Packet Optical Transport: Migrating networks with next gen Packet Optical Network Platforms

ECOC - Torino
Agenda

- Network Challenges
- History
- Network Trends
- Key features of POTP’s
- Applications Migrating networks
Network Challenges?

- **Provide more Cost-effective Bandwidth**
  - Fueled by video and the web
  - A shift to packet based services, making current network incapable or inefficient
  - Residential/enterprise/wireless demands
  - Dealing with declining revenue per bit

- **Migrate the network, how?**
  - L2/L3
  - What about the Legacy traffic
  - Who is doing the migration and the skills
  - Concern for Just Capex, what about Opex

- **Mixed TDM + Ethernet Environment**
  - Sustained growth in TDM circuits & revenue
  - Large growth in Ethernet

- **Moving to Packet networks, what is the right architecture to provide Ethernet Scaling, QoS, & Protection**
  - Packet loss requirements for video
  - Latency requirements for wireless backhaul
  - Private-line equivalent Ethernet for business
  - Utilizing a scalable architecture
 Networks have tended to grow in layers over the years
a brief History

- Optical Fibre Networks have traditionally used Add Drop Multiplexers (ADM’s) to combine multiple streams of data into a single beam of light. This is the basis of fibre networks and was present from 1980’s.

- 1990’s/early 2000’s saw a growth in Multi Service Provisioning Platforms (MSPP’s) which were a lower cost alternative to ADM’s that could manage multiple fibre rings from a single chassis. They could also allow connections directly from Ethernet LAN’s to a service providers optical backbone!

**These devices have served the carriers well in the early years of Packet transport.

- Recently, equipment has evolved into Packet ONP’s which take the next step of providing huge transport capability (40 Gig/100G) and the ability to manage multiple telecoms inputs (DWDM, SONET/SDH, Ethernet).
PONP’s – Why so Important?

- The jump from MSPP –
  - Sounds like a natural evolution but actually a ‘step change’!

- PONP’s
  - MSPP’s only bolt on L1 Ethernet services which do not provide aggregation
  - PONP’s optimised for all packet transport of L1 and L2 Ethernet, supports service aggregation
  - With COE, more bandwidth efficiency = More Service Revenue and Higher Margins
  - ALSO support all legacy transport, or any combination of packet and legacy, plus an eye to the future, eg, OTN.

- So, PONP’s can solve a distributed aggregation and transport problem in the metro environment where traffic is moving very aggressively toward packets but still has a strong TDM (legacy) presence
PONP’s – Setting the Stage

- Some customers are galloping ahead to an all IP network and have large transport/optical requirements for high bandwidth or triple play
  - PONP’s with WDM and Connection Oriented Ethernet for Router bypass and Ethernet transport

- There are many others who need to move on but still derive a sizeable chunk of revenues from legacy. TDM is huge and is still forecasted so these customers need a solution that can cope with both
  - PONP’s with TDM and OTN support.

- Networks are evolving from ATM, Frame Relay, Ethernet over SDH into 2 layers – Carrier Ethernet and ROADM/WDM
  - Network is collapsing
  - Important to integrate these 2 layers into a single device
Looking at Network Trends

- Increasing focus on convergence of packet/optics/TDM
  - Drives efficiency and economics
  - Lower cost transport models

- Packet traffic growth & network transformation
  - Drives Ethernet and WDM

- Clear trend toward higher speeds
  - 40G, 100G…
  - Applicable in the Core and Metro networks
  - 100G near term economics?

- OTN switching will be a clear requirement
  - OTN will be used to support Legacy TDM
  - ODU Flex and ODU1

- ROADM evolution
  - Higher degrees
  - Core will use for add-drop, ring interconnect, and mesh connections, Metro predominately add-drop applications
  - Colorless, directionless, contentionless

SONET/SDH Declines as WDM Ethernet Revenue Grows
Source: Infonetics
Attributes of PONP’s (1)

- **High Integration of TDM fabric, Packet fabric and ROADM technology**
  - Typically 5 to 10x equipment consolidation
  - Automated SDH/SONET, wavelength and COE provisioning

- **Photonic switching / ROADM as the foundation**
  - Next gen ROADM technology has 10x reduction in transit costs and 4x density evolution, with benefit of ROADM technology migrating from shelves/systems to pluggable cards
  - Increased ROADM simplicity, fewer jumpers, improved automation with nodal tests, monitoring points and span measurements.

