



WDM MPLS Testbed

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The Goal

*A reconfigurable WDM MP λ S Testbed
based on Ethernet hardware*

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The Drivers

- Network Traffic is dominated by Internet traffic (**burst** in nature)
- A large fraction of Internet traffic is in **Ethernet** format
 - Ethernet technology is cheap!
- Explosive growth of end user bandwidth capability in Ethernet (GbE and 10GbE)
 - Access to fat pipe
 - Bandwidth on demand
- ☞ Efficient reconfigurable network
 - Ethernet format has the lowest per bit bandwidth cost
- ☞ A testbed for studying network control and management intelligence

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LIGHT READING MAY 10, 2001 PREVIOUS NEWS ANALYSIS

Qwest, Broadwing Go Gigabit Ethernet

LIGHT READING MAY 10, 2001 PREVIOUS NEWS ANALYSIS

Cisco Pushes Ethernet Over MPLS

SAN JOSE, Calif. --(BUSINESS WIRE)-- May 9, 2001--Building on its established portfolio of Multiprotocol Label Switching (MPLS) product offerings, Cisco Systems, Inc., the worldwide leader in networking for the Internet, today announced its Ethernet over MPLS (EoMPLS) metro-based network solution developed on the Cisco 7600 Optical Services Router (OSR) platform, the high-performance, IP services-optimized router designed for service providers.

To highlight the benefits of MPLS in general, and EoMPLS for metro aggregation specifically, Cisco also announced today that it is participating in the EoMPLS technology demonstration at the InteropNet Labs (ILabs) at Network + Interop 2001 Las Vegas, at the Las Vegas Convention Center, May 8 through May 11. The ILabs is NHF's test bed addressing advanced protocol development and vendor interoperability, and has been instrumental in the development and interoperability testing of MPLS, as well as many other networking technology standards.

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Key Issues for a Reconfigurable Network

- Intelligence
 - Electronic layer Routing protocol (MPLS)
 - Optical layer Wavelength routing
- Connectivity fabric
 - Electronic layer Gigabit/Terabit router-switch
 - Optical layer WDM OXC switch
- Network Architecture
 - Performance
 - Economics
 - ☞ Connectivity

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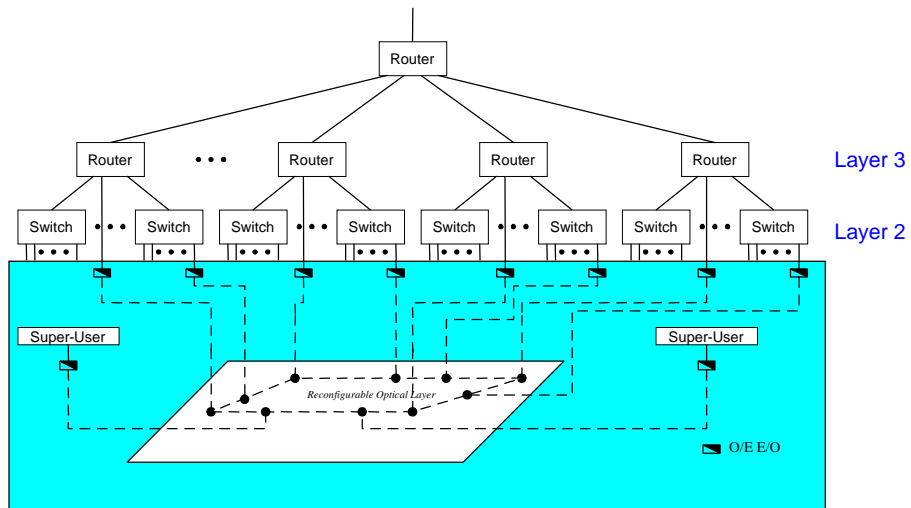


Layer Two WDM LAN Implementation Mapping Wavelength to Port

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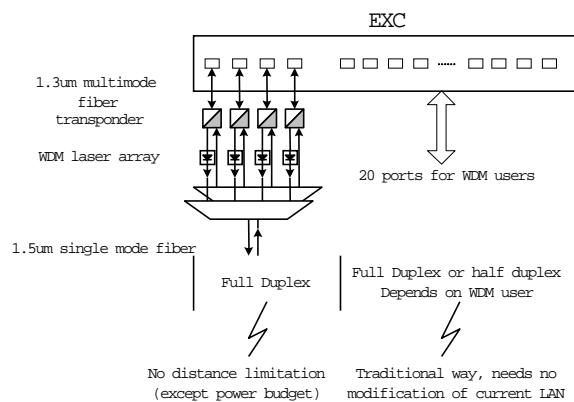
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WDM Interface (WDM-I)



