

A Light Reading Webinar

# The Role of Ethernet in the Rise of Packet-Optical Transport Systems

Wednesday, September 10, 2008

Hosted by

**Sterling Perrin**

Senior Analyst, Heavy Reading

Sponsored by:



# Speakers

## **Daive Marazza**

Product Strategy, Optics  
Alcatel-Lucent

## **Tony Downes**

Principal Technologist,  
Network Protocol Division  
Data Connection

# Alcatel-Lucent: Our Experience



- Most successful optical vendor in the world
- Strong End-to-End Portfolio
- Leading industry standards and research for packet optical and microwave transport networks, 40G/100G deployments

ABILITY TO  
INNOVATE

MORE THAN  
1000  
CUSTOMERS  
IN OVER  
150 COUNTRIES

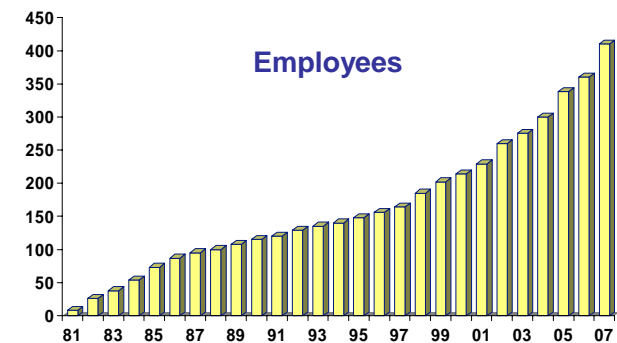
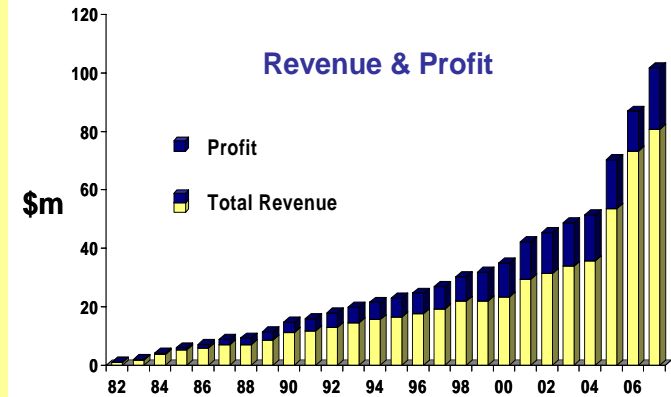
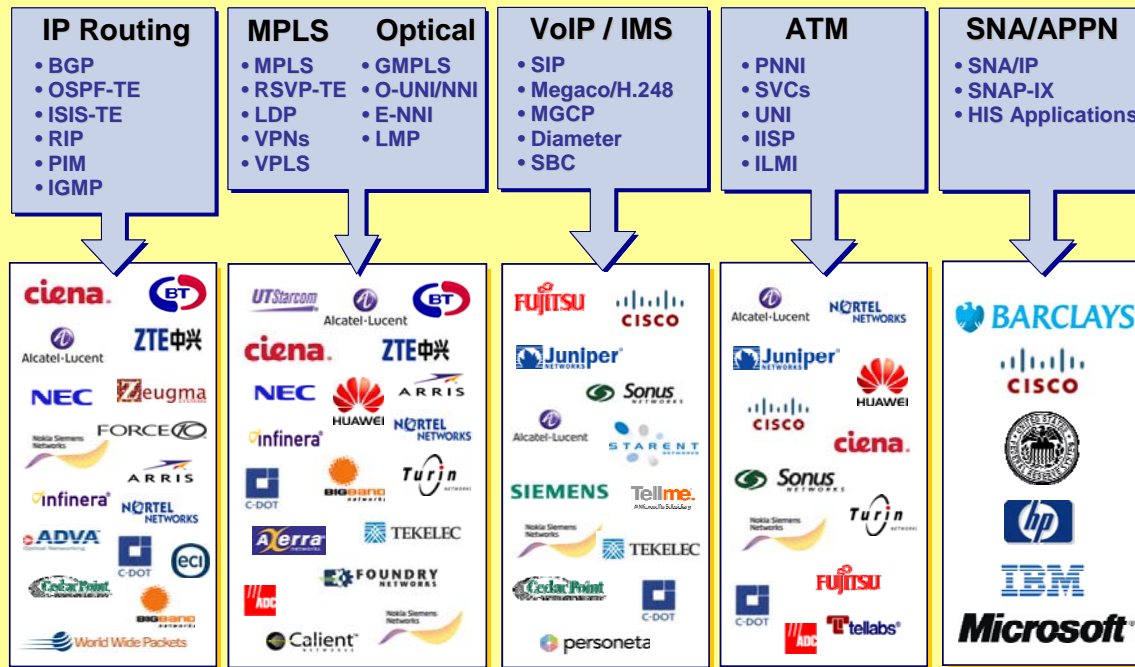
ABILITY TO  
EXECUTE

... For Network Transformation

# Data Connection Ltd. (DCL)

Among other protocols, DCL's Networking Protocols Division develops and licenses portable optical and packet routing and (G)MPLS software toolkits.

## Products & Customers



# Agenda

- Topic Introduction & Market Drivers
- P-OTS Systems Overview
  - Operator Issues/Challenges
  - P-OTS Architecture Solution
- Packet-Optical Transport Enabling Technologies
  - Data Plane
  - Control Plane
- Q&A

# Heavy Reading Survey: Application Drivers For Next-Generation Optical Technology

Q: On a scale of 1 to 10, with 1 being “not important at all” and 10 being “most critical,” please rate the importance of each of the following applications in choosing next-generation optical networking technology. (N=72)

APPLICATION	SCORE*
IPTV and VOD	11.48
Point-to-point Ethernet	11.07
VOIP	10.38
Multipoint Ethernet	10.06
Very-high-speed Internet access	9.66
Managed VPN	9.58
Business continuity/disaster recovery	9.19
Wholesale backhaul of 3G traffic	8.99
Backhaul of broadband wireless (e.g. WiMax) traffic	8.72
Fixed/mobile convergence	8.43

