Optical Networks Infrastructure

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Area of interest

- Need for building new services utilizing agile optical
- What are the new services?
- Impedence mismatch
- Static Provisioning
- Carrier Hotels
- Optical Ethernet - 802.17 RPR - Resilient Packet Ring
- ASON - Automatically Switched Optical Networks
- EFM - Ethernet First Mile
- Where are the bottlenecks - it is changing
- OXC - Optical Cross Connects - long hope - move intelligence to the edge
Need for new services
Patch Panel - Manually provisioning
New services takes too long

- Manually cable connections
- It takes 4-6 months to provision a new optical connection
- Cross bounders
- Tier 1, Tier 2, Tier 3
  - Why not Tier 3 talk directly with another Tier 3?
  - Small Metro providers in LA and NY want to connect via small LH provider.
  - Why we need the big players?
Service Composition

- Service composition of light path across service provider
- Many AS each of them does not have access to the rest
- Build a light path among service providers
- Many different networks, no one can have full coverage,
- Network infrastructure is extremely expansive (Billions of Dollars), service composition save resources (I’ll use your infrastructure, you’ll use mine)
- Service composition to set light path between technologies (Access, Metro and Long Haul)
- Grid computing, SAN
Cooperation and Brokering

- Service composition
Impedance Mismatch

- Cross boundaries (Control, Management, security)
- Cross Technologies (Sonet, DWDM, ATM)
- Cross topologies (P2P, Rings all types, mesh, )
- Circlet, packets
- Speeds (1.5, 10, 51, 100, 155, 622, 1G, 2.4G, 10G...)
- Fiber, copper, wireless
- Level of media security
Business Case for Direct Peering

- Typical Internet transit costs - $1000/Mbps per month
  - For 100 Mbps Internet transit then $100,000/mo
- But coast to coast 100 Mbps channel is $1000/mo (e.g. www.Cogent.com)
  - New optical technology will reduce that cost further
- Compelling business case to do as much no-cost direct peering as possible
  - See http://www.nanog.org/mtg-0010/tree.doc
- OBGp is a proposed protocol that will allow massive direct peerings
  - Each optical switch is in effect a mini-IX to allow direct no cost peering
  - OBGp will also automate peering relationships
- Significant business opportunity for carriers who want to partner with CANARIE in building next generation optical Internet
- For example Telia claims that they save 75% in Internet transit fees with massive direct peering
- Speeds up convergence time on BGP routing

Source – cook report
ASON – Automatically Switched Optical Networks

- Dynamically switch the light path
- Enabler for many applications
- Controlled by UNI and NNI - Allow applications to set the light path
- Allow to add the intelligence into the optical core
What is ASON?

- The Automatic Switched Optical Network (ASON) is both a framework and a technology capability.
- As a framework that describes a control and management architecture for an automatic switched optical transport network.
- As a technology, it refers to routing and signalling protocols applied to an optical network which enable dynamic path setup.
- Recently changed names to Automatic Switched Transport Network (G.ASTN)
## Optical Network: Today vs. Tomorrow

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<td>- 2F/4F BLSR</td>
<td>- 2F/4F BLSR</td>
<td>- Provisioned path connection</td>
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<tr>
<td>- STS-n</td>
<td>- Matched Nodes</td>
<td>- Linear</td>
<td>- Trail management across multiple rings</td>
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<td>- STS-nc</td>
<td>- Head end ring prot.</td>
<td>- 1+1</td>
<td>- Multiple product</td>
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<td>- OC-48T, (OC-192T)</td>
<td>- NUT (non-preemptive unprotected traffic mixed with protected in ring/linear)</td>
<td>- 1:n</td>
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<td>- 1GE</td>
<td>- Unprotected (extra traffic)</td>
<td>- Path protection</td>
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<tr>
<td>- (134Mb/s)</td>
<td>- Protection SW time</td>
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<td>- 140Mb/s</td>
<td>- Clear P =60ms</td>
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<td>- With ET=160ms</td>
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<td>- VC-4-nc</td>
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<tr>
<td>- NUT</td>
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<td>- Extra Traffic</td>
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<tr>
<td>- Broadcast</td>
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<td></td>
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<tr>
<td>- VC-4-nv</td>
<td>- Wider range of SLA capability</td>
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<tr>
<td>- 10GE</td>
<td>- Path diversity verifiable</td>
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<tr>
<td>- Flexible i/f</td>
<td>- Scalable to large NW size</td>
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<tr>
<td>- Billing method (distance, time, bw, QoS)</td>
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<tr>
<td>- Asymitric bw connections</td>
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<tr>
<td>- Point-to-multipoint</td>
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<td></td>
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<tr>
<td>- sequential</td>
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**Today**

- **Optical Service and Applications**
- **ASON value added**
- **Source Nortel**

**Tomorrow**

- **Optimized IP application - current driver for transparent NW**
- **Additional SLA capability**
- **Mesh network**
- **Auto connection & resource mgnt**

