1.13 Metro IP Solutions for Service Providers

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Agenda

- Introduction
- Understanding Transport Considerations
- Ethernet-based Services
- The Enterprise Experience
SP Ethernet – So Many Terms, So Much Confusion

- Choose the right technologies and features
- Understand what the provider will want to sell
- Understand what the enterprise will want to buy

Metro Ethernet Technology Framework

Rules for Thinking About Metro Ethernet

- Metro Ethernet is/can...
  1. Provide Ethernet interface to the service provider’s customer
  2. Complimentary to SONET and SDH
  3. Inclusive of Cisco’s routing platforms (Cisco 2600 to 12000) and optical platforms (ONS-11/14/44)
  4. Capable of allowing a provider to offer enhanced services (voice, video)
  5. Can create a service offering a provider can make money from

- Metro Ethernet is NOT...
  6. Necessarily about Ethernet end-to-end
  7. Synonymous with Transparent LAN Services
  8. About only Ethernet switching
  9. About a cheap service
  10. About bandwidth-on-demand (although that’s a component)
Metro Ethernet End Customer Value

Familiar Gear, Familiar Protocol
Lower Cost of Ownership

Fiber Availability and Ethernet Access

In what room do you want me to put it?

Agenda

Introduction
Understanding Transport Considerations
Ethernet-based Services
The Enterprise Experience
Transport Options – Incumbent vs. Dark Fiber

- Transparent LAN-optimized
- Effective for a small number of customers
- Redundancy has to be carefully planned due to Spanning Tree
- Ethernet service over an existing structured fiber plan
- Incumbent architecture
- Larger implementations
- Build-in resiliency scheme (UPSR, BLSR) can eliminate Spanning Tree

Here’s What a Provider Wants to Do…

- Provider wants to offer Ethernet access to customers
- Considering point to point fiber to each customer using Ethernet switching as the backhaul and aggregation
- However…

…And Here’s What a Provider is Stuck With

- Fiber plant doesn’t run in straight lines. More fiber required to follow streets, highways, ducts, etc. And...
- …how does that scale to offer service to more customers?
Fiber Plant Ring-based Installation

- To scale access to the customer base, providers will use fiber rings.
- To scale capacity, providers will run many cores in the duct.
- To scale bandwidth, providers will use DWDM or CWDM.
- To scale efficiency, providers will use SONET/SDH.

Metro Network Hierarchy

- SONET/SDH is existing transport.
- Discussion w/ SP must include best utilization of existing infrastructure.

Transport Architecture

- Ethernet, DPT, SONET/SDH and DWDM
- DWDM - scale fiber infrastructure
- SONET/SDH - maintaining investment protection
- DPT/RPR – IP/MPLS optimized ring topology
- L2.15 VPN
- VPLS
- Internet Access
- Ethernet – low cost hub-and-spoke or rings
- Residential VPDN
**Ethernet Economics**

Industry Wide Ethernet vs. Legacy SONET/SDH Port Pricing

| $/Gigabit Bandwidth | $1,000 | $2,000 | $3,000 | $4,000 | $5,000 | $6,000 | $7,000 | $8,000 | $9,000 | $10,000 | $11,000 | $12,000 | $13,000 | $14,000 | $15,000 | $16,000 | $17,000 | $18,000 | $19,000 | $20,000 | $21,000 | $22,000 | $23,000 | $24,000 | $25,000 | $26,000 | $27,000 | $28,000 |
|---------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|

Assumptions: Average Metro Access and Metro Core per port pricing.

Source: Network Strategy Partners and Metro Ethernet Forum, 2002

**Different Rings Solve Different Problems**

<table>
<thead>
<tr>
<th>SONET/SDH</th>
<th>Switched Ethernet using Spanning Tree Protocol</th>
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<tbody>
<tr>
<td>STM-N</td>
<td>DWDM/CWDM</td>
</tr>
<tr>
<td>OC-N</td>
<td>ODF/IDF</td>
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<tr>
<td>DWDM and SDH</td>
<td>Backbone Network</td>
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<tr>
<td>STM1/4/16/64</td>
<td>Business Network</td>
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<tr>
<td>MetroPOP</td>
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**Ethernet over DWDM**

- DWDM via ONS-15200 or ONS-15540 provides 16 and 32 lambdas, respectively
- Service delivery for service providers with limited fiber availability or budget for fiber
- Convergence at 50 ms
### CWDM GBICs