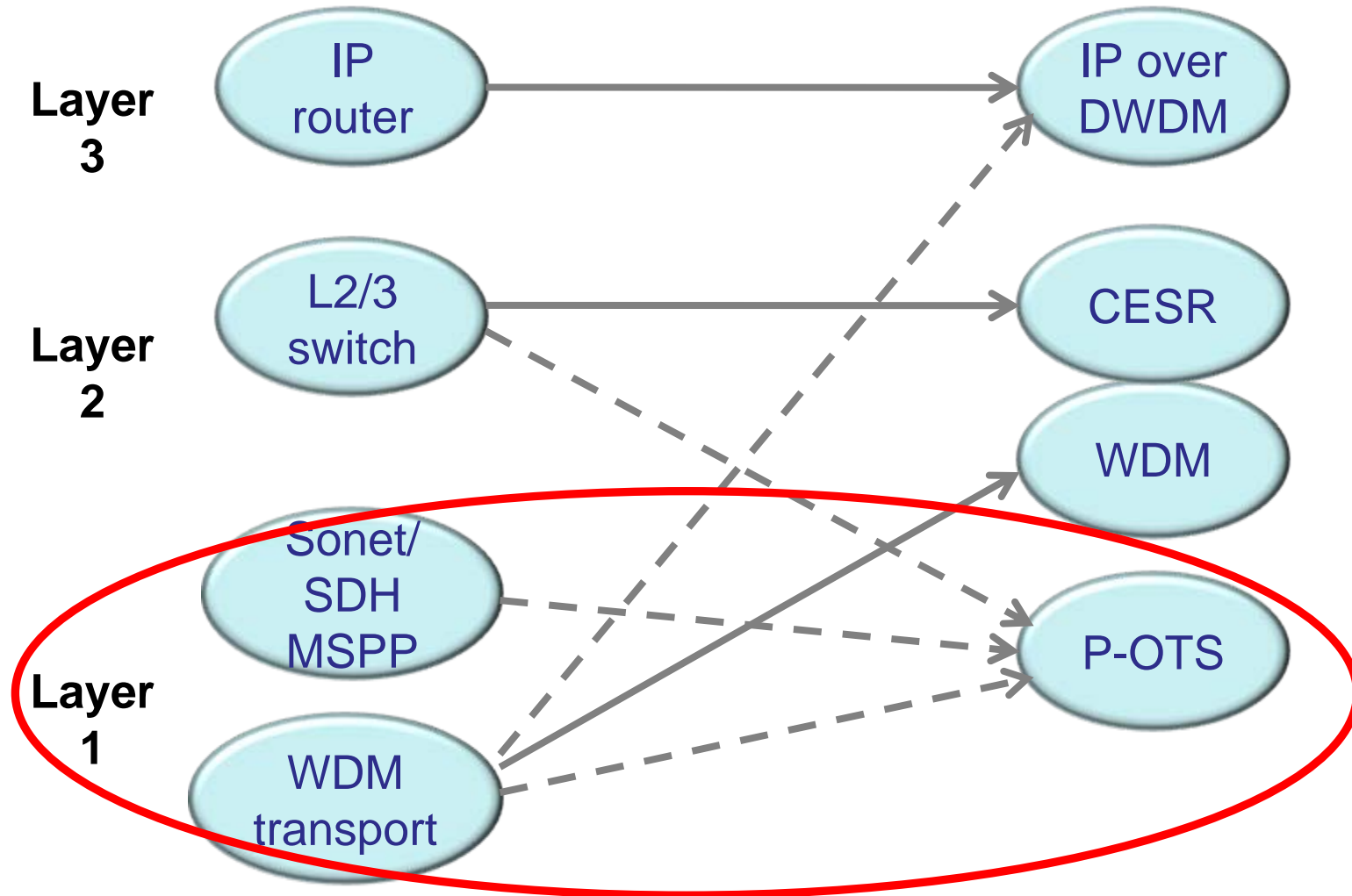
Source: Heavy Reading Multi-Client Study on Packet-Enabled Optical Networking, June 2006

\* Some composite scores exceed 10 because ratings of “10” were given a double weighting.

# A Tale of Three Migrations

Network element "heritage"