**Mesh**

- Port connectivity
- unconstrained
- arbitrary

**ASION value added**

- Auto discovery of NW configuration
- Connection provisioning of paths over unconstrained line topology
- No pre-provisioning of connections?
- User signaling i/f for connection provisioning
- Scalable to very large NW
- Fast connection establishment <2s
- Resource (bw) management and monitoring
ASON Network Architecture

Client e.g. IP, ATM, TDM

OCC

NNI

IrDI

OCC

IrDI_NNI

GUI

Integrated Management

User Signaling UNI

Transport Network

GHCT NE: Global High Capacity transport NE
ASON: Automatic Switched Optical Network
OCC: Optical Connection Controller
IrDI: Inter Domain Interface

Interfaces:
UNI: User Network Interface
CCI: Connection Control Interface
NNI: ASON control Node Node Interface

Legacy Network

Clients e.g. IP, ATM, TDM
ASON Service Composition

Network Layer

Domain/Region Layer

Conduit Layer

Fiber Layer

Optical Service and Applications
Optical Ethernet – RPR

- RPR - Resilient Packet Ring - IEEE 802.17
- Ethernet over MAN (Ethernet is winning all time)
- Distributed L2 switch over MAN
  - Can have one part of the same subnet at SF, another part in SJ and SC
  - Virtual organization over MAN with NO routing.
  - Started to be deployed in the field

- Cost - much cheaper than WAN
The Metro Bottleneck

End User
- Ethernet LAN
  - IP/DATA
  - 1GigE

Access
- T1
- DS1
- DS3
- LL/FR/ATM
- 1-40Meg

Metro
- OC-12
- OC-48
- 1Gig+

Core
- OC-192
- DWDM n x!
- 10GigE+

Optical Service and Applications
RPR - Expanding the LAN to the MAN/WAN

LAN

- Low Cost
- Simplicity
- Universality

LAN in the MAN Paradigm

MAN/WAN

- Low Cost
- Simplicity
- Universality
- Scalability
- Reach
- Robustness

Optical Service and Applications
What is RPR?

Ethernet networking on Optics (STS-Nc)
Scalable Bandwidth and Services

OC-3 / 12 / 48 / 192

STS-N
TDM

VT’s
VT’s
VT’s
VT’s

1000M

300M

500M

1M

80M

Ethernet

Optical Service and Applications
Network & Customer Management

- Customer Privacy through managed Virtual LANs (802.1Q tags)
- Customer Agreements through flow attributes (802.1p prioritized queues and traffic policing)
Streaming media as bandwidth driver

- Streaming needs big pipes - 2-3 orders or magnitudes more than web surfing.
  - Speed of 3Mbs is about 1GB per hour
- Constant traffic (can be turn on for hours with no one watching)
- Web looks like a big traffic driver on the edge - but it is small traffic on the core.
  - One hour web, 10 second a page, 360 pages, 10KB page → 3.6MB
EFM – Ethernet First Mile

- Ethernet at the first mile start to be attractive.
- Drive more bandwidth to the end users
- Three proposals:
  - 22Mbs on the current phone line
  - PON – Passive Optical Network – split the optical link to 4 and additional 8 total 32 customers (60Mbs per residence)
  - Point-to-point optical – more expansive
- SBC and alike are interested.

- The tight of way is the main issue. Optical fibers work fine in harsh environment
  - Sewer net, Power line, Gas line, water line.
Where are the bottlenecks

- Optical networking is evolving
  - Much more bandwidth
  - Agile reconfiguring of light path
- As soon as one problem is solved, the bottleneck is moving to a new place
- Currently it looks like the bottleneck is at the first mile
- Streaming media - bottleneck push on routers
- Much more bandwidth in the MAN move the bottlenecks away from the access and the edge
- Peering points between service providers
Optical Cross Connect

- Optical cross connects - less need for core routing
  - Fat pipes replace core routers with NO delay
- It looks more like circuit switching instead of packet switching (ouhh)
- MPLS, MP!, S, LDP - Label Distribution Protocol - room for binding it to services on the edge.

- UNI - User Network Interface, - allow the end machines and edge to send service request to the core
- NNI - Network Network Interface, - control of the core (if the core agree to provide the service, might say no)
Backup Slides
# Major Data Transport Solutions

## Packet Switch
- Data-optimized
  - Ethernet
  - TCP/IP
- Network use
  - LAN
- Advantages
  - Simple
  - Low cost
- Disadvantages
  - Unreliable

## Circuit Switch
- Voice-oriented
  - SONET
  - ATM
- Network uses
  - Metro and Core
- Advantages
  - Reliable
- Disadvantages
  - Complicate
  - High cost
Optical BGP Networks

Dark fiber Network
City X

ISP A

To other Wavelength
Clouds

ISP B

AS100

AS200

Wavelength Routing Arbiter
& ARP Server

ISPs

Customer Owned
Dim Wavelength

Customer Owned
Dim Wavelength

Dark fiber Network
City Y

ISP C

Dark fiber Network
City Z

ISP A

ISP B

Optical Service and Applications

Figure 12.0