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WDM Reconfigurable MPLS Testbed

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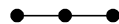
Network Topologies

Network 1



2 nodes
6 users
1 link

Network 2



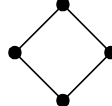
3 nodes
8 users
2 links

Network 3



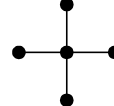
3 nodes
6 users
3 links

Network 4



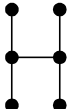
4 nodes
8 users
4 links

Network 5



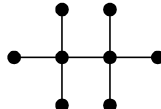
5 nodes
12 users
4 links

Network 6



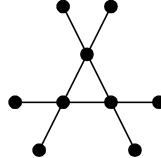
6 nodes
14 users
5 links

Network 7



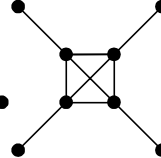
8 nodes
18 users
7 links

Network 8



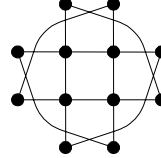
9 nodes
18 users
9 links

Network 9



8 nodes
12 users
10 links

Network 10

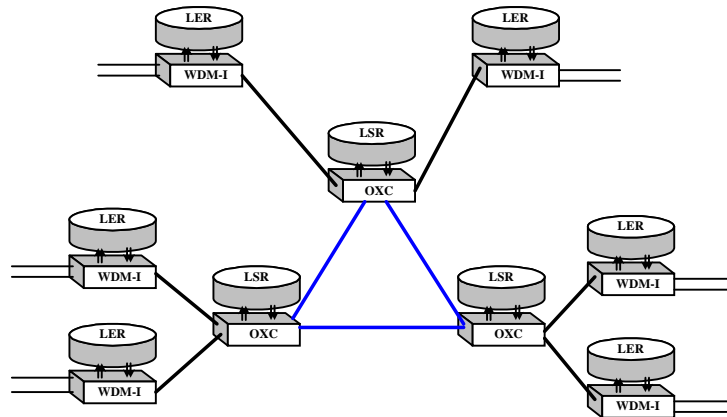


12 nodes
16 users
16 links

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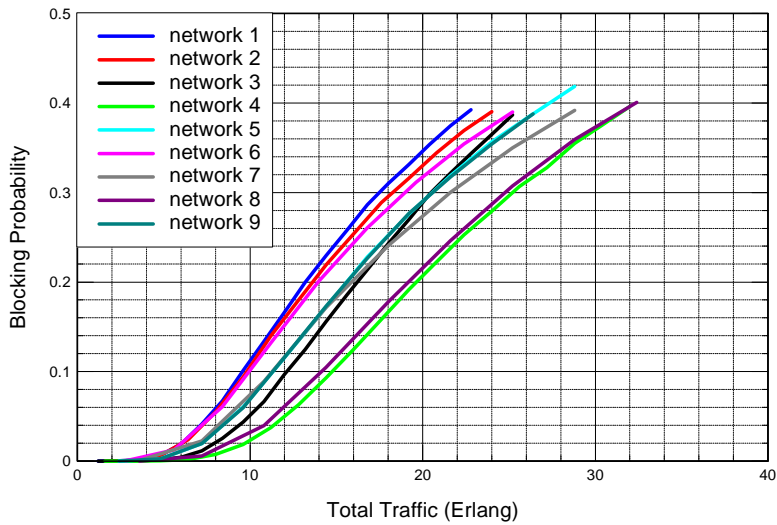
MPλS Testbed Architecture



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Blocking Probability Comparison (8λ)

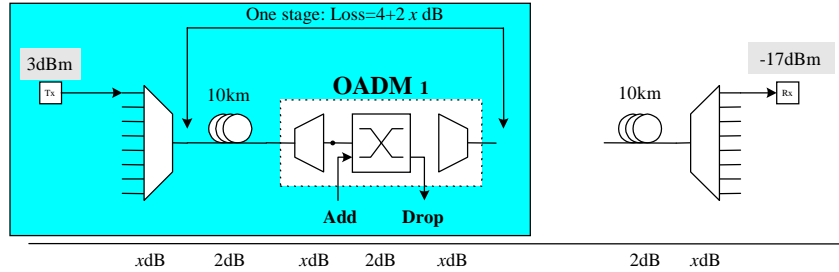


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Power budget for the WDM MPλS System (1Gbps data rate)