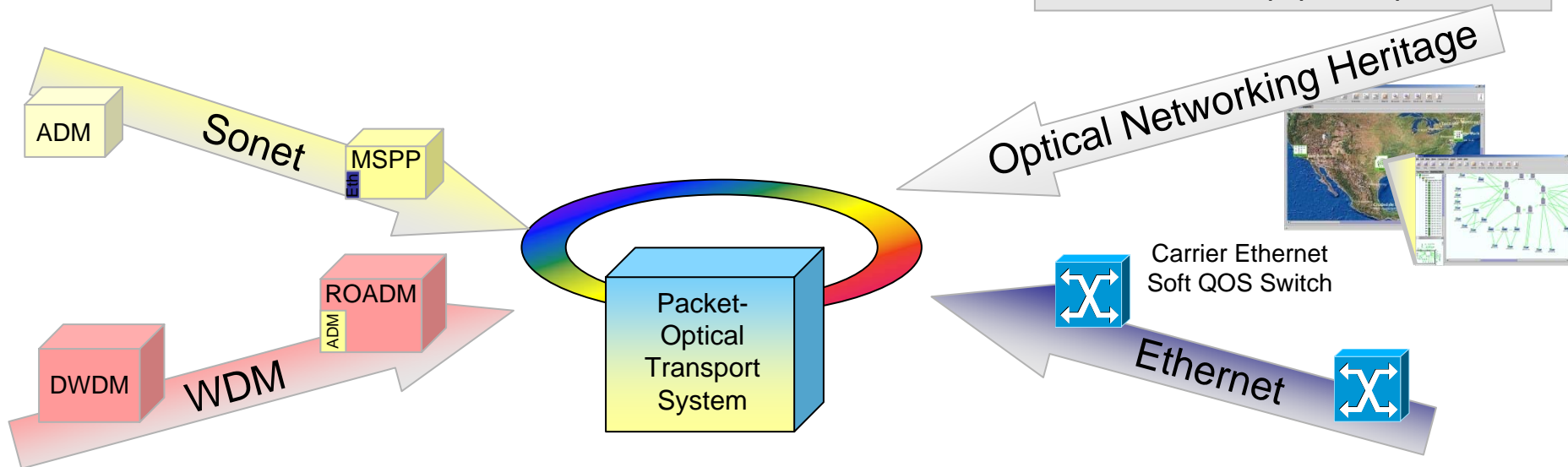
Future mode of operation



# Packet-Optical Transport Systems Evolution

*Morphing the best of many categories into a new modular network element*

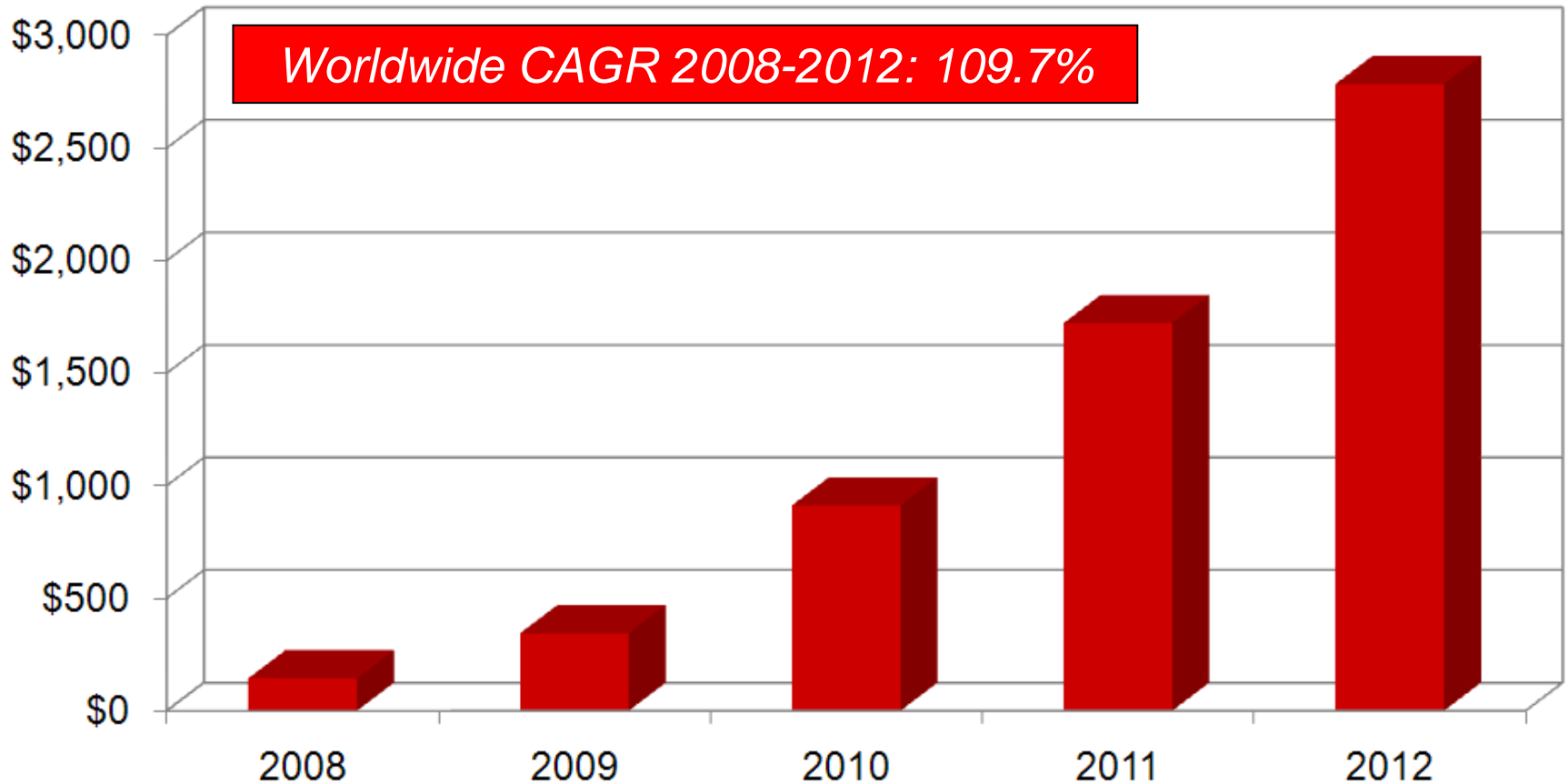
- Deterministic data plane
- Precision fault sectionalization
- In-service software upgrades
- Robust management interface
- Network & equipment protection



Source: Fujitsu and Heavy Reading

# Fastest Growth Opportunity in Optical Transport

## Worldwide P-OTS Revenue, 2008-2012 (\$M)



Source: Heavy Reading, Packet-Enabled Optical Networking Quarterly Market Tracker, June 2008

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# Major Issues for Network Operators



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## Evolution to packet:

- Seamless Migration with Packet-Optical Transport

- Carrier Class Transport for flexible mix of technologies with expected availability and resilience
- Introduce packet when needed to meet network and service demands



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## Utilization of existing investment:

- Investment Preservation with Packet-Optical Transport

- Eliminate the need to reinvest in new transport infrastructure for future services
- Re-use of existing operations mechanisms and skills



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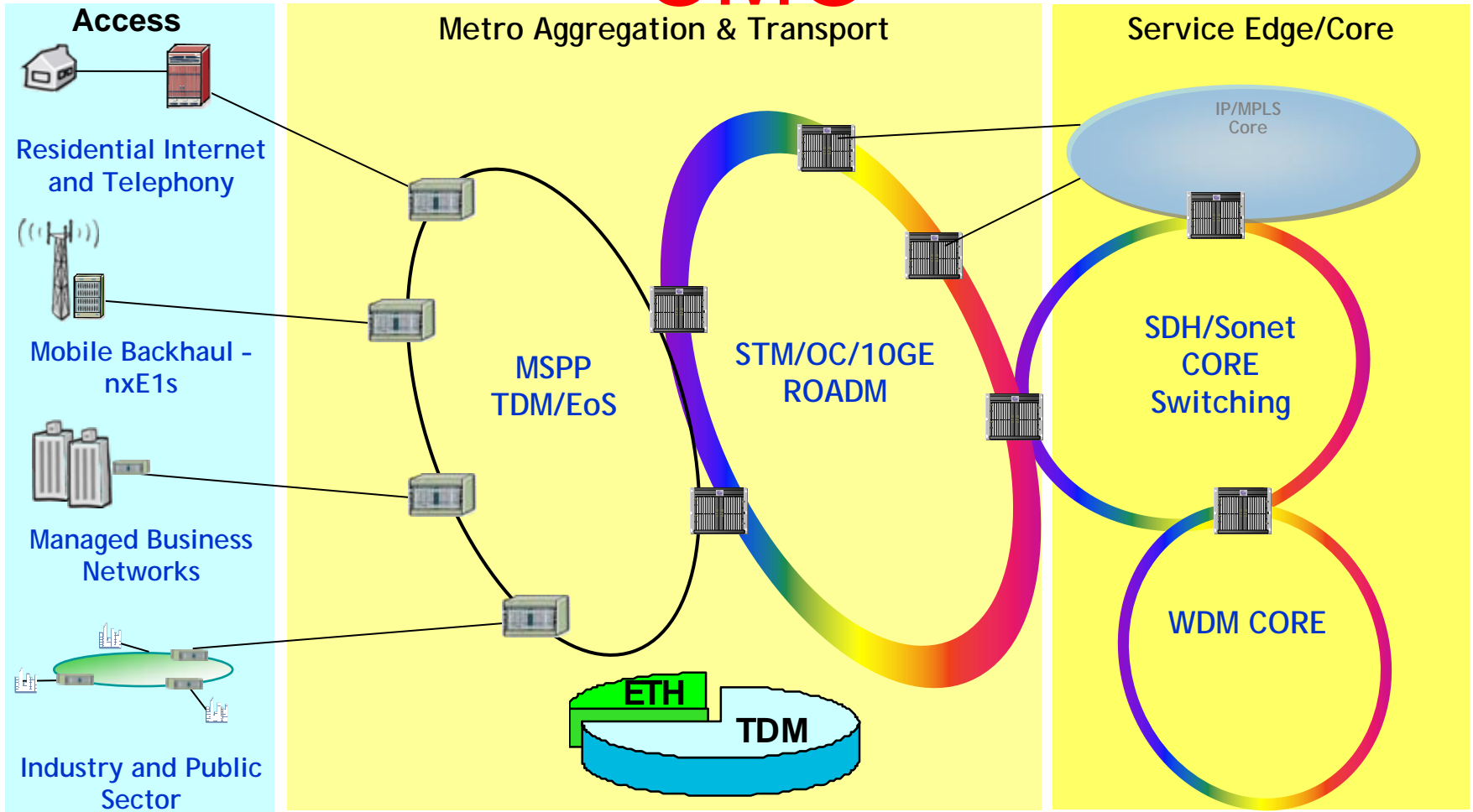
## Increasing Revenue:

- Revenue Generation with Packet-Optical Transport

- Provision new transport services faster
- Provide Quality of Experience required for new service types

