Turin Networks

MPLS/GMPLS for Next Generation Optical and Carrier Ethernet Networks

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MPLS JAPAN

Objectives for Carrying Ethernet over a SONET/SDH Transport Network

- **Enable scalability for Ethernet Services over SONET/SDH infrastructure**
- **Provide fast reroute for Ethernet Service protection**
- **Efficient bandwidth usage over SONET/SDH network**
- **Enable TDM service to be carried in conjunction with the packet based services**
- **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**
- **OAM – Optical + ethernet + MPLS**

GMPLS Background

- **Used by SONET/SDH MSPP to automate service provisioning**
- **Each network element running GMPLS supports:**
  - OSPF-TE routing
  - RSVP-TE signaling
  - Label distribution through RSVP
- **GMPLS is a partial superset of MPLS**
  - Common traffic engineering (TE)
  - Implicit vs. explicit labels
  - Bi-directional labels
  - Label sets, link bundling
- **Overlay, peer and hybrid models**

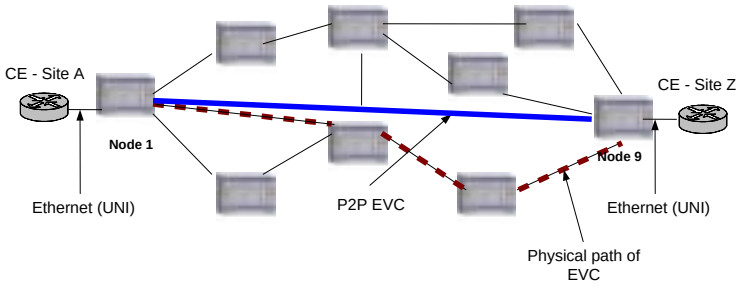
Turin GMPLS solution

- **Distributed, GMPLS based control plane**
- **Neighbor discovery, topology discovery and distribution**
- **OSPF based routing protocol with support for unnumbered interfaces**
- **Traffic engineering (OSPF-TE) and TE database**
- **OSPF-TE extensions with opaque LSA (RFC 3630)**
  - Per-area type 10 opaque LSA
- **Path computation on ingress node (CSPF)**
  - Support for fully strict, loose, and partially constrained paths
  - 1+1 path protection - node and link diverse paths
- **RSVP-TE (with support for hot-standby/redundancy)**
- **Generalized, switch managed labels**
- **Support for e2e low-order services**

Bridging the MPLS and GMPLS domain

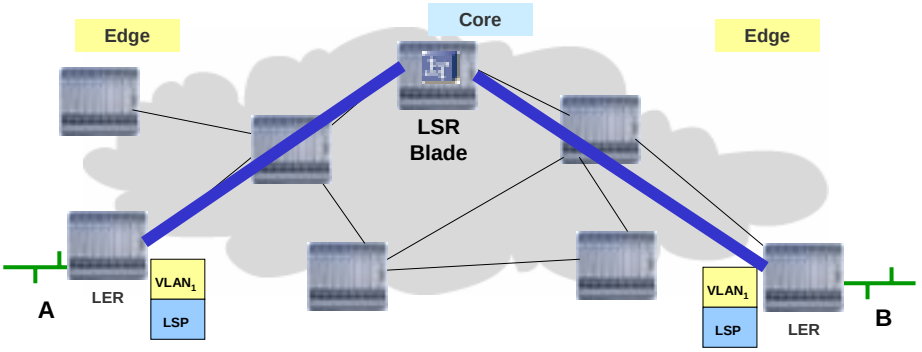
- **Ethernet cards in MSPPs can be adapted to exchange the necessary routing information to allow MPLS and GMPLS domains to communicate**
- **These Ethernet cards will be responsible for**
  - Receiving and sending RSVP requests
  - Switching MPLS labels
  - Performing normal Ethernet (L2 switch) related operations
- **The adapted Ethernet cards are simply a client interface into the existing GMPLS control plane**
- **Use existing GMPLS control plane to**
  - Establishing a forwarding adjacency (FA)
  - Exchanging IP routing information
- **The adapted Ethernet cards are simply a client interface into the existing GMPLS control plane**