- 20nm Coarse WDM Grid, Non-Amplifiable
- CWDM GBICs plug into Switches and Routers
- Up to 8 lambdas
- Etherchannel and Layer 3 equal cost routing can be used for protection
- Supported Platforms: Cisco 7600, Catalyst 6500, Catalyst 4000, Catalyst 3550, ONS 154XX, 153XX

### Ethernet over SONET/SDH

- Logical hub-and-spoke network over a physical ring-based network
- Use Ethernet interfaces in SONET/SDH platforms
- SONET/SDH transparent to Layer 2/3 overlay

### Dynamic Packet Transport (DPT)

- Eliminates SONET/SDH equipment for IP transport while retaining resilience benefits
- Intelligent Protection Switching (IPS) provide fast ring restoration (< 50ms)
- Minimize provisioning configuration and maintenance requirements
- Based on SRP (Spatial Reuse Protocol)
Metro Ethernet Business & Technical Summit

Cisco Metropolitan IP Systems
Extend Internet WAN into the Regional Metro

- Expand Internet footprint
- Bypass traditional TDM infrastructure
- Achieve greater operational efficiencies

Cisco Metropolitan IP Systems
Extend Internet WAN into the Metro Access

- Expand Internet footprint to the edge
- Preserve Internet dimensioning, functionality and management planes

Topology Considerations – Ring or Hub and Spoke?

- Significant performance and failover characteristics
- Tune 802.1d wherever possible
Comparison of Ring Technologies

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<td>• Evolutionary approach for the service providers vs. revolutionary</td>
<td>• Perceived simplicity of Ethernet switching</td>
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<td>• Best choice for large scale deployments</td>
<td>• Fairness, bandwidth, delay/jitter dependent on location on the ring</td>
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<td>• Best use of fiber infrastructure</td>
<td>• 10-12 node limit</td>
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<tr>
<td>• Hierarchical bandwidth</td>
<td>• LAN switch as edge device (no MPLS, Traffic shaping, QoS, etc)</td>
</tr>
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<td>• Best fiber utilization for dual homing</td>
<td>• 1-50 second convergence (standard 80-120 sec for RPR)</td>
</tr>
<tr>
<td>• Next-gen SONET, with VCAT, LCAS, GFP, will help optimize SONET for data</td>
<td>• 50 ms convergence</td>
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- Ethernet-based Services
- The Enterprise Experience

Ethernet Service Portfolio

**Layer 2 Services**

- High Bandwidth Point-to-Point
  - Point-to-Point VLAN-based TLS (similar to FR/ATM - ERS)
  - Point-to-Point Port-based TLS (similar to Leased Line - EWS)
  - Multipoint-to-Multipoint
    - QinQ Multipoint with L2 Backbone
    - Multipoint VLAN-based with MPLS Backbone (VPLS)
  - Multipoint Port-based with MPLS Backbone (VPLS)

**Layer 3 Services**

- MPLS VPN Interconnection
Summary of Ethernet-based Services

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<th>Layer 2</th>
<th>Layer 3</th>
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<td>Multipoint</td>
<td>Ethernet Private Line</td>
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<tr>
<td>Ethernet Relay Service</td>
<td>Ethernet Wire Service</td>
<td>Ethernet Multipoint Service</td>
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<td>MPLS VPN</td>
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Ethernet-Based Services

- Analogous to Private Line
- Analogous to Frame Relay
- Similar to ERS only w/ VLAN transparency
- Transparent LAN Service
- Ethernet Wire Service

Ethernet Service Terminology

- CE: Customer Equipment
- PE: Provider Edge
- PE-CLE: Provider Edge Customer Located Equipment
- PE-POP: Provider Edge Point of Presence
- UNI: User Network Interface
- CE-VLAN: VLAN (tag) between CE and UNI
- PE-VLAN: VLAN (tag) within Service Provider Network

Basic Terms

Types of Ethernet Virtual Circuit Connectivity

- Point-to-Point
- Multipoint-to-Multipoint
- Point-to-Multipoint
L2 VPN Basics

**Ethernet Virtual Connection (EVC)**

**Point-to-Point**
- Exactly two UNIs are associated. An ingress frame at one UNI can only be an egress frame at the other UNI.
- Defined by IETF as Virtual Private Wire Service (VPWS)