x : loss of AWG n : the maximum stage number without EDFA

$$3\text{dBm} - [x + (4 + 2x)n] > -17\text{dBm}$$

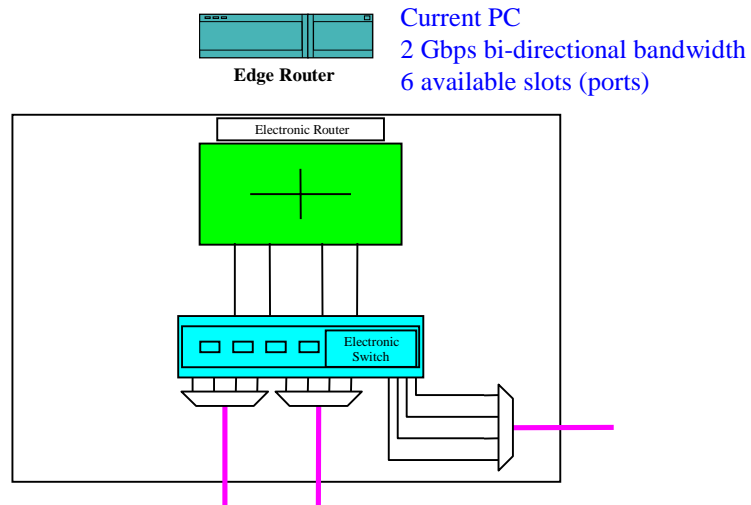
| | |
|----------------|-------|
| $x=5\text{dB}$ | $n=1$ |
| $x=2\text{dB}$ | $n=2$ |
| $x=1\text{dB}$ | $n=3$ |

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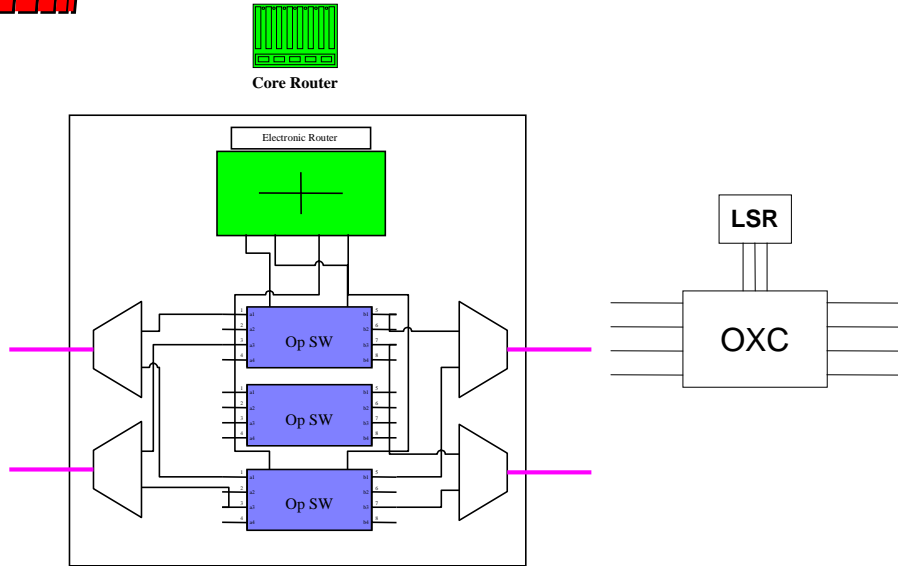
Edge Node Architecture



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Core Node Architecture



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Component Requirement List

| Component | Units | Cost |
|---------------------------|-------|------|
| Routers (LSR/LER) | 9 | |
| Gigabit Electronic Switch | 6 | |
| Transponder (1Gbps) | 36 | |
| 6 × 6 Optical switch | 12 | |
| EDFA | 6 | |
| WDM Laser Array | 9 | |
| AWG | 60 | |
| Gigabit NIC | 48 | |

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Near Term Objectives

- Enable a reconfigurable WDM MPLS network
- Reuse the λ path
- Request/Setup/Delete λ through *Traffic Engineering* (TE) (*BC/CP*)
- Alternative Routing Selection (*BC/CP*)
- Protection (*UMBC*)
- Traffic Monitoring (*UMCP*)
- Traffic Engineering (*UMCP*)

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