End to End Ethernet Service Provisioning



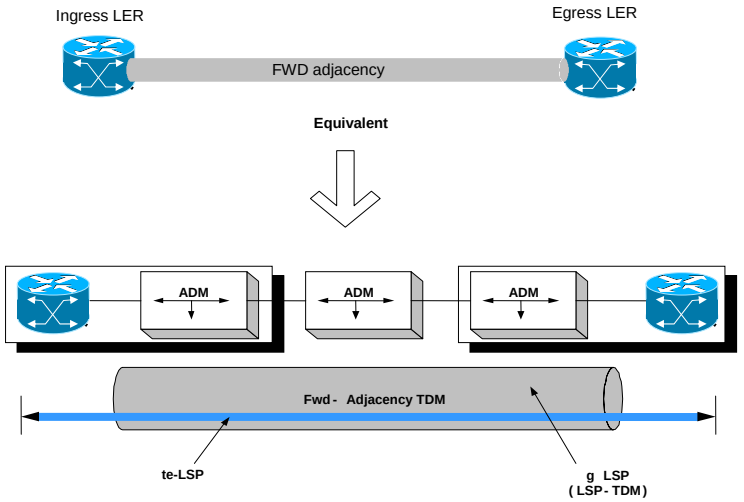
- **User points and clicks at Nodes A to Z, and network setup the connection**
- **D-LSPs are routed & switched on the intelligent Ethernet card**
- **G-LSPs continue to created on optical switching nodes**

MPLS over SONET/SDH migration

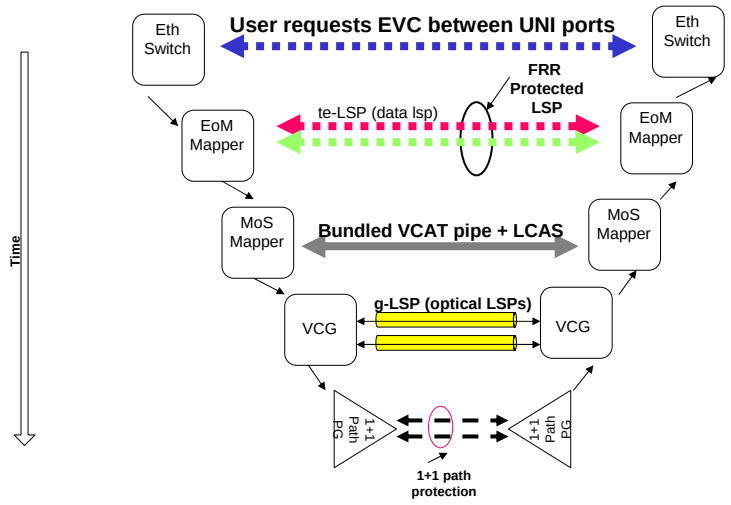


- Introduce LSR functionality as the services grow
- SONET/SDH partitioned to carry MPLS
- Partitioning can be static or dynamic

