WDM Stuff AKA.

IP/Optical integration & Management

Sami

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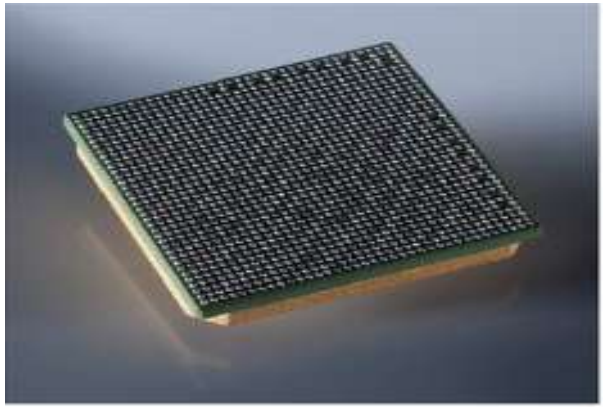
BEYOND 100G
FIRST TO MARKET IN 400Gb/s



		PSE
Year	2010	2012
Speed	100 Gb/s	400 Gb/s
Line rates	40G, 100G	40G, 100G, 200G, 400G
Capacity	8.8T	>23T
Reach	2,000 Km	> 3,000 Km
Power/Gb*	650 mW	425 mW

*Chipset power per Gigabit

MARKET'S FIRST COMMERCIAL 400G SOLUTION

HIGHER DENSITY, BETTER PERFORMING 100G SOLUTIONS

4 X Speed
400G

4X Density
>2.5X NW
Capacity

>1.5X Performance
3000km

AGENDA

1. DRIVERS FOR IP - OPTICAL CONVERGENCE
2. CROSS-LAYER ARCHITECTURE AND CONNECTIVITY OPTIONS
3. END-TO-END SERVICE DELIVERY AND MANAGEMENT
4. FROM CONNECTIVITY TO TRACKING CAPABILITIES
5. CONCLUSION

BANDWIDTH DRIVERS TRANSFORM THE OPTICAL NETWORK

MORE THAN

80%

OF ALL NEW SOFTWARE WILL BE AVAILABLE AS **CLOUD SERVICES** BY 2014*

APPROXIMATELY

58%

OF ALL INTERNET TRAFFIC **WILL BE VIDEO** BY 2015**

MORE THAN

20 BILLION

SMART DEVICES WILL BE **CONNECTED** BY 2020***

*Bell Labs – Value of Cloud for a Virtual Service Provider study, 2011 **Informa Telecoms and Media, 2011 ***Strategy Analytics

MEETING THE CHALLENGE

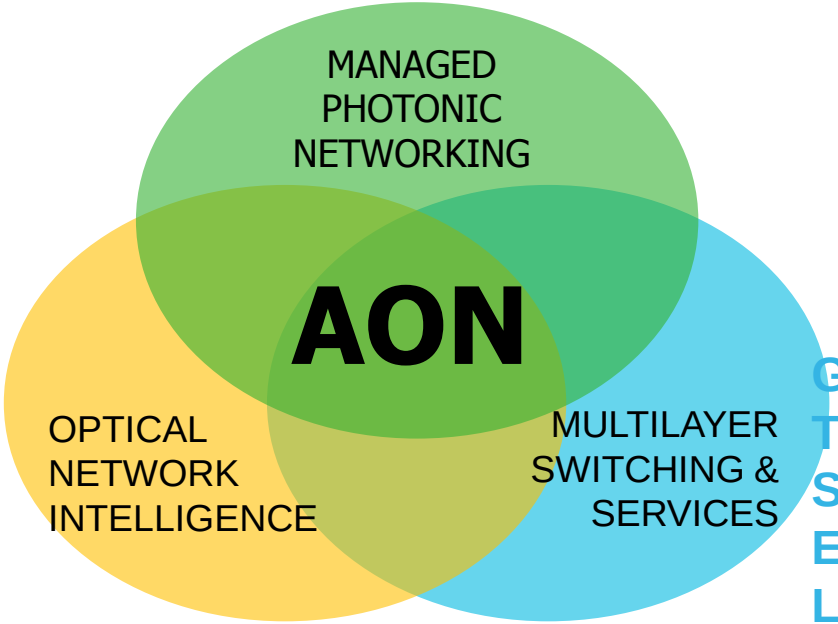
- Address network capacity needs with 100G
- Ensure 100G is deployed optimally and cost effectively
- Add packet to reduce service delivery costs
- Introduce more services at multiple layers to more highly leverage the optical network and accelerate time-to-revenue

