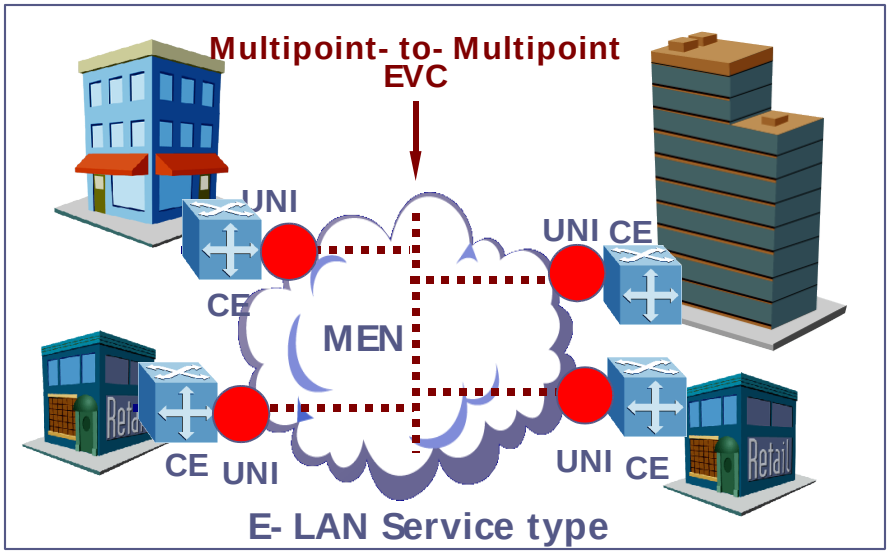


EVCs help conceptualize the service connectivity

E-Line and E-LAN Service Types

- E-Line Service used to create
  - Private Line Services
  - Ethernet Internet Access
  - Point-to-Point VPNs
- E-LAN Service used to create
  - Multipoint VPNs
  - Transparent LAN Service



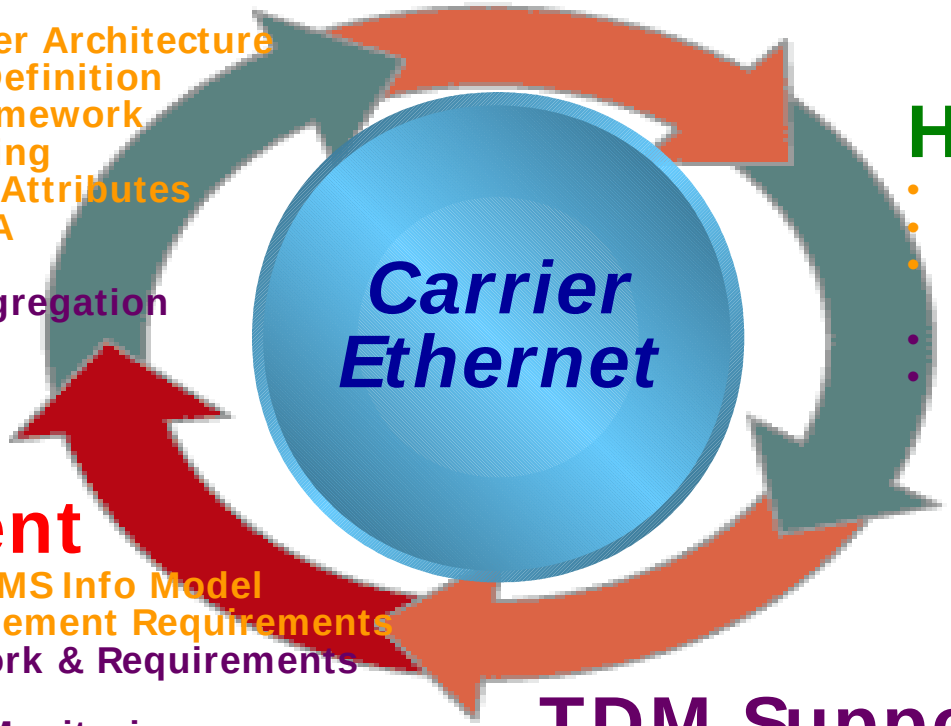


Service Types defined in MEF ESD Spec.