# Packet-Optical Transport Evolution

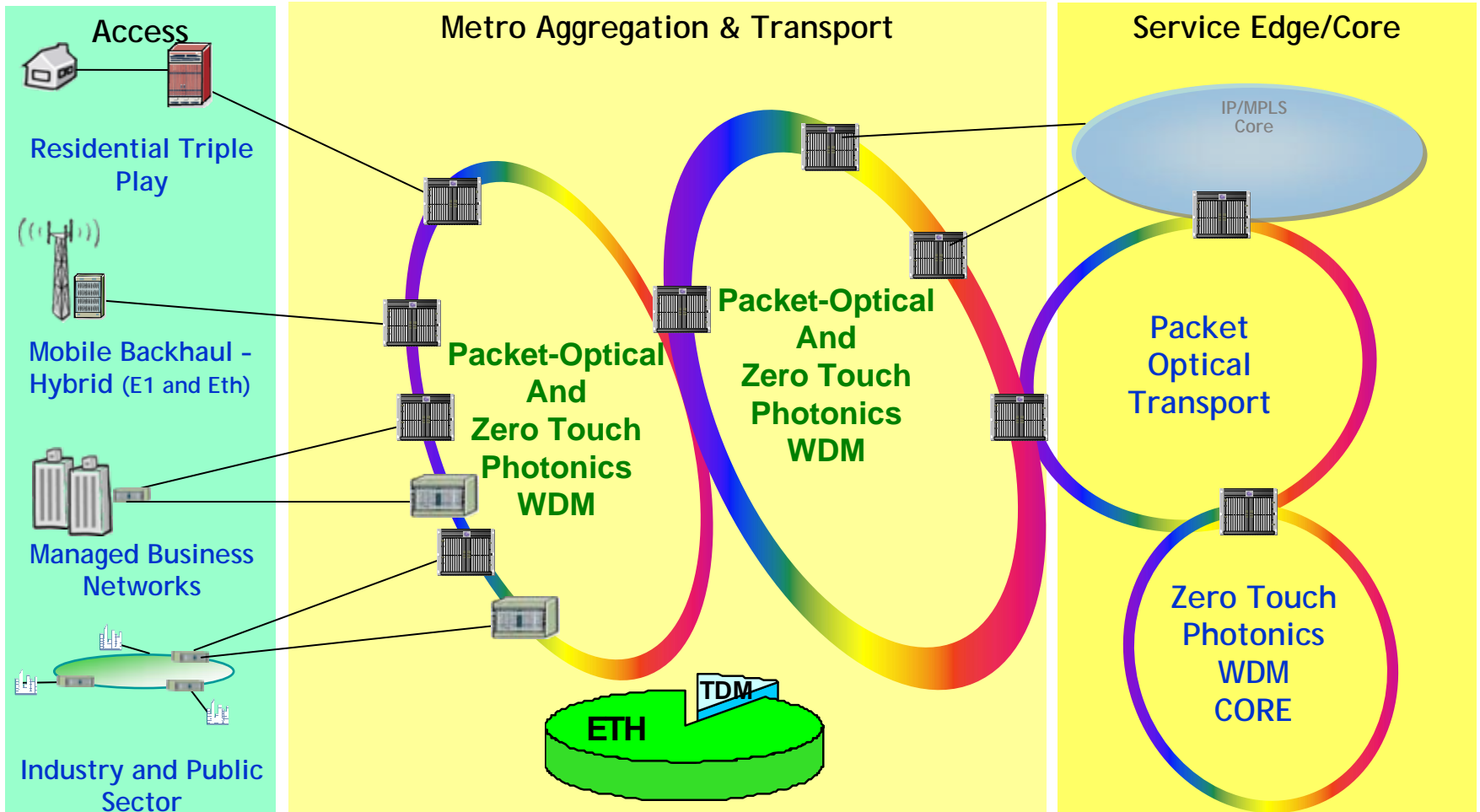
## CMO



← Integrated Optical Transport Management →

# Packet-Optical Transport Evolution

## FMO



# Expanding the Transport Network Architecture With Packets

Management Plane

Control Plane

Data Plane

Survivability (Protection, Restoration)

OAM

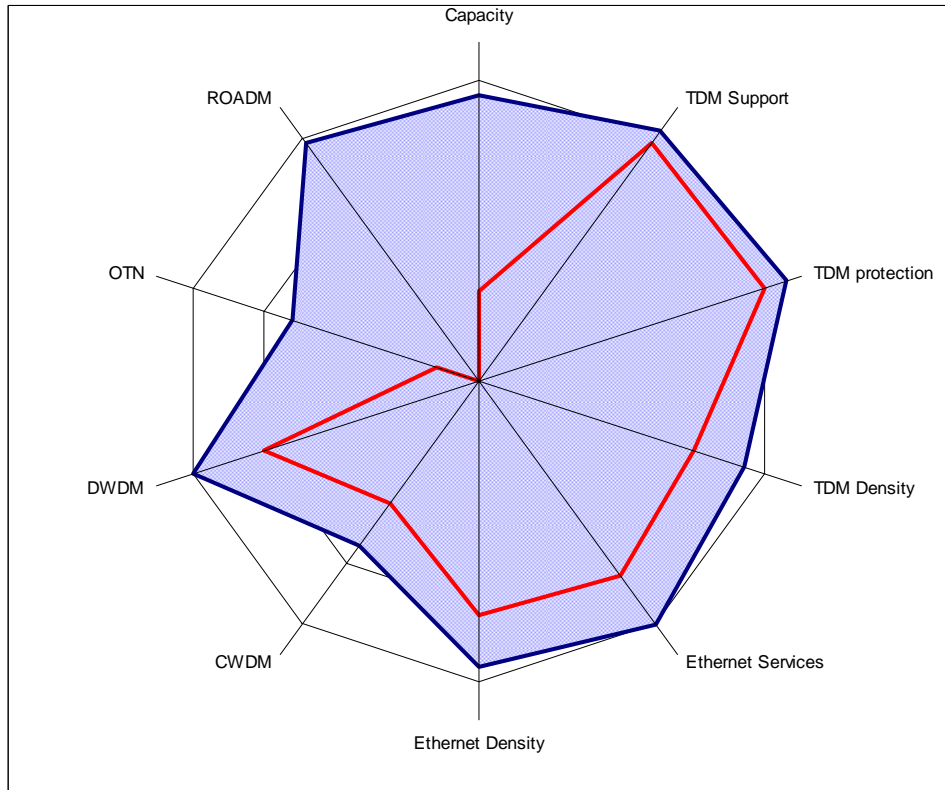
SDH Layers  
Framing, Forwarding,  
Encapsulation

OTN/WDM Layers  
Framing, Forwarding,  
Encapsulation

T-MPLS/MPLS-TP  
Layers  
Framing, Forwarding,  
Encapsulation

Common multilayer operations, survivability, control, and management paradigms for packets, channels, and photonics

