iConnect™ MPLS/GMPLS for NG Converged Optical and Carrier Ethernet Networks

9 October 2007
MPLS/GMPLS and Converged Network

Transitioning the Optical Edge™
MPLS Objectives for Ethernet and TDM Services over a SONET/SDH Transport Network

- Enable scalability for Ethernet Services over SONET/SDH infrastructure
- Provide fast reroute for Ethernet Service protection
- More efficient bandwidth usage over SONET/SDH network
- Enable TDM service to be carried in conjunction with the packet network
- Simplify Service Operations versus provisioning a router
- Provide “Point and Click, End to End” provisioning
- Allow Carriers to build on SONET/SDH resiliency and provide Carrier Ethernet Service SLAs with QoS
GMPLS Background

- Used by SONET/SDH MSPP to automate provisioning

- Each network element running GMPLS supports:
  - OSPF-TE routing
  - RSVP-TE signaling
  - Label distribution through RSVP

- GMPLS is a superset of MPLS
  - In IP MPLS, data and management packets mixed in same bit stream.
  - TDM GMPLS establishes bidirectional LSPs

- MPLS and GMPLS are peers
Ethernet cards in MSPPs can be adapted to exchange the necessary routing information to allow MPLS and GMPLS domains to communicate.

These Ethernet cards will be responsible for:
- Establishing an OSPF neighbor relationship
- Exchanging IP routing information
- Receiving and sending RSVP requests
- Switching MPLS labels

The adapted Ethernet cards are simply a client interface into the existing GMPLS control plane.
What problem are you trying to solve?
- All Services over a Common Network Infrastructure
- All services over an Ethernet Transport Network

Network needs to support Ethernet services and TDM services
- Different ways to implement – each having pros and cons

Different approaches to take depending upon which problem you want to solve
Converged Transport Technology Choices

- IEEE 802.1ad (Provider Bridges / QinQ)
- IEEE 802.1ah (Provider Backbone Bridges)
  - Provider Backbone Transport (PBT)
- Ethernet over SONET/SDH
- Ethernet over MPLS (Pseudo wires)
Converged Transport Technology Choices - Ethernet Transport

- **IEEE 802.1ad (Provider Bridges / QinQ)**
  - Most commonly implemented Ethernet service delivery technology
  - S-VLAN ID (S-VID) used to identify 4095 services
  - Uses customer’s MAC address for forwarding
  - RSTP or MSTP for protection/restoration

- **IEEE 802.1ah (Provider Backbone Bridges)**
  - I-SID used to identify 16M services
  - B-VLAN ID (B-VID) used to identify backbone tunnel
  - RSTP or MSTP for protection/restoration

- **Provider Backbone Transport (PBT)**
  - Backbone tunnels (working and protected) identified via globally unique 60 bit B-VID+Destination MAC address
    - Can use GMPLS to pre-provision protected tunnel
  - Disables Ethernet control plane (BPDUs)
  - Can use GMPLS (g-LSPs) as control plane for simplified tunnel provisioning
    - RSVP-TE for CAC for deterministic QoS and BW management
Converged Transport Technology Choices
- SONET/SDH Transport

- Uses 802.1ad (S-VID) or 802.1ah (I-SID) for service identification
- Uses VCAT and LCAS for bandwidth on demand
  - Dynamic resizing of SONET/SDH VC containers
- Can use RSTP/MSTP or SONET/SDH APS for protection
  - Can use GMPLS to pre-provision or calculate protected path/tunnel
- Uses GMPLS (g-LSPs) as control plane for simplified end-to-end path/tunnel provisioning
  - RSVP-TE for CAC for Ethernet packet services for deterministic QoS and BW management
  - Simultaneously supports TDM services

MSPPs today support Switched Ethernet and EPL Services over SONET/SDH
GMPLS provides the common control plane for Ethernet and TDM services
Service Types and Requirements
A look at the services and converged infrastructure performance requirements

Transitioning
the Optical Edge™
Converged Services Transport

Wireless Backhaul

DS1s/E1s and PDHoE (PWE/CESoP)

Converged Services Transport Network

WSP

ISP

TSP

VSP

DS1s/E1s and PDHoE (PWE/CESoP)

E-Line (EPL, EVPL), E-LAN, TDM Voice and Private Lines

Business, Government, Education

Ethernet P2P and P2MP Ethernet Virtual Connections (EVCs)

Residential Triple-Play

ISP

TSP

VSP
802.1Q VLAN ID can identify subscriber or service

If typical customer subscribes to 3 to 5 services

- 802.1Q VLAN ID would support ~800 subscribers per Access Mux
Services to support over Converged Transport Network – Business, Govt. and Education Services

