The Current State Of The Optical Industry

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Overview

The Current State Of The Optical Industry

- Quick Look Back on 2000
- Reality vs. Myth
- Innovations in Optical Networking
- Challenges to Success
- Looking Forward
2000 In Review
Over the next decade, computer speeds will rise about a hundredfold while bandwidth increases a thousandfold or more.... the last two decades have been the epoch of the computer industry; the next two decades will belong to the suppliers of digital networks.

- George Gilder, Telecosm
2000 In Review

- Everyone recognized the need to “improve” or “replace” SONET, although the approaches vary
- Optical networking gains prominence in the longhaul core—meshed becomes the ring alternative
- Optical networking successfully creates many new service and infrastructure improvements

- Services
  - New wavelength services
  - Faster provisioning intervals
  - Declining prices
  - Priority-based protection options
2000 In Review

- **Infrastructure**
  - Scalability increased and cost decreased by new orders of magnitude
  - Reduced signal regeneration improves transmission economics and lowers costs per bit
  - 3000+ km transmission distances achieved
  - Protection switching achieved with meshed infrastructure ("SONET-like" protection without SONET)
  - Steps taken to reduce network layers and infrastructure complexity
  - DWDM increasing number of available channels per fiber
  - Power and space consumption reduced with many new solutions
- The excitement and innovation that began in longhaul cores extends into metropolitan networks
Reality Vs. Myth
Optical Network Drivers

Interactive Access

Assumes average bandwidth per connection of:
50Kbps for wireless Web, 56Kbps for dialup, 1Mbps for DSL, 3Mbps for cable
Optical Network Drivers

Future Bandwidth Drivers

Source: Williams Communications
Optical Network Drivers

- Every 1% decrease in costs equals a 3% increase in demand

Source: Williams Communications
Facts Imply A Bandwidth Glut

- Technology improves bandwidth bottlenecks and bandwidth delivery
  - Lower cost per bit
  - Increased wavelengths per fiber
  - Increased utilization per wavelength
  - Improved fiber utilization

- More fiber is being deployed than ever
  - Fiber is replacing copper in metropolitan networks
  - CLECs and longhaul players are leveraging metropolitan fiber networks
Dispelling The Bandwidth Glut

- "More Fiber" does not mean capacity is available
- Service providers continually evaluate economics of lighting fiber vs. maximizing wavelength channels per fiber
  - More longhaul capacity will be required as high-speed metro services take off
- Additional capacity will be required but availability may never exceed demand
  - Equivalent to demand because of just-in-time deployment practices
  - No incentive for carriers to deploy more bandwidth than what's required
    - Funding and capital restrictions
    - Risks to successful business plan warrant conservative approach
Optical Network Innovation
Optical Network Innovation

Innovation impacts equipment value propositions in all segments

Long Haul

Metro Core (CO-CO)

Metro Access (CPE-CO)

Premise (CPE-CPE)

xDSL or Cable Modem  PSTN/Cellular  PON, FTTC, FTTH  ATM / Ethernet  Wireless, FSO

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Optical Network Innovation

**Premise**
- Optical service activation platform for managing multiple services using software tools and a single Ethernet interface

**Access**
- “The layerless edge” is introduced to provide unprecedented scale
- Dense Virtual Routing
- Wavelength splitting for providing high-speed optical access
- Open-air, optical-meshed networks
Optical Network Innovation

Metropolitan

- Optics and routing collapsed together
- Increasing network utilization by oversubscribing the optical layer
- Increased wavelength utilization by packing multiple services onto the wavelength
- Displace legacy ADM, multiplexers, access routers, SONET with Gigabit Ethernet
- Simplified metropolitan networks to accommodate legacy traffic while optimizing for data
- Incorporating DWDM, SONET, and layer 2-3 intelligence for switching and routing into one box
Optical Network Innovation

