

GMPLS based Digital Optical Networks for Next-gen IP Backbone

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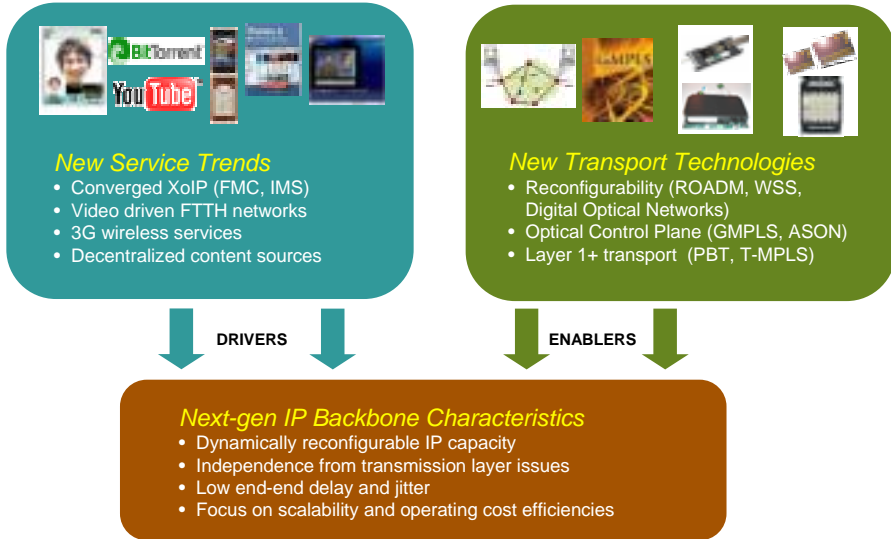


Outline

- Next-gen IP backbone - Drivers and characteristics
- Photonic Integrated Circuits and Digital Optical Networks
- Role of GMPLS in Digital Optical Networks
- GMPLS enabled applications in Digital Optical Networks
- Summary

Next-gen IP Backbone

Drivers and Characteristics



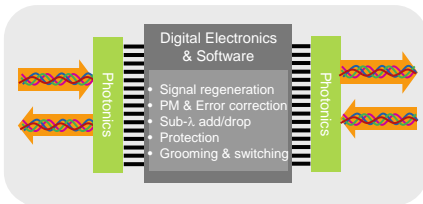
Photonic Integrated Circuits

100Gb/s Receive 100Gb/s Transmit

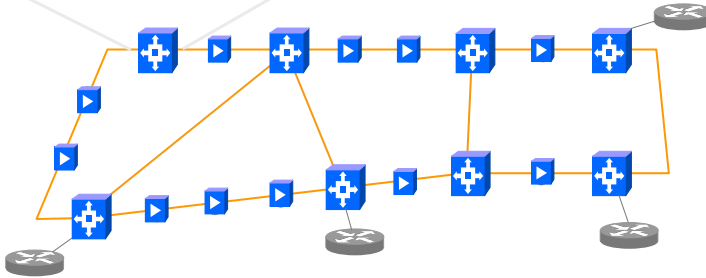


- **Direct Benefits**
 - Reduces size, power, cost and improves reliability
- **Strategic Benefits**
 - Low-cost OEO conversion allows a digital network paradigm

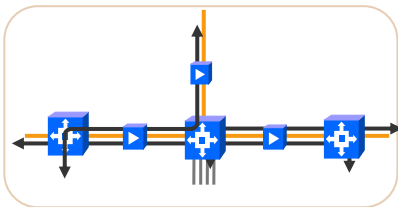
Digital Optical Networks



- Digital Optical Networks combine DWDM, Bandwidth Management functionality and GMPLS intelligence
- Digital Optical Networks provide a scalable and reconfigurable IP bandwidth layer that conventional DWDM systems cannot
- End-end GMPLS and sub- λ granularity at each site enable new applications