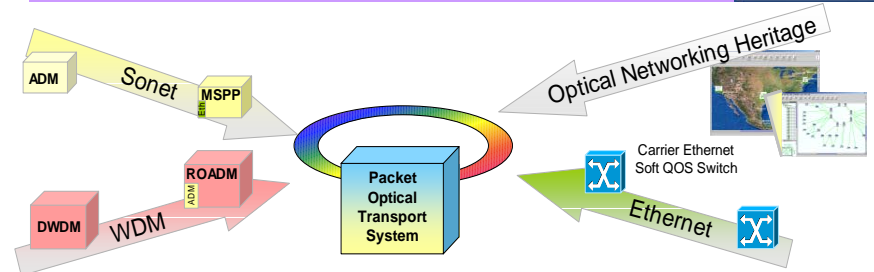
# Packet-Optical Transport System



■ MSPP Systems (\*)   
 ■ Packet-Optical Transport Systems (\*)

(\*) Average of products from various vendors

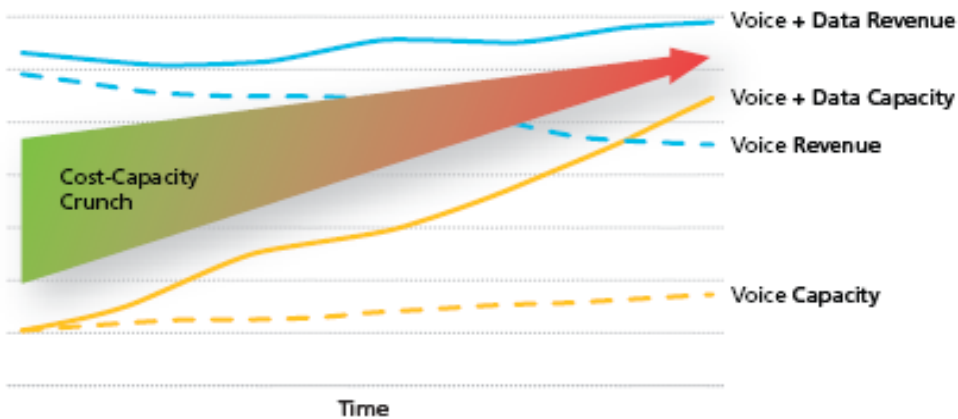
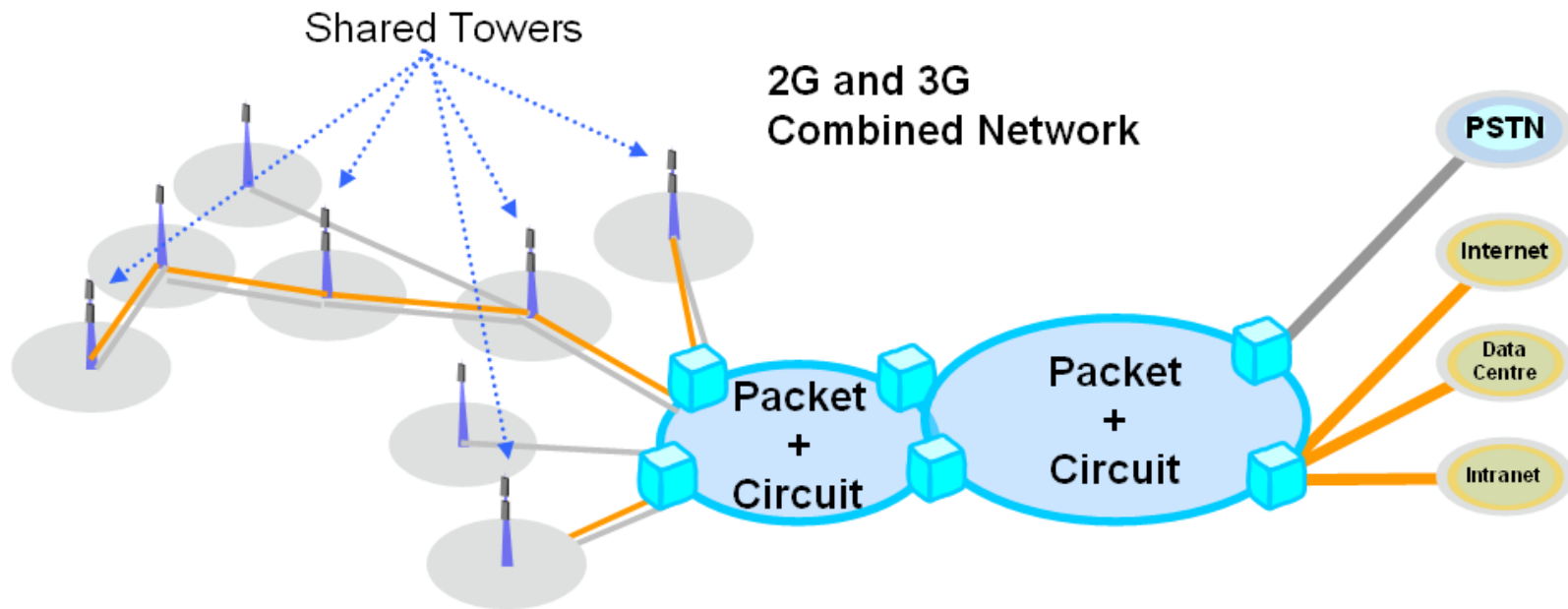
Carrier-class Ethernet services are a key capability of future Optical Transport Products



- Deterministic data plane
- Precision fault sectionalization
- In-service software upgrades
- Robust management interface
- Network & equipment protection