- **Longhaul Core**
  - Improved port scalability while consuming less space and power by using a photonic switching core
  - Optical service creation
  - Optical switches are being introduced with higher port densities
  - Building optical switches using fiber amplifiers
  - Continuing to improve longhaul transmission distances
Optical Network Innovation

Innovation impacts service providers

Long Haul
Bypass Legacy Core

Metro Core (CO-CO)

Metro Access (CO)
Bypass Legacy Access

Premise (CPE-CPE)

xDSL or Cable Modem
PSTN/Cellular
PON, FTTC, FTTH
ATM / Ethernet
Wireless, FSO

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Optical Network Innovation

- **New Internet Providers**
  - Providers seeking to extend performance guarantees (SLAs) across multiple ISP networks

- **New Access and Building-Centric Providers**
  - Metro providers using Gig E, WDM, and optics to provide high-speed access at lower prices
  - High-speed, in-building connectivity with tailored bandwidth and services via Web portal
  - Free fiber upgrade in exchange for customer ownership rights
  - Integrating applications, services, and transport for building-centric markets
Optical Network Innovation

**Service Providers**
- Content delivery management
- Bandwidth clearing houses
- Fixed high-speed wireless services (1-20Mbps)

**Storage Providers**
- Software for replicating data across distances over dial-up lines, or dedicated access lines using T-1 or ATM
- Hybrid storage devices that switch, route, and bridge Fiber Channel and SCSI traffic over IP networks for bridging geographically distant storage networks with DWDM
New Developments In Optical Networking

- **Equipment solutions targeting:**
  - Wavelength management
  - Improving fiber capacity
  - Bandwidth efficiency
  - Increased port switching density

- **Optical switches with various switching cores**
  - MEMS
  - Liquid crystals
  - Bubbles
  - Thermal optical
  - Holograms
  - Liquid gratings
  - Acousto optics

- **Increasing available wavelength channels at higher distances**
New Developments In Optical Networking

Technology Solutions

- Tunable lasers
- Hybrid optical switches with OEO and OO cores
- Dispersion compensation modules limit chromatic dispersion and improve bit rate, optical channels, and span length
- Use of Metropolitan DWDM when dark fiber leases cannot be justified
- Raman amplification improves transmission distances
- Integrated L-band and C-band amplifiers
- Emergence of FTTC, FTTH, and FSO
New Developments In Optical Networking

Architecture changes

- Service layer displaced to the network’s edge
- Rings migrate to meshed networks in long haul, regional metro networks but remain in access networks
- ADMs and cross connects replaced by a new generation of optical equipment
- ATM and SONET continue to lose ground to Gig E
- Elimination of OEO where it’s not required
- IP over DWDM
- Network layers are streamlined to improve scale, service delivery, operations, network management, etc.
Challenges To Success
Optical Market Challenges

Metro Stabilization 2001-2002

CLEC Turmoil
Service Provider Adoption
Proliferation of Entrants
Mergers & Acquisitions
Optical Networking Challenges

- Relieving metro and access network bottlenecks
- Broken service provider business models may begin the demise for many service providers and equipment vendors
- Hiring, training, and retaining talented employees
- Proliferation of wavelength services creates the need for additional value and differentiation
- End-to-end network management, interoperability, and SLA reporting across a growing number of vendor solutions
  - Need to provide fault detection and isolation
  - High level of granularity and segmentation
Optical Networking Challenges

- Improving costs for metro DWDM solutions
- Increasing the number of available wavelength channels at higher distances
- Equipment implementation and validation by service providers
- Disagreement among optical interworking standards
- Delayed equipment adoption and implementation
  - Service providers’ back-office systems
  - Equipment manufacturing delays
Conclusion

- 2000 provided a good start
- Technology continues to drive changes in solutions and service provider business models
- There will be just enough bandwidth – no glut
- Metropolitan market and solutions stabilize
- Many challenges will be overcome by innovation and new equipment developments
- Solutions and providers will compete for viability in 2001
- The next 12 to 18 months will lead to a handful of winners and the consolidation or end to many
Thank You!

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