Carrier Ethernet Specifications

Reliability
- MEF 2 – Ethernet Protection
- MEF 4 – Architecture Framework
- MEF Service Attributes II

Scalability
- MEF 4 – Architecture Framework
- MEF 12 – Eth Layer Architecture
- MEF 6 – Service Definition
- MEF 11 – UNI Framework
- MEF 9 – UNI Testing
- MEF 10 – Service Attributes
- MEF 13 - UNI I IA
- MEF UNI Type II
- MEF Ethernet Aggregation



Hard QoS
- MEF 6 – Service Definition
- MEF 10 – Service Attribute
- MEF 14 - Service Attribute Testing
- MEF Service Attributes II
- MEF Service Definition II

Service Management
- MEF 7 – EMS and NMS Info Model
- MEF 15- NE Management Requirements
- MEF OAM Framework & Requirements
- MEF E- LMI
- MEF Performance Monitoring

TDM Support
- MEF 3 – CES Framework
- MEF 8 – CES Implementation
- MEF TDM Testing

The MEF Certification

- Ensures ensure global equipment/ services compliance to the MEF standards and resulting interoperability
- 39 devices from 16 vendors received certification to MEF 9

- On October 13, the MEF launched Ethernet Service Certification to certify service providers. Tier 1 providers committed to it.

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- November 2nd MEF approved MEF 14 certification testing

IEEE Work

Provider Bridges (802.1ad)

- Standardizes QinQ/Stacked VLANs

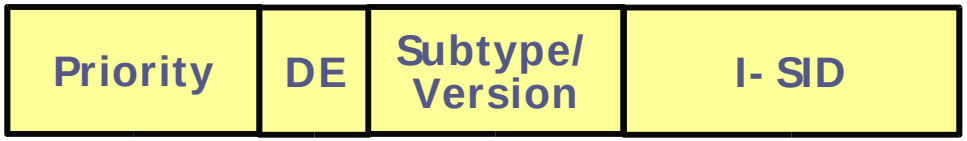
- New Definitions:
  - C-VLAN/C-TAG: Customer (internal)
  - S-VLAN/S-TAG: Service (external)
  - DE: Drop Eligible bit
    - CFI in S-TAG
    - Derived from PCP (802.1p) in C-TAG
  - Etype 0x88A8 for S-VLAN TAG

Provider Bridges (802.1ad)

- Work is considered to be done (draft 6)
- It does not solve:
  - Lack of scalability (4K Services / MAC learning)
  - Limited Traffic Engineering (STP/ MSTP)
  - Limited QoS (802.1p)
  - Limited Protection (STP/ RSTP)