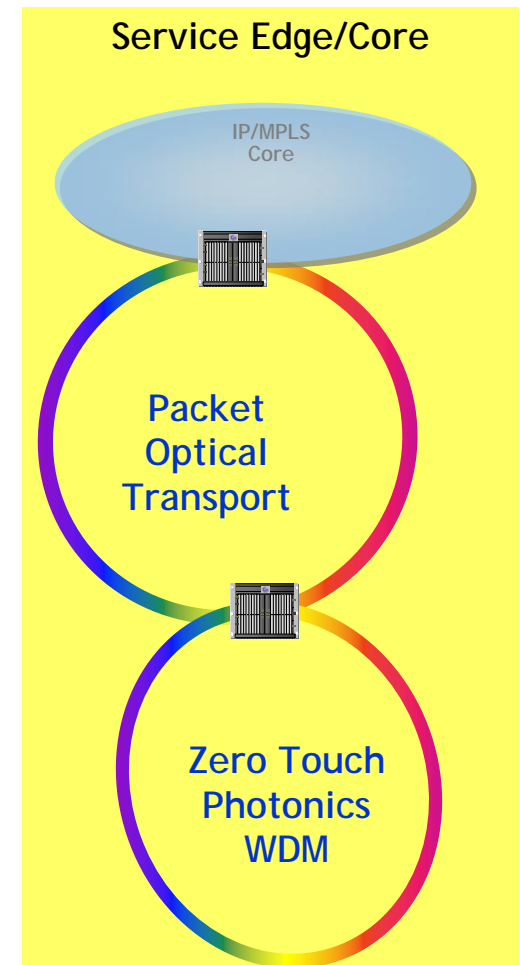
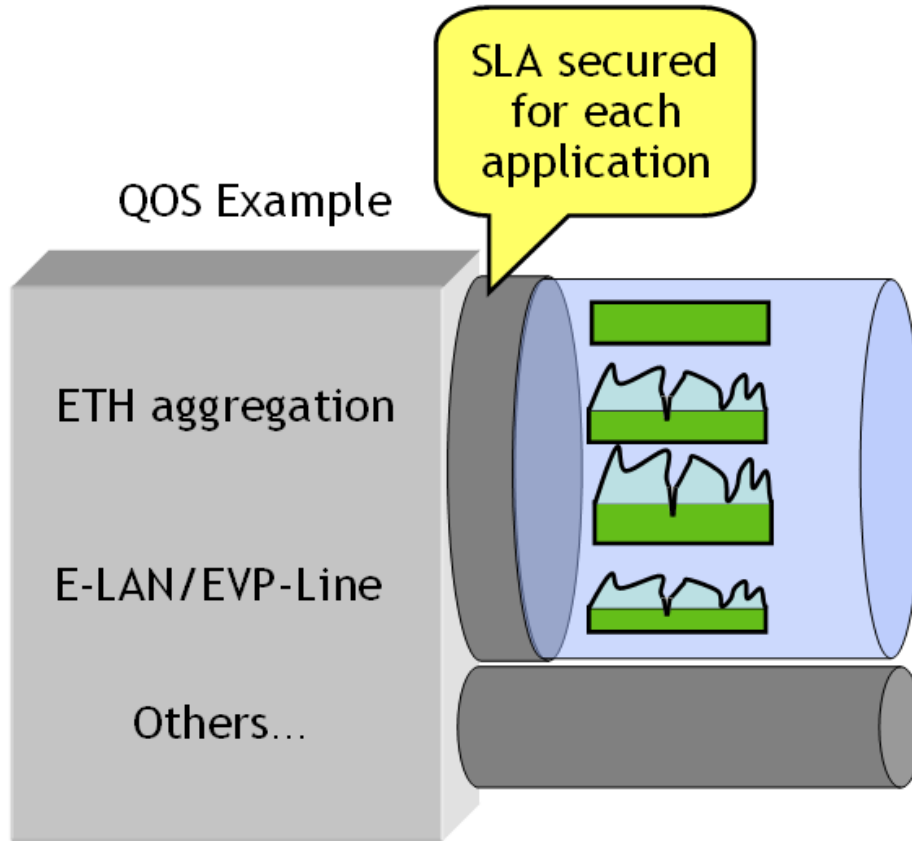
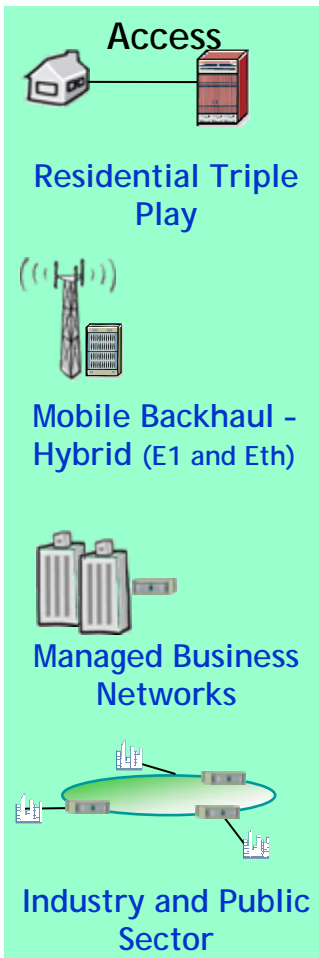
***Morphing the best of many categories into a new modular network element***

# Enabling Next-Generation Services...

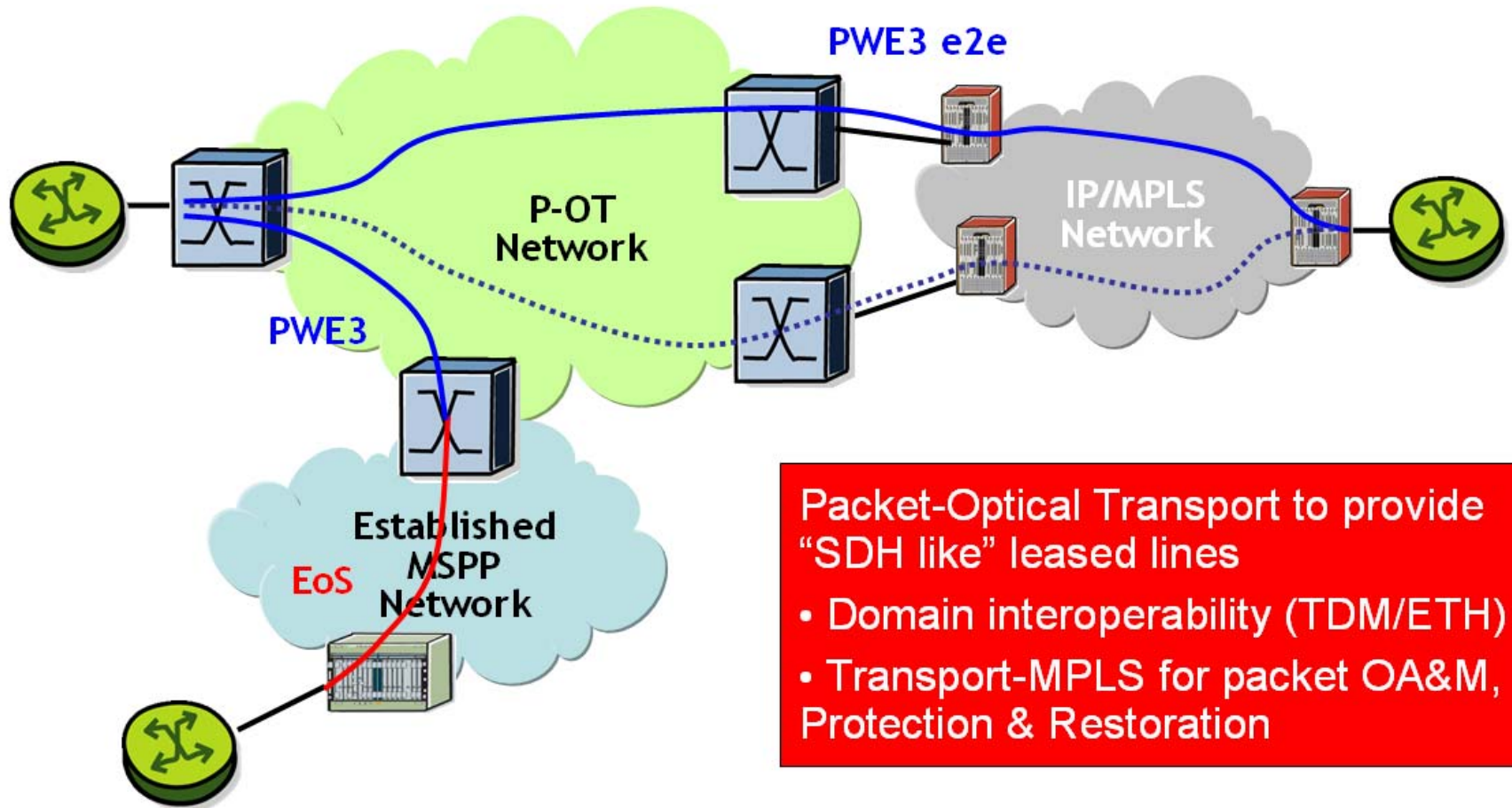


Backhaul solutions must have the flexibility to support diverse traffic types over a combination of transport options, principally SDH/Sonet and Ethernet