- **Sub-lambda aggregation and grooming**
  - Integrated grooming eliminates subtended SDH and Ethernet elements with on average 50% hub site cost savings
  - Integrated non-blocking, cross-system grooming eliminates additional sub-tended NE setup and provisioning

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Attributes of PONP’s (2)

- Industry standard implementation of Connection Oriented Ethernet with the ability to Scale Metro Ethernet
  - Early “Switched” Ethernet access architectures are not sustainable as access costs rise dramatically with locations and were often overlaid on EoS networks
  - Allows a general purpose infrastructure that supports Native Ethernet (and EoS) services
  - Distributed aggregation and transport with the PONP’s reduces network costs 35-45%, provides a hard QoS and 50ms protection

- Optical Carrier Class Networking
  - Simple software upgrades
  - Hitless fabric switching
  - Robust EMS and Optical planning tools
COE Ecosystem
6 Attributes of Connection-oriented Ethernet

Standardized Services
- MEF Service Definitions
- MEF Service Attributes

Reliability / Availability
- G.8031 50ms EVC Protection
- 802.3ad UNI & ENNI Protection

Scalability
- Layer 2 Aggregation
- Statistical Multiplexing
- Tag Swapping/Reuse

Deterministic QoS
- Lowest Delay, Delay Variation, Loss
- Bandwidth Resource Reservation
- Connection Admission Control

Ethernet OAM
- 802.3ah Link Fault Management
- Y.1731 Service Fault Management
- Performance Monitoring

Security
- Bridging disabled-MAC DoS attacks mitigated
- Completely Layer 2 - no IP vulnerabilities
COE Fundamental Attributes
Carrier Ethernet with Traffic Engineering

1. Ethernet Frames take a predetermined path
   - Guarantees Consistent EVC/OVC Performance

2. Bandwidth Reserved per EVC/OVC/Tunnel
   - Also supports oversubscription
Definition of Connection-oriented Ethernet (COE) Networking

- “Flow” can be an EVC, OVC, tunnel or a CoS instance of an EVC, OVC or tunnel
  - EVC, OVC can have multiple CoS instances
  - Tunnel can have multiple EVCs, OVCs

- “End to End” EVC or OVC defined by service/application
  - MEF EVC (UNI to UNI association)
    - End user UNI to UNI at IP/MPLS network edge using COE
    - COE between end users
  - MEF OVC (UNI to ENNI association)
    - End user UNI to ENNI at partner provider’s network using COE
Key reasons for migrating to PONP’s

- **Price/performance**
  - achieving the lowest cost-per-bit transport;

- **Service reach**
  - providing the widest geographical footprint for customers;

- **Multi-service**
  - so that costs are shared across multiple lines of business;

- **High availability**
  - with low failure rate, fast protection and optional restoration schemes;

- **High QoS**
  - predictable latency, low errors and deterministic service delivery;

- **Transparency**
  - to handle any end-user or carrier's service unaltered;

- **Strong security**
  - to support any customer's data with confidence;

- **SLAs**
  - delivering on a carrier's promise for performance and availability.

Plus TCO is lower

*src: Network Strategy Partners*
Applications

- **Consolidated core metro/regional networking**
  - Integration and collapsing of NGADM and ROADM networks
  - More scalable support for Ethernet infrastructure

- **Triple play networks**
  - Integrated ROADM transport with packet aggregation enables bulk bandwidth delivery and eliminates costly elements

- **Consolidated Ethernet services networks**
  - EoS and EVPL service delivery
  - ELAN tails

- **Wireless backhaul networks**
  - Supports TDM and Ethernet transport, aggregation and growth
Verizon Target Architecture