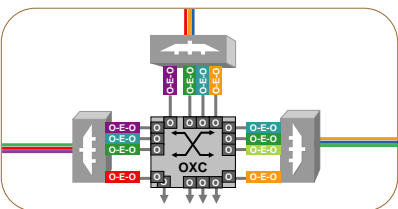


Digital Optical Networks - Applications



Digital Optical Networks - Applications

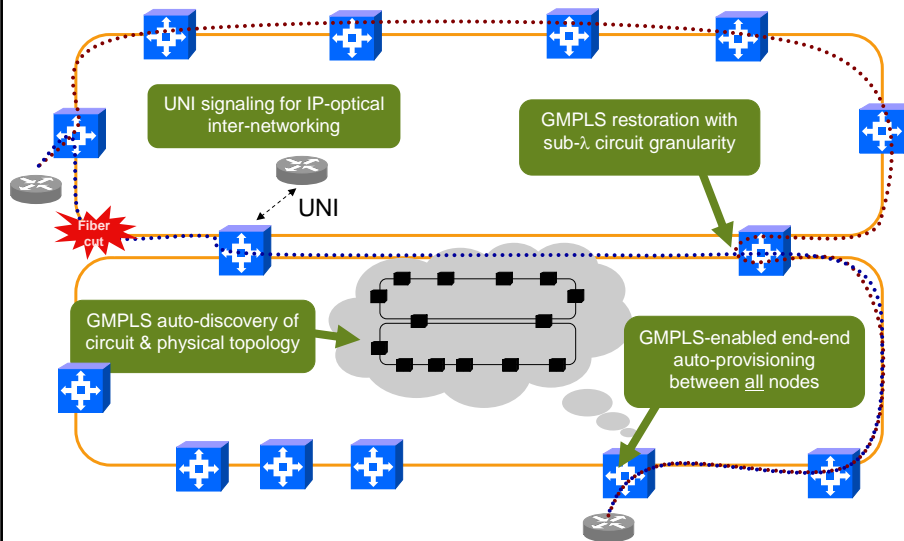
- Switched Layer-1 VPNs
- Dynamically Reconfigurable IP Bandwidth
- Digital Protection and Restoration
- Layer-1 Multicast
- Super Lambda Services - 100 Gb Ethernet



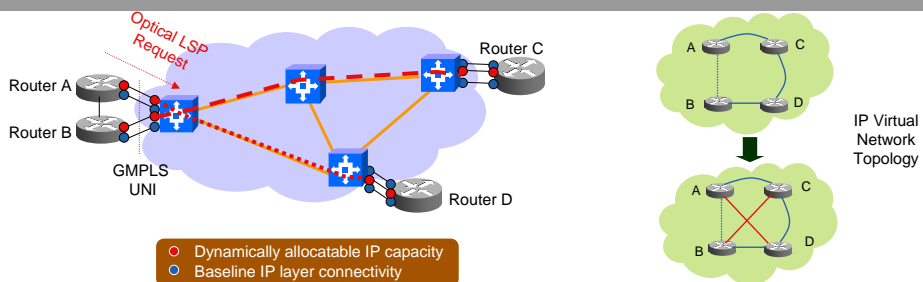
Conventional DWDM Systems - Limitations

- Needs separate OXC for switching
- No end-end GMPLS
- No auto-provisioning across DWDM and OXC
- No dynamic reconfiguration of IP bandwidth
- GMPLS intelligence limited to OXC