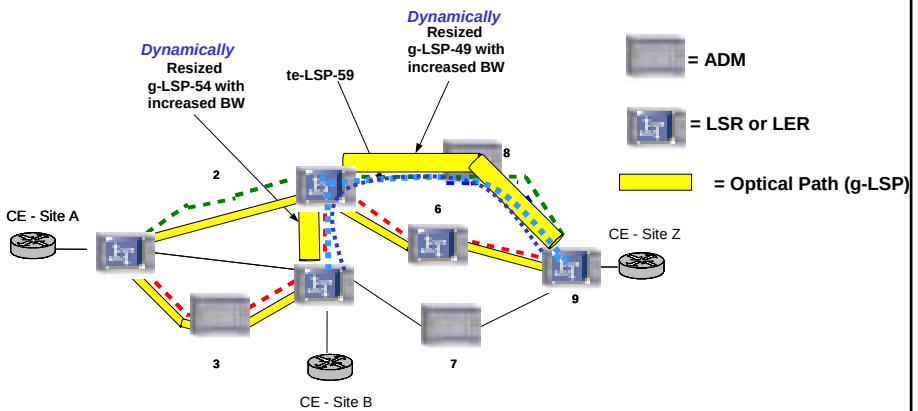
Data LSPs over Optical LSP



LSPs Set up steps

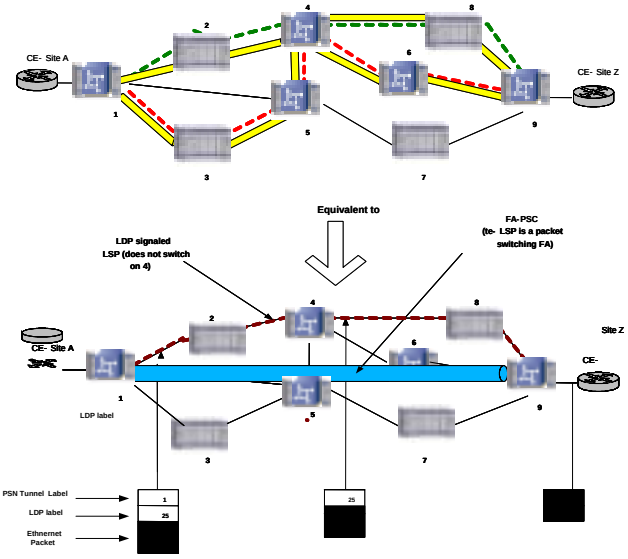


Efficient Path Bandwidth Management

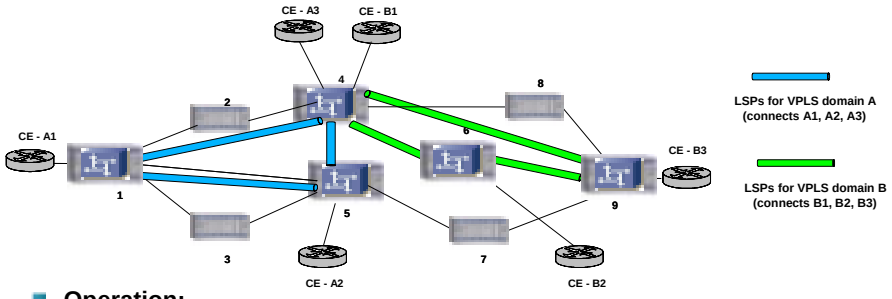


- **Dynamic resizing of bandwidth for optimal sizing of service routes**
  - **te-LSP (blue) needs to route thru' nodes 5 and 4**
  - **Optical path g-LSP is dynamically resized**
- **Use of VCAT/LCAS to allow hitless resizing**

Pseudo-wire tunnel (PWE)



MP2MP service (VPLS)

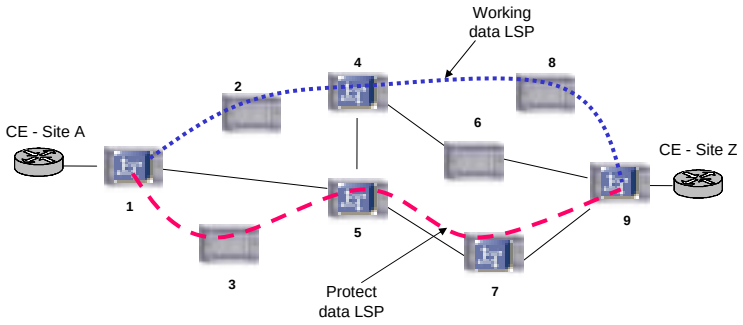


- **Operation:**
  - Full mesh of point to point LSPs
  - Support for customer port (untagged) or multiple VLANS with subscriber VLAN tags
  - Learning and forwarding based on MAC addresses, Flooding on per VSI-x basis
  - Loop free topology with split horizon (no forwarding from one VSI-x trunk port to another VSI-x trunk port)
  - Failure recovery based on FRR (RSVP-TE)
  - Membership discovery based on provisioned information from management plane