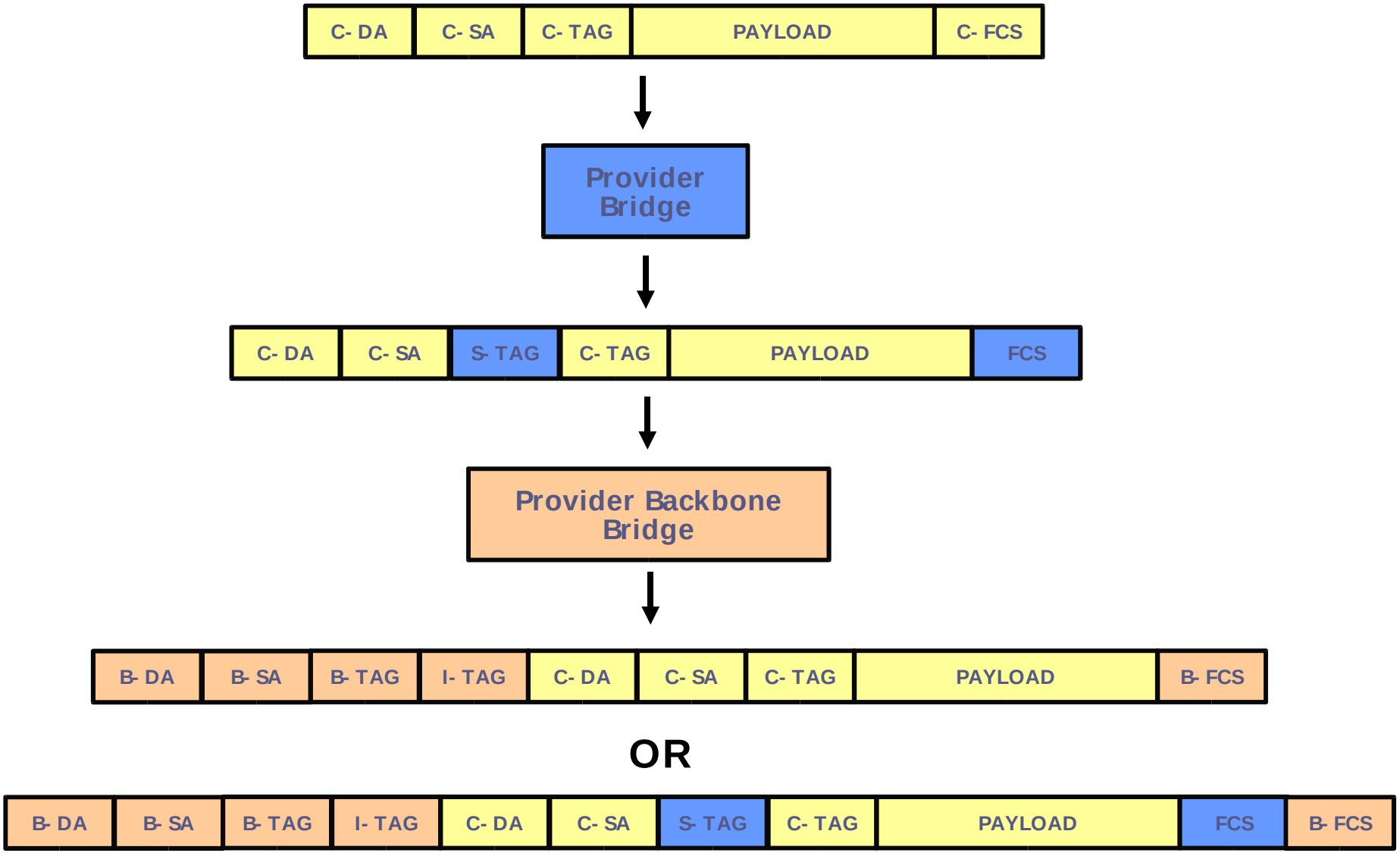
Provider Backbone Brides (802.1ah)

- Also know as MACinMAC
- The objective is to connect multiple 802.1ad networks in a scalable way
- New Definitions:
  - B- MAC: Backbone MAC addresses
  - B- TAG/ B- VLAN: Backbone VLAN (tunnel)
  - I- TAG/ I- SID: Service Instance TAG/ ID:



4 bytes

802.1ah Encapsulation



Provider Backbone Brides (802.1ah)

- Work on the initial stage only (to be finished in 2007)
- Many topics under discussion
- It does not solve:
  - MAC scalability (Backbone MACs+ Customer MACs in PBB Edge Nodes)
  - Limited Traffic Engineering (STP/ MSTP)
  - Limited QoS (802.1p)
  - Limited Protection (STP/ RSTP)

Connectivity Fault Management (802.1ag)

- Provides end-to-end OAM functionality to Ethernet
- Receiving input from MEF and ITU (Y.17ethoam)
- New definitions:
  - MEP: Maintenance End Point
  - MIP: Maintenance Intermediate Point
  - MA: Maintenance Association
- Complements 802.3ah – Ethernet in the First Mile – OAM functions
- Work to be finished in 2007

Connectivity Fault Management (802.1ag)

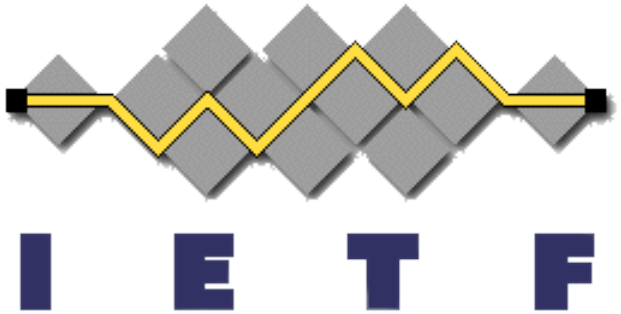
- OAM Functions:
  - Continuity Check (CC)
  - Loopback (L2 ping)
  - Link Trace (L2 traceroute)
  - Alarm Indication Signal (AIS) – may be removed
  - Intrusive Loopback being considered
- Provides 8 levels of maintenance domains
- Uses Ethernet frames to perform the OAM functions
  - Multicast frames with bridge group addresses (01-80-C2-XX-XX-XX)
  - Frame formats under discussion