**Multipoint**
- Two or more UNIs are associated. An ingress frame at one of the UNIs can be an egress frame at one or more of the other UNIs.
- Defined by IETF as Virtual Private LAN Service (VPLS)

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L2 VPN Point-to-Point Ethernet Service

**Ethernet Virtual Connection (EVC)**

**Point-to-Point**
- Private Line Equivalent
- Physical Port to Physical Port
- Good Fit for Switches and Routers

**Multipoint**
- Frame Relay Equivalent
- Logical Port to Logical Port
- Good Fit for Switches and Routers

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L2 VPN Multipoint Ethernet Service

**Ethernet Virtual Connection (EVC)**

**Point-to-Point**
- Could support Ethernet Multiplexed and Non-Multiplexed UNIs
- SP cloud must perform:
  - MAC address learning/aging
  - Forwarding and packet replication
  - Good Fit for CE Switches and Routers

**Multipoint**
- Non-Transparent or Multiplexed
L2 VPN Multipoint Ethernet Service

- Ethernet Virtual Connection (EVC)
- Multipoint
- Point-to-Point

- Does it really meet customer demand?
  - Most enterprise WAN networks are P2P using routers as CPEs
  - Some TLS facts from US SP customers:
    - Majority of their customers are P2P
    - Majority of their customers have only two MAC addresses facing the SP (i.e. CPE are routers)
    - MP2MP customers have an average of 5 sites

Multiple Names – one meaning

- Tying It Together...
- TLS
- PW
- EVCS
- VPWS
- VPLS
- EVPL
- ERS
- EWS

What is VPLS?

- A Virtual Private LAN Services (VPLS) is a multipoint Layer 2 VPN that connects two or more customer devices using Ethernet bridging techniques
- VPLS is an ARCHITECTURE defined within IETF Draft-lasserre-vkompella-ppvnp-vpls-02.txt
- A VPLS emulates an Ethernet Switch
VPLS...

- Often referred to as a Transparent LAN Service (TLS)
- Service Provider cloud appears to be a switch, with UNI supporting VLAN transparency
- The service provider cloud will switch based on (the enterprise's) MAC addresses

VPLS System – An Example

- Single-PE architecture shown
- Distributed-PE architecture (H-VPLS)
- MAC Learning
  - Cisco Ans.: limit MAC learning per VLAN/VSI
- Packet Replication
- Key Components:
  - VSI - Virtual Switch Instance
  - Auto Discovery
  - Auto Configuration

Virtual Private Wire Service (VPWS)

Virtual Private Wire Service = VPWS
L2 transport over IP = L2TPv3/UTI
L2 transport over MPLS = AToM
The Ethernet Relay Service (ERS)

- Service multiplexing allows single port to provide service to multiple end-points (referred to as "point-to-multipoint")
- EVC identified by the VLAN
- CE-VLAN must be the same as SP-VLAN
- Service analogous to Frame Relay, functionally, it is the same – encourages a router as CE edge device, not a switch (except for remote site)
- ERS allows interworking with FR/ATM (future)

Interworking between Ethernet and ATM/FR

Ethernet to Frame/ATM Interworking: Seamless transition and in-service migration from present services

Point-to-Point VLAN-based TLS (ERS)
Point-to-Point VLAN-based TLS (ERS)

Life of a Packet – ERS example

The Ethernet Wire Service (EWS)

• Analogous to a private line in that all data transverses, unaltered across the EVC
• Port-to-Port mapping, no service multiplexing allowed. Therefore all services must exist on one port (All-to-One Bundling)
• Switches or routers can be deployed as CE edge devices
Access into an MPLS VPN Service – 1

Option 1: Routed connection with MPLS to the edge

Option 2: VLAN to VRF Mapping

- Separate routing instance per customer
- No MPLS required at the network edge

Access into an MPLS VPN Service – 2

Option 3: VLAN to VRF Mapping (Layer 3 Forwarding instance)

Point-to-Point L3 and MPLS/VPN Access

- EDGE: 3550, 4500, 6500
- DISTRIBUTION: 7600, 10720, 12000
Cisco Metro Solutions: Hong Kong Broadband

Over 145,000 signed subscribers
1,000,000 homes passed

Merci
N’oubliez pas de remplir votre formulaire d’évaluation.