Protection schemes

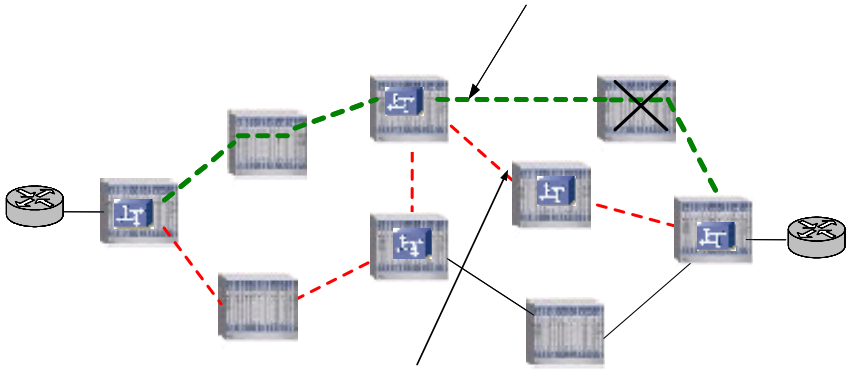
- **No Protection**
- **Optical protection**
  - Ring based schemes (UPSR/2f-BLSR)
  - Mesh based (node/link diverse path)
- **te-LSP protection**
  - Path protection (source based)
  - Local protection with fast reroute (FRR)
    - Link failure
    - Node failure
    - 1:1 protection
    - 1:N protection
- **Failure detection and notification**
- **Bi-directional failure detection (BFD) protocol**

Te-LSP based Path Protection



- **Source computes working and protect LSP paths**
- **Resources can be reserved before failure (double booking)**
- **Fastest with pre-computation and pre-signaling**
- **Detection at ingress may be slow, but allows complete QoS control of secondary path**

1:1 Protection



1:1 Protection

- Segment of working LSP protected by a backup LSP
- Point of local repair (PLR) and merge point (MP)
- Can protect against link failures
- Backup link is called a ‘detour’
- PLR calculates and signals detour path during primary path setup resulting in creation of MPLS forwarding state ate PLR, MP and transit nodes (3,5 in example)
- PLR detects failure and swaps incoming label to that of the detour path
- MP understands relationship between working and protect paths
- Increased state in MP/PLR
- Support for working path QoS along protect path

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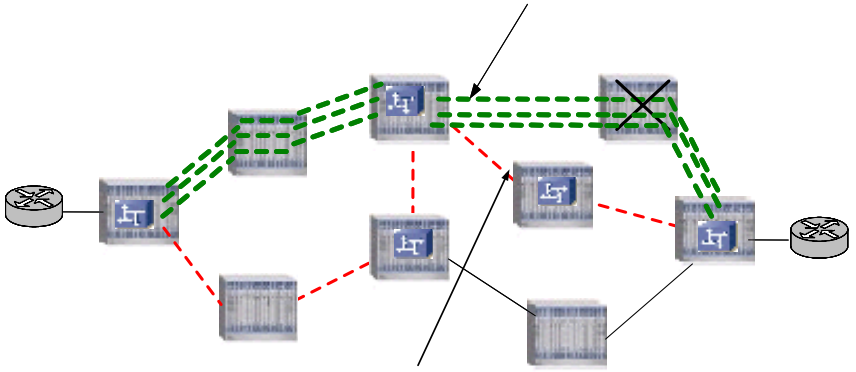
N:1 (facility protection)



N:1 Protection

- Every N working LSPs protected by a single LSP
- Label stack
- Based on label swap and insert of protect LSP label into label stack at PLR
- Can protect against node/link failures
- No new forwarding state at MP
- Penultimate-hop popping (PHP) on last transit node along protection path
- BW protection
- Interaction of FRR and path protection
- Scalability – new LSPs, increased forwarding state

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Conclusion

- Turin solution builds on existing GMPLS based control plane
- Allows Ethernet switching layers to request optical tunnel setup
- Hitless addition/removal of optical BW using VCAT/LCAS
- Selective upgrades to mesh network along spans that are heavily used
- Allows TDM/Ethernet/MPLS 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

Thank you

- Questions ?