# ...With Packet Awareness...



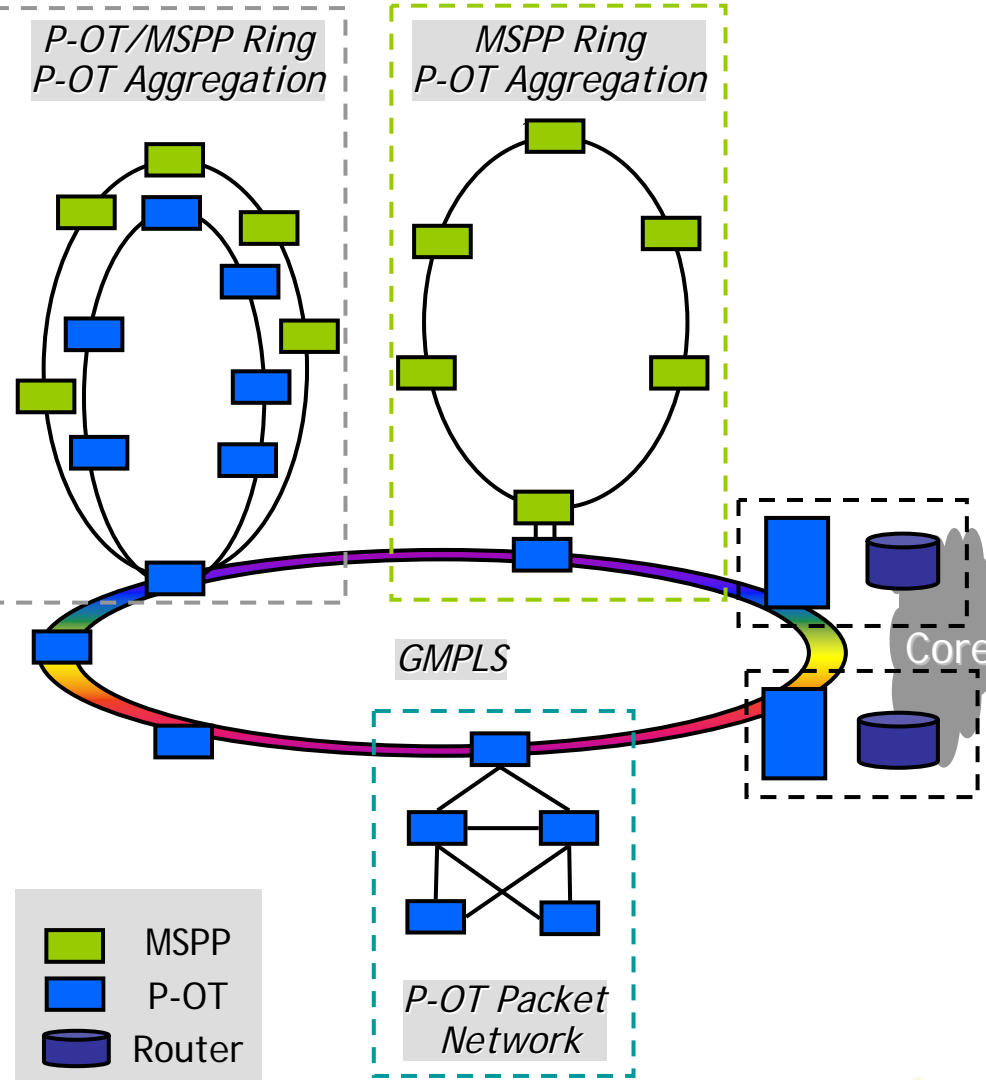
# ...and High Reliability



Packet-Optical Transport to provide "SDH like" leased lines

- Domain interoperability (TDM/ETH)
- Transport-MPLS for packet OA&M, Protection & Restoration

# Real Example



UNI	UNI	NNI	NNI
	SDH	SDH	Backbone
<ul style="list-style-type: none"> <li>MSP 1:1</li> <li>SDH Linear or Ring protection</li> </ul>		<ul style="list-style-type: none"> <li>GMPLS Based Restoration</li> </ul>	
	ETH	SDH	Backbone
<ul style="list-style-type: none"> <li>LAG</li> <li>Packet Linear or Ring protection</li> <li>DNI</li> </ul>		<ul style="list-style-type: none"> <li>GMPLS Based Restoration</li> </ul>	
	ETH	PACKET	Backbone
<ul style="list-style-type: none"> <li>LAG</li> <li>Packet Linear or Ring protection</li> <li>DNI</li> </ul>		<ul style="list-style-type: none"> <li>GMPLS Based Restoration w/ T-MPLS/MPLS-TP</li> </ul>	

Note: For graphical simplicity SDH is shown. Same applies also to Sonet.

# Advantages of Packet-Optical Transport

**CAPEX**

**OPEX**



## **One** platform for all transport needs

- Integrates packets, optical and photonic layers all in one box
- Fully scalable
- Start anywhere, get anywhere with the same platform

## **Native switching** of transport technology

- Technology-dependent traffic processing performed by the relevant linecard (PKT, TDM)
- Pay as you need → no cost penalty due to technology-specific constraints
- Gradual investment overtime

## **Flexible** network planning

- Streamlined resources allocation overtime

## **Unified** cross-layer management

- One service provisioning tool for packets, optical and photonic technologies
- GMPLS ready multi-layer, multi-vendor
- Interwork with existing transport infrastructure

## **Integrated** OAM

- End-to-end fault management, performance monitoring, and protections
- High availability, fast fault localization

## **Optimized** operational resources

- Training, spares, power, footprint

# Audience Poll #1

What are the forecasted plans for deploying Packet-Optical Transport solutions?

- Now, it's already going on
- Next year
- Within the next 1-3 years
- Within the next 3-5 years
- Packet-Optical Transport Systems will be deployed, but the timeline is yet undefined
- Other