G.709 & Optical Control Plane

Cust. Prem.  Access  Metro  LH

T1  DS3  OC-3  OC-12  1 GbE  10 GbE

OC-48/OC-192  xPON  ONT  ADM

Local Node

Local Node

OTN Switch

ULH OTP

ULH OTP

ULH OTP

ULH OTP

ULH OTP

ULH OTP

ULH OTP

P-OTP: Packet Optical Transport Platform (ROADM/WSS+ADM+DCS+EN Switch)
ULH-OTP: Ultra-Long Haul Optical Transport Platform (ROADM+ADM)
OTN Switch: Optical Cross Connect (OXC) + ADM + OTU switching
OLT: Optical Line Terminal (PON head end)

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Source: VZ, Elby, OFC 2008
Layer 1 Network Modernization

- PONP w/ Mux on a blade and SWF support for COE and OTN switching
- Ready for Packet services
- 5x – 10x reduction in space requirements
- 10x reduction in fiber / cabling
- Reduction in power, cooling costs
- Reductions in maintenance, spares costs
- Single craft interface
Video Transport Optimization

Intermediate routers for VoD
- 10GE to 1GE multiplexing
- Video service protection

Integrated aggregation and transport
- Uses PONP w/ WDM and COE
- Protection and multiplexing for all services
- ROADM for bandwidth scaling
- Removes intermediate routers
- Simpler operations
Scaling the Network: Ethernet Cross-Connect

- Manual Ethernet Interconnection

Existing Ethernet Network

- Connection-oriented Ethernet DCS
- Simplify, Reduce Cost, Increase Reliability

Existing Ethernet Network
Interworking Domains – Ethernet and EoS

Migration of Ethernet traffic from multi types of services in a large POP
Legacy EoS traffic and native Ethernet traffic into a core switched network

Ethernet VLANs
(over SDH, nxE1, E3, or Native Ethernet)
Migration

Reducing component’s

Router by-pass
- IP traffic growing 40-50% per year
- 30-60% of traffic through core IP router is transit traffic\(^1\)
  - i.e. traffic not destined to that core router
  - Routers are the highest cost-per-bit network element

\(^1\) Heavy Reading, December 2009, “The Core Packet-Optical Transport Evolution”

Using PONP with integrated ROADM/COE to bypass transit traffic
PONP metro core with DWDM, COE and SyncE capabilities
Mitigates separate use of traditional E1 timing sources
COE provides SLA’s needed by mobile carriers
Facilitates mobile backhaul services
  - Increased bandwidth requirements
  - Reduces CAPEX for new deployments
  - Desire to evolve network to all Ethernet to reduce OPEX
  - Support for lower cost “Flat BTS” architecture that combines all functions of the radio access network into a single IP node
  - Eliminate need for GPS

SyncE
  - Very similar to using SONET or SDH to provide a synchronization reference
  - Advantages: Not affected by network traffic and Very good quality has been observed (< 2ns Wander)
Mobile Backhaul with COE

- Easier turn-up by Transmission engineers, eg, end to end provisioning does not require Layer 3 engineering expertise.
- Simpler management utilizing one management plane vs multiple Control Planes.
- Utilizing industry standards like Y.1731 and 802.1ag, Maintenance domains, with multiple Maintenance End Points can monitor points that you want to monitor. Facilitates Loopbacks, Trace and SDH-RDI functionality similar to traditional SDH networks.
- Guaranteed Latency for both working and protection paths. Defined protection path guarantees latency on both working and protect paths.
- Protection switching times guaranteed <50ms. No need to worry about fast reroute protocols and hits on traffic due to alternate reroute calculations.
- No Flooding of traffic based on switching protocols.
- Ext gen platforms can provide SyncE
Summary

- Carriers will be challenged to get more out of their networks
- Ethernet as a transport will increase while SDH will become less important
- Migration of networks are important to preserve capex and lower opex
- PONP’s offer highly integrated WDM/TDM/Packet capabilities
  - Allows lower cost aggregation solutions based on COE and transport
  - OTN switching
  - Highly scalable WDM/ROADM functionality
- Multiple Opportunities exist to migrate networks using PONP platforms
Thank You!