- **Ethernet Private Line and Ethernet Internet Access**
  - "Pipe service" most commonly implemented over SONET/SDH

- **Ethernet VPNs**
  - E-Line (EVPL) and E-LAN (VPLS, TLS)
  - Can implement over Ethernet, MPLS and SONET/SDH

- **Legacy services over Ethernet**
  - PBX PRI Trunks
  - T1/E1 Private Lines
  - Require PDHoE to implement over Ethernet or MPLS
  - Transported unaltered over SONET/SDH
Multiservice Transport Network Service Management Requirements

- **Fault Isolation**
  - Need to determine if the fault is in the Ethernet Service Layer or Transport Layer
  - Need to be able to troubleshoot:
    - Ethernet Service, end to end (Service Continuity Check)
    - End-to-end path and local interconnections

- **QoS Performance Monitoring (PM)**
  - Need to measure/report at service level and transport level:
    - Delay, Delay Variation and Loss
    - Goodput and Throughput
  - Required for Service Level Objectives specified in SLA
Converged Services Transport Technology “Magic Quadrant”

Deployments

Early Stages

Mature

Potential

PBT(GMPLS)

PBB

EoMPLS (PWE)

EoS/EoSDH (VCAT/LCAS/GMPLS)

PB (QinQ)
iConnect™ Network

Transitioning
the Optical Edge™
Turin Optimized Service Delivery Architecture

Seamless delivery of Ethernet End-to-End Services
Guaranteed Ethernet SLA Service delivery quality
Access over any media, coexistence of SONET and Optical Ethernet.

- **iConnect™**

- Ethernet
- MPLS
- SONET
- Ethernet

---

**Residential**
- TE-300
- TE-206
- OC-48

**Wireless**
- TE-25
- PWE3
- Enet

**Business**
- TE-a
- GFP
- DS3/E3
- nxT1

**Access**

**Metro**
- 10GbE
- Ethernet /SONET/OTN

**Service Edge**

**Core**
- IP/MPLS
- 10GbE

**Internet**

**Video**

**Voice**
Mobility Network Evolution Target
Any to Any Service with Ethernet Transport

- All Transport is over Ethernet
- Takes advantage and benefits of MPLS with reduced cost
- Simplifies operational complexities
- Allows legacy services currently deployed to be managed and transported on same transport network.
Mobility Network Evolution 2007 with Turin Traverse

- Ethernet transported EoPDH at Access
- Ethernet transported Ethernet over SONET at Edge
- TDM Transported TDM/SONET
- GMPLS based path protection
Mobility Network Evolution
2009 with Turin Traverse

- TDM Pseudo-wire aggregation on the Edge
- MPLS routing and protection in the core for all service
GMPLS

- Delivers End-to-End Ethernet over TDM/Lambda
- Support Path Restoration, more flexible use of BW.
- Support sub 50mS protection switching without dependency on SONET protection (EPL & EVPL)
- Support Provider Backbone Bridge and PBB-TE
Mobility Network Evolution
End-to-End Ethernet - MPLS (beyond 2008)

MPLS
• Delivers Ethernet over MPLS
• Opens the Traverse Routing to external Routers.
• Provides E2E over the Core Routers
• Traverse can be used as an LER (Edge Router for services)
• Provides Fast Re-Route
Conclusion

- Turin solution builds on existing GMPLS based control plane
- Several Technology Choices for converged services infrastructure
- Hitless addition/removal of optical BW using VCAT/LCAS
- Selective upgrades to mesh network along spans that are heavily used
- Allows TDM/Ethernet/MPLS/PBT switching to co-exist on the same network element
- MPLS encapsulation of Ethernet (EoMPLS) and pseudo-wires
- Fast-reroute based protection of the RSVP tunnels
- Enable an evolutionary change from TDM to packet switched networks (pay as you grow)
- Unified control plane model leverages the best of TDM/packet worlds to provide optimal solutions
Summary – Why Turin?

Versatile, Next-Generation Product Offerings
- Rapid delivery of new packet-based services for the lowest cost
- Supports future product extensions through a continuous stream of new service modules

Large and Diverse Customer Base
- Tier-1 such as Verizon, Alltel, NTT and Cable & Wireless as well as numerous ILECs, CLECS, Utilities, Wireless carriers, and MSOs
- Drives broad feature set while fostering an emphasis on product resilience

Focus on Customers
- Large enough to be considered a industry leader, small enough to care about our customers