Shortest Path Bridging (802.1aq)

- Objective: to use SPF to build one tree for each node, optimizing transmission paths
- Eliminates Spanning Tree from the network
- Alternative to IETF's Rbridge (more later)
- First draft not ready yet, to be finalized by the end of 2008

Other Intersting WG

- Two-port MAC Relay (802.1aj)
- Multiple Registration Protocol (802.1ak)
- Residential Ethernet
- 802.3 Network Congestion Management



IETF Work

Carrier Ethernet with MPLS

- The IETF uses MPLS (VPLS) to transport Ethernet frames
- Most Ethernet Challenges solved by MPLS/ VPLS based solutions
  - 4K VLAN limitation → MPLS Labels
  - STP limitations → IP/ MPLS Routing, MPLS TE, VPLS full mesh
  - Limited QoS → MPLS TE, DiffServ
  - Limited Protection → Backup LSP, Fast Reroute
  - OAM → VCCV, LSP PING, BFD

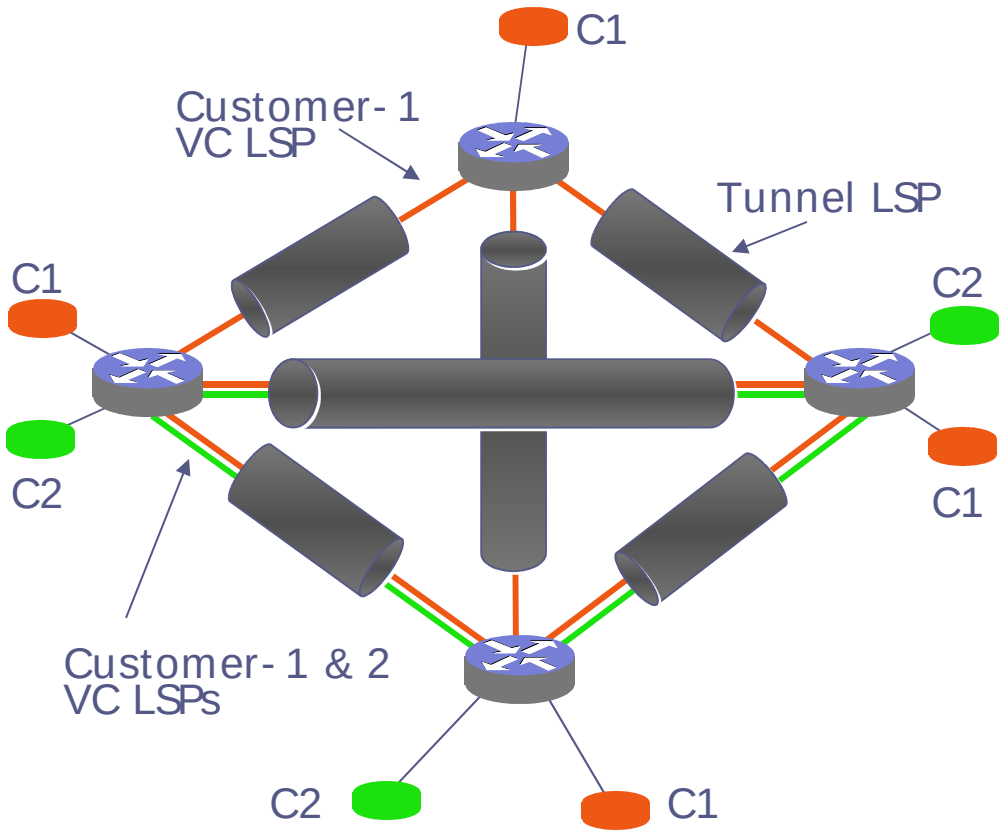
IETF VPLS Standards

- VPLS Standards
  - There are 2 VPLS IDs that the IETF intends to progress as RFCs
    - draft-ietf-l2vpn-vpls-ldp
    - draft-ietf-l2vpn-vpls-bgp
  - Final revision of VPLS-LDP draft (-08) submitted to IETF
    - Current Status: Proposed Standard
    - IESG Review

