Evolving Networks – Towards IP over WDM

- Optical Transport Networks
- Overlay and Peer Networks
- The ITU Optical Transport Network (OTN) Standard
  - Automatically Switched Optical Networks (ASON)
  - Generalized Multiprotocol Label Switching (GMPLS)
  - Multiprotocol Label Switching – Transport Profile (MPLS-TP)
- Multi-Service Network Nodes
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• Optical transport networks contain WDM signals, optical cross-connects for both wavelength and fiber switching, and optical add-drop multiplexers
• Optical transport networks provide data transport services for their client networks
Overlay networks have separated control planes
Peer networks have a single, unified control plane.
Optical Transport Network (OTN) Protocol Standard

- An evolved form of SONET
- Supports the establishment of “light paths” end to end connections on a single WDM wavelength
- Strong forward error correction for error-free transmission in noisy, high-speed, WDM environments
- Designed to carry any client signal “transparently” (e.g. Ethernet, ATM, SONET ...)
- Packets carry information to facilitate handoff between administrative domains (networks controlled by different operators)
OTN Network Layers

**Optical Layers**
- OTS = Optical Transmission Section
- OMS = Optical Multiplexing Section
- OCh = Optical Channel

**Electrical Layers**
- OTU = Optical Channel Transport Unit
- ODU = Optical Channel Data Unit
- OPU = Optical Payload Unit

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**IrDI = Inter-Domain Interface**
**IrAI = Intra-Domain Interface**
OTN Optical Layers

- OTN layers manage the interfaces between the sections or channels they are named after.
OTN Optical Layers

- The Optical Multiplexing Section and Optical Transmission Section Layers are not defined in the ITU G.709 recommendation.
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Automatically Switched Optical Network (ASON)

• ASON is being developed in a series of ITU recommendations starting with:

• ASON builds on the Optical Transport Network recommendations (e.g. G.709) by discussing signaling (i.e. control plane functions)

• ASON is an “overlay” model
Automatically Switched Optical Network (ASON)

- The ASON model has three basic units: nodes, links, and subnetworks.
- The simplest subnetwork is a single node.
- Subnetworks can contain subnetworks.
- A subnetwork may be represented as a virtual node.

From *GMPLS: Architecture and Applications*, Adrian Farrel & Igor Bryskin
ASON defines a User-to-Network Interface (UNI), an Internal Network-to-Network Interface (I-NNI) and an External Network-to-Network Interface (E-NNI)

From GMPLS: Architecture and Applications, Adrian Farrel & Igor Bryskin

- ASON defines a User-to-Network Interface (UNI), an Internal Network-to-Network Interface (I-NNI) and an External Network-to-Network Interface (E-NNI)
ASON describes, in general terms, signaling by way of calls and connections that are made across reference points.

From GMPLS: Architecture and Applications, Adrian Farrel & Igor Bryskin
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Multiprotocol Label Switching

- Internet protocol tells us how to route across networks but does provide a way to do explicit routing (i.e. to establish virtual circuits) or how to ensure Quality of Service (QoS) for real time applications.
- Multiprotocol Label Switching (MPLS), developed by IETF (the internet people) provides a way to add these functions, including establishing a “Label Switched Path” (LSP) by insertion of a “shim” header into a data frame.
Generalized Multiprotocol Label Switching (GMPLS) extends the MPLS control functions to include switching of fibers, wavelengths, and TDM slots.

The hierarchy of switching types.

- Generalized Multiprotocol Label Switching (GMPLS) extends the MPLS control functions to include switching of fibers, wavelengths, and TDM slots.
GMPLS provides a potential protocol for implementing the very general control plane architecture of the ASON
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MPLS-TP is a recently established collaborative effort between ITU (the telecommunication and transport network people) and IETF (the internet people) to refine MPLS and GMPLS to be used for transport networks.
MPLS-TP: Key Extensions

• MPLS-TP emphasizes Operations, Administration, and Management (OAM) functions
  – Fault Detection
  – Performance Monitoring (A CIAN emphasis)

• MPLS-TP can be used without Internet Protocol
MPLS-TP: Interesting Point

- MPLS-TP supports “in-band” control signaling
Options for Implementing MPLS-TP

STB = Set Top Box
PON = Passive Optical Network
DSL = Digital Subscriber Line
BNG = Broadband Network Gateway
PE = Provider Edge
ROADM = Reconfigurable Add-Drop Multiplexer
VoD = Video on Demand
TV = Television
SIP = Session Initiated Protocol (phone calls, video conferencing)
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Multiservice Network Nodes

MSPP = Multi Service Provisioning Platform
ONP = Optical Networking Platform

Aggregation Platform:
Packet & TDM Svcs. + Optical transport

CIAN Box = All-optical (no OEO) switching node
with built-in performance monitoring

Customer Premises CIAN Regime Core Transport
• CIAN’s Testbed for Optical Integration (TOAN) includes two Flashwave 9500 packet optical networking platforms.