Connection-Oriented Ethernet for Delivery of Private Cloud Services

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Private Cloud Service Delivery for Large Enterprises

The Market Opportunity
Current Challenges using the Internet
% Spend of Multi-$B U.S. Firms on IT deployments

Private Cloud Service delivery over Carrier Ethernet WANs and Ethernet Services

Enterprise Cloud Service delivery Challenges

- Today, Internet is predominant WAN to deliver cloud services
  - Surprising, little attention paid to it by the Cloud Community

- Larger Enterprises hesitant to move mission-critical applications to the cloud when delivered via the Internet

Cloud Service Delivery Challenges over the Internet
- Security Vulnerabilities
- Performance
- Data Governance
- Regulatory Compliance

The WAN is critical for cloud service performance (SLAs)
Cloud Service Delivery via COE WANs

- Addresses Internet challenges for mission critical apps.
  - Using COE to connect to on-net private cloud services

- Generates additional telecom provider revenue
  - Private cloud services and Ethernet services with SLAs

Private Cloud Service Delivery via COE
- Secure
- Predictable Performance
- Control of Data Governance and Regulatory Compliance
Different Implementations of Carrier Ethernet

Connectionless Ethernet (CLE)
Connection-Oriented Ethernet (COE)
Connectionless Ethernet (CLE)

- When most think of Ethernet, they think of Ethernet LANs
  - Technically referred to as Connectionless Ethernet
  - Single User per Ethernet Interface
  - Network is inside a building

- CLE is also used in Carrier Networks
  - Subscriber sites connect to an Ethernet UNI
  - Multiple Users per Ethernet Interface (UNI)
  - Network is across a wide area
Challenges with Connectionless Ethernet (CLE) when used for WANs

- Non-Deterministic QoS and Traffic Patterns
  - Variable QoS performance (Packet Delay, Delay Variation, Loss)
    - Traffic paths vary due to spanning tree topology changes
  - Difficult to traffic engineer variable traffic paths

- Difficult to Guarantee Bandwidth
  - Multiple ingress and egress points in the network
    - Resulting in variable traffic paths
  - Oversubscribed bandwidth impacts committed (CIR) bandwidth

- Difficult to provide High Network Availability
  - Spanning Tree cannot meet demanding application requirements
    - G.8032 (ERP) as an STP replacement only works for ring topologies
  - Difficult to provide end-to-end Ethernet service protection

CLE requires technology augmentation to make it “Carrier Grade”
Connection-Oriented Ethernet (COE) The best of both worlds

Connectionless Ethernet
- Layer 2 Aggregation
- Statistical Multiplexing
- Flexible Bandwidth Granularity
- Cost Effectiveness

SONET/SDH
- Deterministic QoS
- Guaranteed Bandwidth
- 99.999% Availability
- Highest Security (Layer 1 service)

Connection-Oriented Ethernet for Delivery of Private Cloud Services

COE provides the Flexibility and Scalability of Ethernet with the Performance, Reliability and Security of SONET/SDH
What is Connection-Oriented Ethernet?

- High performance implementation of Carrier Ethernet
  - Used for P2P and P2MP metro and wide area networking

- Disables Ethernet bridging
  - No Spanning Tree Protocol
  - No MAC address learning/flooding

- Ethernet paths provisioned by Management System

- Implementations use “label-based” frame forwarding
  - Ethernet / VLAN Tag Switching: C-VIDs + S-VIDs
  - PBB-TE: BMAC Address + B-VID
  - MPLS-TP: MPLS label

COE technologies have been deployed for over 10 years
Different approaches to COE
Technology selection depends on what problem you trying to solve

**MPLS-centric COE**
- Static PW
- MPLS-TP

  - Ethernet
  - MPLS Pseudowire (PW)
  - MPLS Label Switched Path (LSP)

**Ethernet-centric COE**
- PBB-TE
- Ethernet Tag Switching

  - Ethernet

- **Optimized for Multi-service (ATM, FR, TDM, Eth, IP) Transport**
  - Three OAM Layers
  - Less optimal for Ethernet service delivery and transport

- **Standards Under Development**
  - G.8113.1 & G.8113.2 Service OAM
  - G.8131 & G.8132 Path Protection

- **Optimized for Ethernet / IP Service Delivery and Transport**
  - One OAM Layer
  - Less optimal for multi-service transport

- **Standardized Now**
  - Reuses existing Carrier Ethernet standards for SOAM & Protection

Ethernet-centric COE optimized for Ethernet/IP Service Transport
MPLS-centric COE optimized for Multi-service Transport
1. Ethernet Frames take a predetermined path
   - Guarantees Consistent Performance