VPLS Standards Status

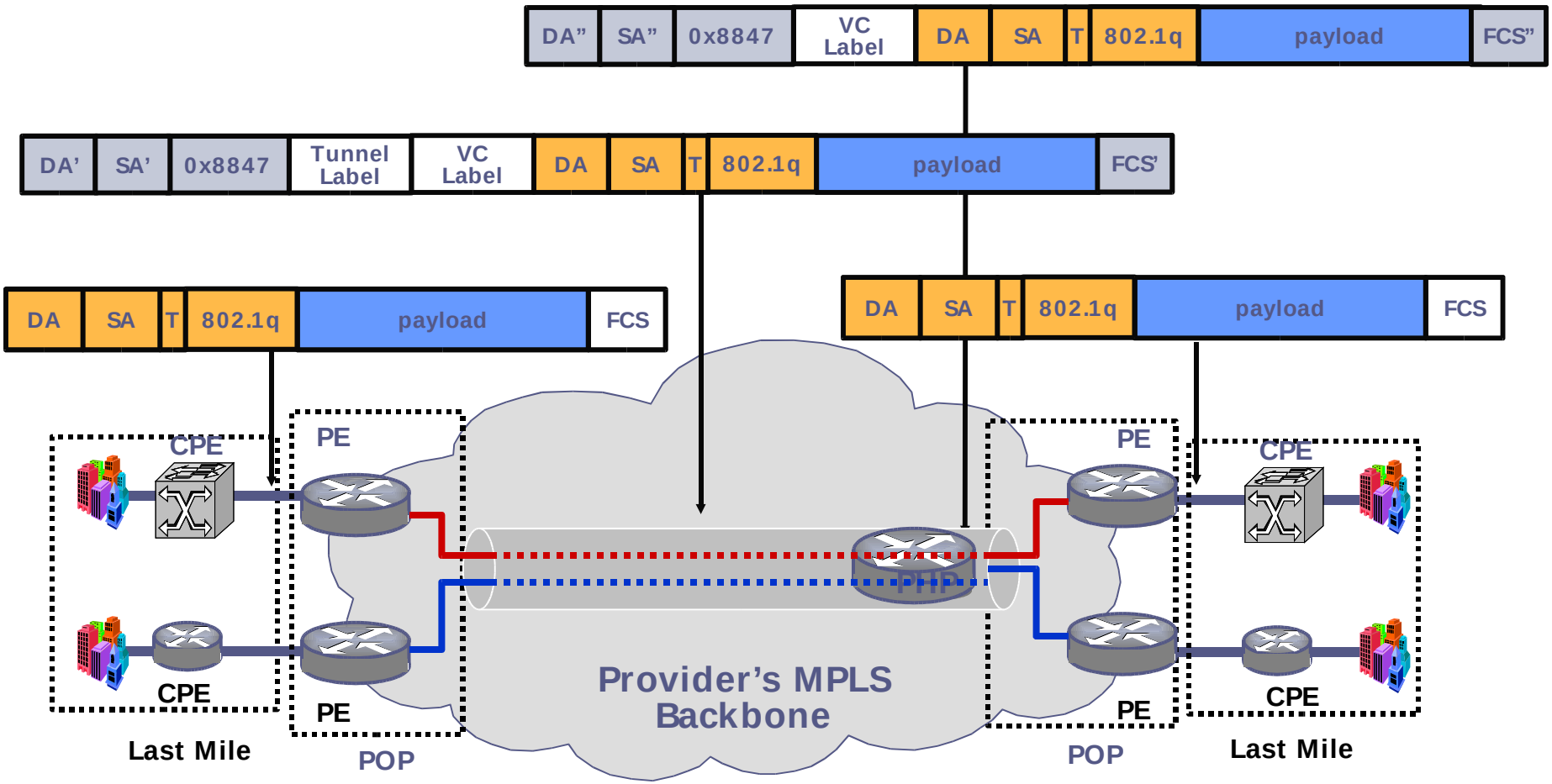
- VPLS draft dependencies
  - draft-ietf-pwe3-ethernet-encap
    - Status: Proposed Standard
    - IESG Evaluation
  - draft-ietf-pwe3-control-protocol
    - Status: Proposed Standard
    - RFC Editor queue
- VPLS drafts to be placed in RFC editor queue as soon as final IESG comments are provided
  - Expected RFC status: Early 2006