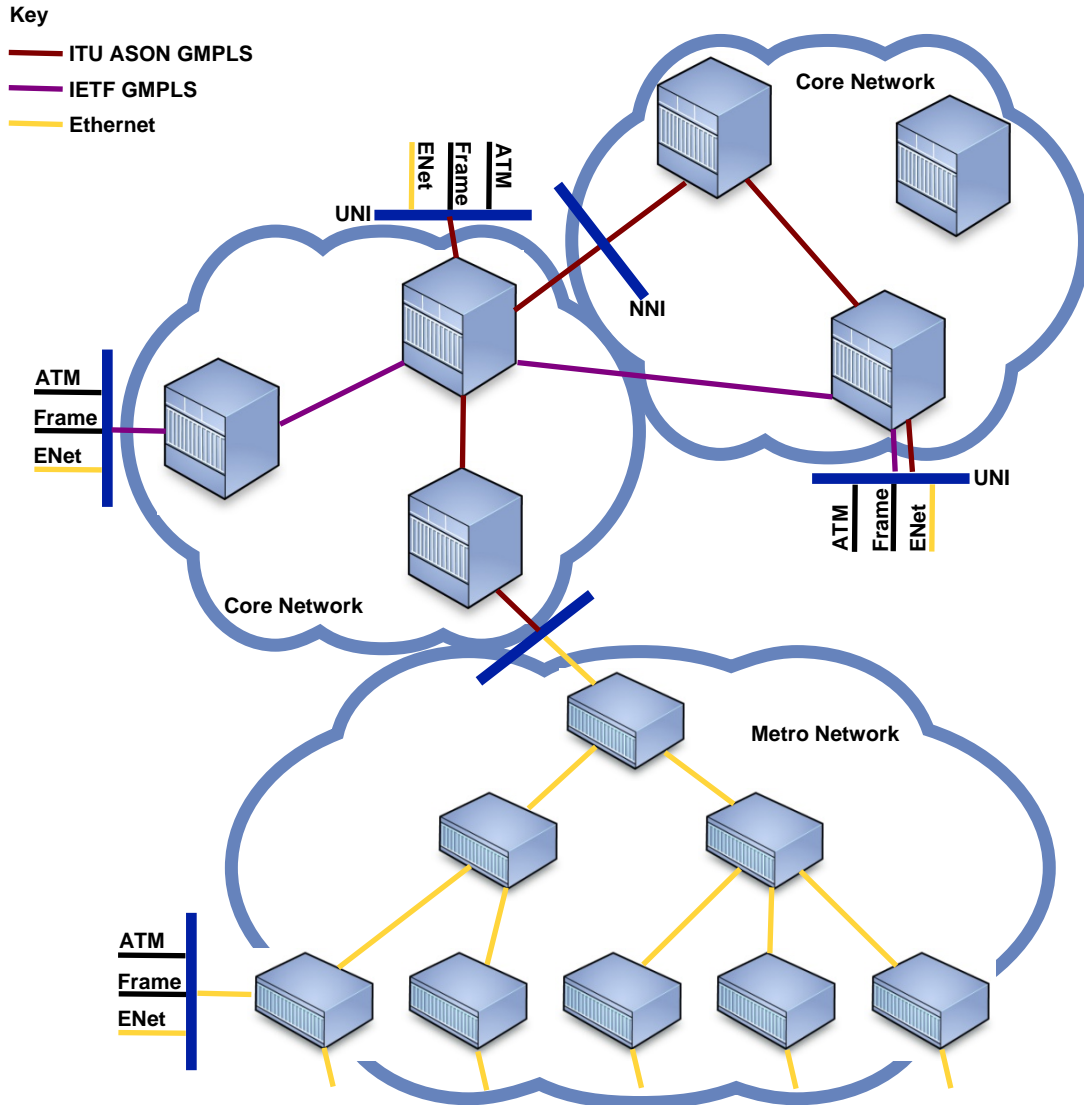
# Agenda

- Topic Introduction & Market Drivers
- P-OTS Systems Overview
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  - P-OTS Architecture Solution
- **Packet-Optical Transport Enabling Technologies**
  - Data Plane
  - Control Plane
- Q&A

# Packet Optical Evolution

- Traditional networks tended to be
  - Ethernet in enterprises
  - Packet only at access and edge
  - Optical only in the core
  - Data Connection customers were packet (MPLS) or optical (GMPLS)
- Ethernet has migrated towards the core – particularly in metro networks
- Trend is now to
  - Mix packet and optical interfaces in same system
  - Run both MPLS and GMPLS in multiple flavors
- This has changed requirements
  - Ethernet scaling?
  - How to carry Ethernet across the core?

# Packet Optical Networks



- Data planes
  - Sonet/SDH, WDM
  - Ethernet, PBB, PBT...
- Control planes
  - ITU ASON GMPLS
  - IETF GMPLS
  - OSPF-TE +/- ISIS-TE
  - OSPF-TE + DDRP
  - LMP link discovery
- Diverse architectures
  - Static vs Dynamic
  - Peer vs Overlay
  - p2p, p2mp, mp2mp

# Data Plane (1)

- Classic 802.1Q Ethernet
  - Issues with scale – 7 hop limit, address learning, 12 bit VID
- PBN 802.1ad a.k.a. QinQ
  - Provides a 801.1Q trunk service via VLANs
  - Popular with operators – easy to understand / manage
  - Popular with vendors – fast hardware / little protocol change
  - But still has issues with scale – drivers for 802.1ah
- PBB 802.1ah aka MACinMAC
  - Adds backbone VLANs – but “tweaks” the MAC headers
  - Requires complex Backbone Edge Bridges (BEBs) – but simplifies backbone
  - New 24 bit I-SID resolves 4094 service limit

# Data Plane (2)

- PBT (Provider Backbone Transport) a.k.a. PBB-TE or 802.1Qay
  - Backbone is PBB Ethernet – so BEBs are complex (see previous)
  - RSTP is turned off and forwarding is programmed by “hand”
    - Some proponents argue that this reduces operating complexity
    - Some proponents argue this increases management complexity
  - p2mp is defined – but not seen as a strength
- PLSB (Provider Link State Bridging)
  - Two flavors: SPB (Shortest Path Bridging) and SPPBB (Shortest Path PBB – more advanced?); PLSB is an update to 802.1Q
  - Like PBT, this solution builds on MSTP to assign a set of VLANs for new treatment, rather than using a traditional spanning tree.

***Key point: PBT & PLSB can coexist***

# Data Plane (3)

- MPLS-TP a.k.a. T-MPLS
  - Not just Ethernet – more broadly applicable
  - Better at inter-domain, protection, p2mp, scalability?
  - Hot topic at ITU and IETF – requirements work, no protocol yet
- GELS (GMPLS control of Ethernet Label Switching)
  - aka PBT GELS aka “Transport Ethernet”
  - Provides a control plane for PBT – GMPLS signaling replaces manual configuration
  - GMPLS can improve e2e protection, FRR, segment recovery, etc.?
  - Running a routing protocol allows dynamic updates to topology, computation of diverse backup paths, and so forth.
  - Early days, though – Much of GELS is not ready!

# Control Plane: GMPLS or MPLS

## Similarities

- Both support packet
  - GMPLS works also!
- Both have QOS
  - More direct with WDM
- Both have resilience
  - FRR only for packet
  - Alternatives for optical
- Common architecture
  - IGP with TE for routing
  - Peer vs overlay
  - Identical fault tolerance
    - Restart described for GMPLS

## Differences

- Labels may be significant
  - i.e., a wavelength
- Several extensions
  - Bi-directional
  - Label allocation restriction
  - Out of band signaling
- GMPLS a superset
  - Natural base for new features
- RSVP only, no LDP
  - QOS and TE essential

# Packet Optical Evolution

- Ethernet is driving massive change
  - Impacts hardware, data plane, and control plane
- Data plane is a shifting / developing landscape
  - Multiple standards / variants of 802.1
  - Lots of noise but little agreement
- Control plane is clearer
  - (G)MPLS is the sole choice
  - But still several developing variants at different levels of maturity
- Lots of activity in standards bodies (IEEE, ITU, IETF...)
- Lots of activity in forums (OIF, MEF...)

# Audience Poll #2

Do you plan to develop and/or deploy packet optical technology?

- No
- Yes, with GMPLS/ MPLS-TP/ T-MPLS
- Yes, with PBT/PBB
- Yes, with a mix of 2 or 3
- Yes, with none of the above

# Questions & Answers