2. Bandwidth Reserved per EVC
   - Using Connection Admission Control (CAC)
   - Also supports oversubscription
Focusing on Ethernet-centric Implementations of COE which are predominantly deployed today
Ethernet-centric COE Ecosystem
6 Attributes of Connection-Oriented Ethernet

**Standardized Services**
- EPL, Access EPL
- EVPL, Access EVPL

**Deterministic QoS**
- Lowest Packet Latency and Loss
- Bandwidth Resource Reservation

**Security**
- No Bridging: MAC DoS attacks mitigated
- Completely Layer 2: No IP vulnerabilities

**Scalability**
- Layer 2 Aggregation
- Statistical Multiplexing

**Reliability / Availability**
- G.8031 50ms EVC Protection
- 802.3ad UNI & ENNI Protection

**Ethernet OAM**
- 802.3ah Link Fault Mgmt.
- 802.1ag Service Fault Mgmt.
- Y.1731 Service Perform. Mgmt.
COE Resource Reservation

- **Bandwidth guaranteed in 1 Mbps (CIR) increments**
  - Bandwidth reserved at each network element across network path
    - For both Working and Protect Paths for a given EVC

Deterministic QoS
- Lowest Packet Latency and Loss
- Bandwidth Resource Reservation

CIR bandwidth guaranteed for each EVC
Each EVC traffic engineered to achieve QoS Objectives
Ethernet-centric COE Network and Link Protection

- **Link Protection via 802.3ad Link Aggregation**
  - Protection for UNIs and ENNIs

- **Network Protection via G.8031 Linear Path Protection**
  - Continuity Check Messages (CCMs) monitor the path’s health
  - If failure occurs, CCMs not received from Working Path
    - COE network element switches to Protect Path

Network protection can be applied to EVCs over any type of topology (linear, mesh, ring, etc)
Ethernet-centric COE Security: Comparable to SONET

- No MAC Address Vulnerabilities
  - Immune to MAC Address spoofing of Network Elements (NE)
  - Immune to MAC address table overflow DoS attacks in NEs

- No Spanning Tree Protocol (STP) Vulnerabilities
  - Immune to STP Denial of Service (DoS) attacks

- Immune to IP protocol vulnerabilities and attacks
  - Doesn’t use IP protocols

- Uses few protocols. IP and MPLS require many
  - Fewer protocols = Fewer network security vulnerabilities

COE provides security comparable to a Layer 1 service (like EoS)
Connection-Oriented Ethernet Use Cases for Private Cloud Service Delivery
MEF EVPL Service Use Case

- **Hub UNI at Cloud Service Provider Primary Data Center**
  - Aggregates all EVPL EVCs from Enterprise sites
  - Able to add additional Enterprise sites onto same hub UNI

- **Secondary data center reached through DC-to-DC EVPL EVC**

Solution Supports High Performance On-Net Cloud Bursting
MEF Access EPL Use Case

- **ENNI Provides Interconnections for:**
  - Enterprise Sites and Cloud Service Provider
  - Cloud Service Provider Data Centers
  - Internet connectivity to reach Public Cloud services

Ethernet Exchange Provider Enables Private Cloud Service Delivery through On-Net Interconnections at ENNI
Fujitsu COE Educational Resources

- **Connection-Oriented Ethernet (COE) Home Page**
  - [http://tinyurl.com/6ax8ngo](http://tinyurl.com/6ax8ngo)

- **Webinars**
  - COE: A No-Nonsense Overview
    - [http://www.youtube.com/watch?v=b7jgDjBfJJl](http://www.youtube.com/watch?v=b7jgDjBfJJl)
  - Ethernet versus MPLS-TP for Connection-Oriented Ethernet
    - [http://tinyurl.com/83n6esa](http://tinyurl.com/83n6esa)

- **White Papers**
  - COE – Operational and Deployment Considerations
    - [http://tinyurl.com/5ws8rf4](http://tinyurl.com/5ws8rf4)
  - OpEx Benefits of Fujitsu Ethernet Tag Switching Implementation of COE
    - [http://tinyurl.com/3n4bn8f](http://tinyurl.com/3n4bn8f)
  - Ethernet Service OAM: Overview, Applications, Deployment, and Issues
    - [http://tinyurl.com/5s7ax8t](http://tinyurl.com/5s7ax8t)
  - Carrier Ethernet Essentials
    - [http://tinyurl.com/7z3cwwk](http://tinyurl.com/7z3cwwk)