Services and Applications’ infrastructure for agile optical networks

More questions than answers

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Huge advancements in optical devices, components and networking.

- The underline of the Internet is optical - How can we take advantage of this?
- How can the applications take advantage of this?

Agile Optical Network is starting to appear. What services and interfaces we'll need between the optical control and the applications?

- What are the applications?
- The Internet architecture was built on some 15-20 years old assumptions. Are some modifications needed?

Is packet switching good for all? In some cases, is circuit switching better? (move TeraBytes of SAN date, P2P, Streaming)

End-to-End Argument - Is it valid for all cases?

- What cases not? What instead?

The current Internet architecture is based on L3. What is needed in order to offer services in L1-L2?

Computation vs. Bandwidth 10X in 5 years
How Optical Agility differ? (vs. L3 Routing)

- Current internet architecture is based on L3 routers with static connection of routers ports (point to point)
- Until recently it took 4-8 month to set an optical link coast to coast.
  - Need to cross and contract with 4-6 organization with lawyers
  - Need patch panel with manual cable setting
  - Need static configurations
  - Extremely expensive (10G Monthly - $1M)
- Current peering is mainly in L3, BGP and policy
- New fast provisioning in ASON (seconds)
  - A head of time static rout computation
  - MPLS, MP-I S, CR-LDP, RSVP-TE
- New Service Architecture and mechanisms for composing services
Service Composition

Current peering is mainly in L3. What can be done in L1-L2?

- The appearance of optical Access, Metro, and Regional networks
- L1-L2: Connectivity Service Composition
  - Across administrative domains
  - Across functionality domain (access, metro, regional, long-haul, under-see)
  - Across boundaries (management, trust, security, control, technologies)
  - Peering, Brokering, measurement, scalability
- Appearance of standards UNI – NNI
Compose new type of Applications?

Dynamic L2VPN: enable new type of applications

- Agile connectivity for:
  - SAN across metro, regional and long haul.
  - Plain disk remote storage
  - Backup (start remote backup when the tape in Nebraska is ready and when all the optical connection are ready to be set)

- Set dynamic bandwidth connectivity to the Internet

- What architecture changes are needed?
Technology Composition

- L3 routing - drop packets as a mechanism
  - \((10^{-3})\) lose look good
  - Circuit switching - set the link a head of time
- Optical networking - bit transmission reliability
  - \((\text{error } 10^{-9} - 10^{-12})\)
- L3 delay - almost no delay in the optical layers
- Routing protocols are slow - Optics in 50ms
  - Failure mechanism redundancy
- DWDM’s tradeoff - higher bandwidth vs. more fibers
  - For agile L1-L2 routing may need to compromise on bandwidth
- RPR - break L3 geographical subnetting
- Dumb Network - Smart Edge? Or opposite?
New Architecture Challenges

- We are facing enormous growth of traffic. How the current L3 centric architecture handle this growth?

- Supply - New technologies for the Last Mile
  - Servers and storage are moved to Data Centers with big data pipes
  - Optical Ethernet, MEF, L2VPNs, Passive Optical Networks (PON)
  - Competition in the last mile, mainly business access

- Demand - The need for more bandwidth
  - Distribution of data, storage and computation.
  - Streaming, virtual gaming, video conferencing,
  - P2P, KaZaA, Morpheus - the next big thing that consume traffic?
    - Social differences, downloads of Gigabits a day
  - Dialup move to broadband
  - PCs on the edge become servers
DARPA demo – Disaster Recovery concept
Agile setting of light-path on 10GE All Optical switch

- Control and computation - Linux

Control Mesg
1Gbs
10Gbs

SF
NY
FL
Backup Slides
Networking Issues

- Electrical versus Light
- Copper versus Fiber
- Wired versus Wireless
- Packet versus Circuit
- Flow versus Aggregate
- Stateless versus stateful
- Fixed versus Programmable
- End-to-End versus Hop-by-Hop
- Unicast versus Multicast
- Centralized versus Distributed
- Peer-to-Peer versus Client-Server
- Connectivity versus Service.
- Vertical versus Horizontal
- Users versus Provides

It is impossible to eliminate one completely in favor of the other! So, how are we composing the next generation Internet?

- Service Architecture instead of Connectivity Architecture
- Composing end-to-end services by negotiation
- Deploying Optical Agility with Programmability and Scalability properties
Packet vs. Circuit

**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
Networking – Composing the Next Step?

- How are we composing the next Internet?
  - Elimination
  - Addition
  - Combination
  - Survival of the fittest

- Composing the Internet = Choosing and combining components to construct services, at the same time optimizing some utility function (resources, monetary, etc)
  - Service Architecture
  - Optical Core
  - Programmability
  - Scalability
  - Composing by negotiation
Canarie Optical BGP Networks

Dark fiber Network
City X

ISP A

To other Wavelength Clouds

Customer Owned Dim Wavelength

Dark fiber Network
City Y

Wavelength Routing Arbiter & ARP Server

Dark fiber Network
City Z

Figure 12.0
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
Openet Architecture

Control Plane

Swapping Fabric

CPU System

Applications

ORE

System Services

Data Plane

(\textit{Wire Speed Forwarding})

Forwarding Processor

Forwarding Rules

Statistics & Monitors

Traffic Packets

Monitor status \uparrow \quad \textit{New rules} \downarrow
Scalable Bandwidth and Services

OC-3 / 12 / 48 / 192

STS-Nc

Ethernet

STS-N

TDM

VT’s

VT’s

VT’s

VT’s

80M

1M

1000M

10M

300M

500M

80M