Implementation Details
LSP Topology



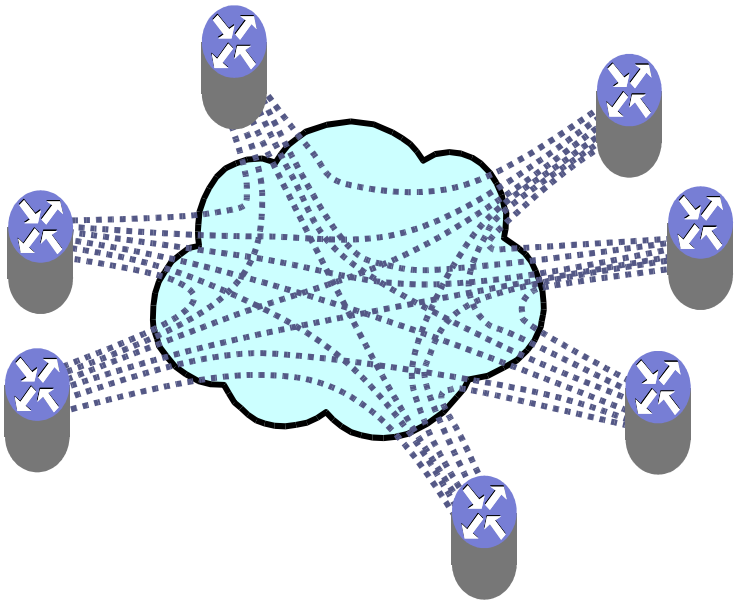
- Tunnel LSPs are established between PEs
  - Full Mesh simplifies loop resolution, as Ethernet is a broadcast capable technology
- VC LSPs are set up over Tunnel LSPs
  - Like VPI/VCI in ATM
- All PEs implement a split-horizon scheme: NO SPANNING TREE IN THE NETWORK

Life of a Frame in VPLS

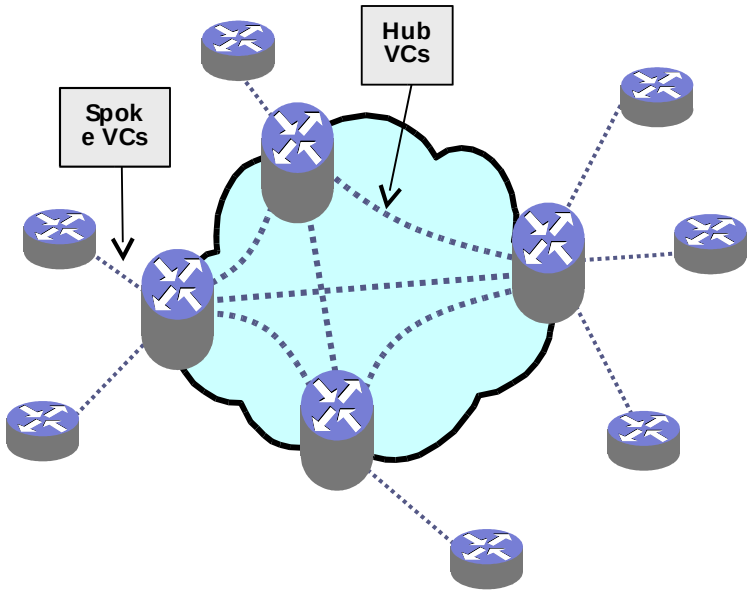


Scaling VPLS

Flat VPLS Topology
- Full mesh
- Ingress replication
- For networks with < 40 PEs



Hierarchical Topology (HVPLS)
- Partial mesh (hub & spoke)
- Distributed replication
- For networks > 40 PEs



Other IETF Ethernet Developments

- TRILL (Transparent Interconnection of Lots of Links)
  - Proposes the use of IP routing to STP in an Ethernet network
  - Similar to IEEE's SPF Bridging
- GELS (GMPLS controlled Ethernet Label Switching
  - Proposes to use GMPLS control plane directly in Ethernet

Conclusions

Which is the best option?

- VPLS is the favored approach to deploy scalable Ethernet Services
  - The only scalable multipoint Ethernet service so far
  - Has addressed key multipoint challenges
    - New proposals are either p2p or face identical challenges
  - Deployed & Mature Standard
  - Same underlying technology from edge to core
    - Ease of management: Same provisioning, same OAM
- VPLS will keep being enhanced
  - Can evolve as service layer over multiple co-ps technologies such as PBT.
  - VPLS Multicast enhancements being defined
  - To be studied, MAC address hiding enhancements

Thanks!

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