GMPLS in Digital Optical Networks

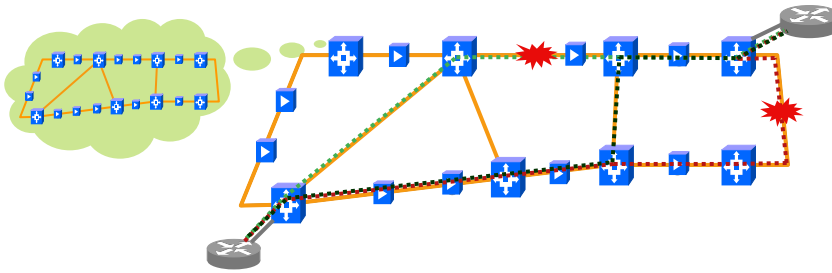


Dynamically Reconfigurable IP Bandwidth



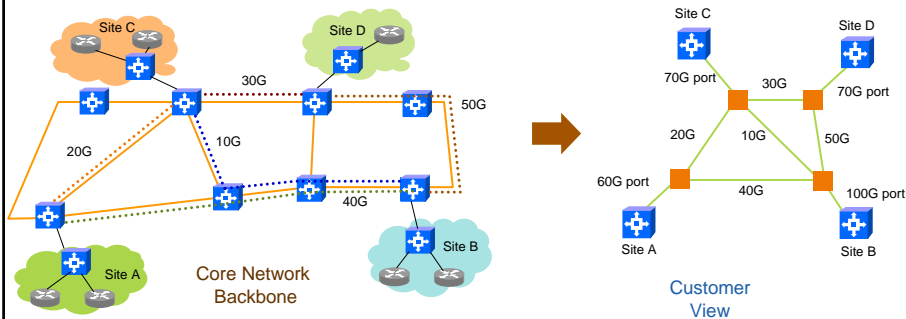
- Digital Optical Networks enable dynamic reconfigurability of IP layer topology
 - PRBS on all non-service bearing DWDM channels → 100G provisionable capacity service ready
 - On-demand express routes between routers for dynamic IP load balancing
 - GMPLS UNI facilitates dynamic bandwidth-on-demand
- Enables multiple circuits to time-share same bandwidth

Digital Protection and Restoration Schemes



- Digital protection & self-healing restoration of transparent wave services
 - Based on precise electrical triggers (Digital Wrapper OH, FEC OH)
 - Multiple options for trade-off between bandwidth efficiency and QoS requirements
 - Dedicated (Digital SNCP) and shared (Digital MS-SPRING) protection
 - GMPLS based path level dynamic restoration

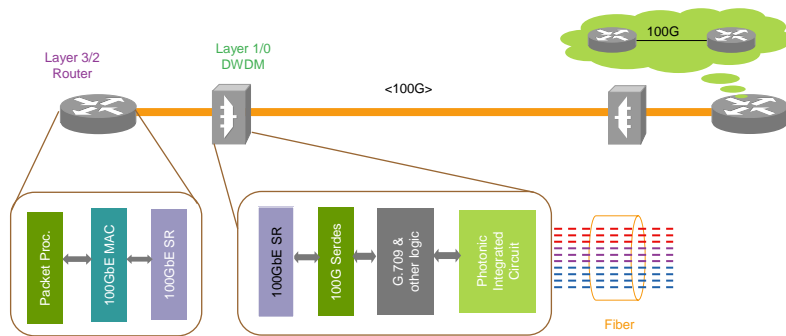
Switched Layer-1 VPNs



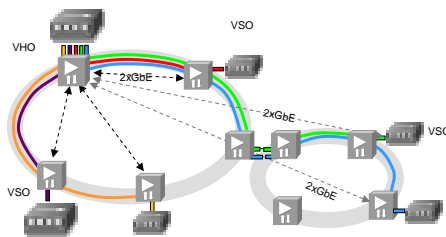
- Switched L1 VPN enables end-customer to dynamically manage capacity at sub-wavelength granularity
 - Pre-provisioned capacity between on-net sites creates virtual switched WDM network
- Customer Network Management
 - GMPLS optical UNI signaling
 - Customer-initiated provisioning and secure access

Super-λ Next-gen Ethernet Services

- PIC enabled Digital Optical Networks provide scalable DWDM line capacity to accommodate higher speed services (40G,100G)
- As IP Link sizes exceed optical line rate, IP core requires “Super-λ” services

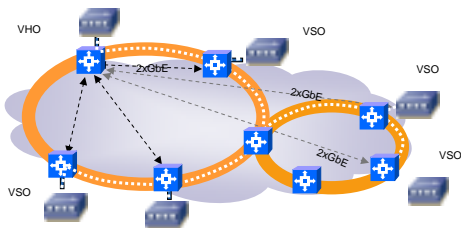


Layer-1 Multicast



Conventional DWDM Systems

- No native multicast capability
- Same copy transmitted on multiple λs to different destinations
- Inefficient for video distribution



Digital Optical Networks

- Native Layer-1 multicast capability
- Optimal for video distribution
- Scalable and bandwidth-efficient

Future Direction and Open Areas

- 100 GbE standardization
- Multi-layer MPLS/GMPLS operations
- Multi-vendor GMPLS operations
- Extension to new packet oriented metro transport technologies

Conclusion

- Next-gen IP backbone needs a dynamically reconfigurable optical layer with sophisticated protection and bandwidth management capabilities
- Digital Optical Networks combine highly scalable DWDM networks with integrated Bandwidth Management and end-end GMPLS intelligence
- Digital Optical Networks enable applications that conventional DWDM systems cannot
 - L1 multicast, GMPLS restoration, Switched L1 VPNs and 100G Ethernet Super- λ services.