ACHIEVE THIS AT LOWEST COST PER TRANSPORTED BIT

AGILE OPTICAL NETWORKING

MOVING TOWARD CLOUD SERVICES DELIVERY

NETWORK PHOTONICALLY AT 100G AND BEYOND



ACCELERATE SERVICE DELIVERY AND AUTOMATE OPERATIONS

GROOM FLEXIBLY TO DELIVER SERVICES AT MOST ECONOMICAL LAYER

IP-OPTICAL INTEGRATION

OBJECTIVES

CROSS-LAYER ARCHITECTURE AND CONNECTIVITY OPTIONS

DESIGN VALUE - MULTIPLE CHOICES FOR OPTIMAL NETWORK UTILIZATION

- Wide range of inter-workable and pre-integrated connectivity solutions
- Multi-layer design tolls/expertise for optimal cost evaluation (lower OpEx and CapEx)
- Maximize GREEN

FROM CONNECTIVITY TO TRACKING CAPABILITIES

PROACTIVE VALUE – HIGH AVAILABILITY

- Identify impact of optical fault on IP services/Customers
- Integration of Wavelength Tracking and IP OAM status
- Zero Touch Photonics management for least cost operations and CAPEX savings

END-TO-END SERVICE DELIVERY AND MANAGEMENT

PROVISIONING VALUE – DYNAMIC SERVICE DELIVERY

- Integrated and automated provisioning of IP Services and Optical paths
- GMPLS and Sharing of Risk Group (SRGL) information to ensure path diversity
- Integrated workflows and templates

CROSS-LAYER ARCHITECTURE AND CONNECTIVITY OPTIONS

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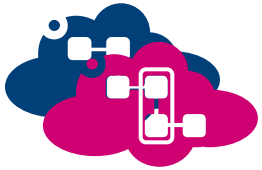
IP OPTICAL CONVERGENCE



PHYSICAL NETWORK EVOLUTION

How will currently separate IP and optical networks evolve into a single converged IP-optical network?

- There are several IP – Optical interworking options with different levels of integration
- The optimal choice depends on network topology, traffic volumes and service mix
- Besides IP – optical interworking considerations this is mostly a business case decision

But what about IP-optical integration at equipment level?

IP-OPTICAL INTERWORKING

DIFFERENT OPTIONS

1

IP and DWDM

- IP OVER FOADM BASED PHOTONIC ARCHITECTURE
- NO OPTICAL CONTROL PLANE

2

IP over DWDM

- IP OVER ROADM-BASED PHOTONIC ARCHITECTURE
- LAMBDA GROOMING
- PHOTONIC CONTROL PLANE

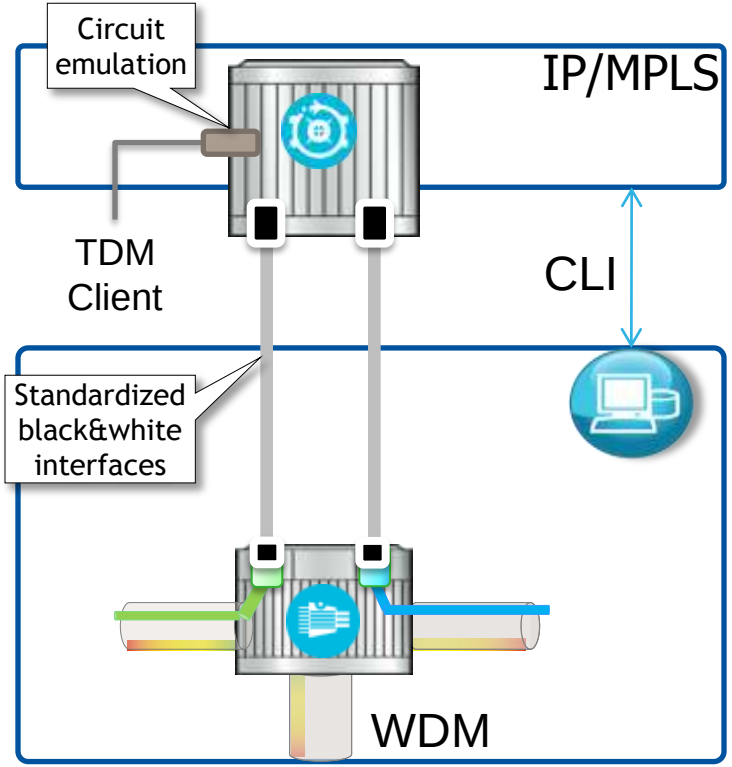
3

IP over OTN

- IP OVER OTN/ROADM BASED SWITCHED/PHOTONIC ARCHITECTURE
- SUBLAMBDA/LAMBDA GROOMING
- MRN DESIGN AND CONTROL PLANE

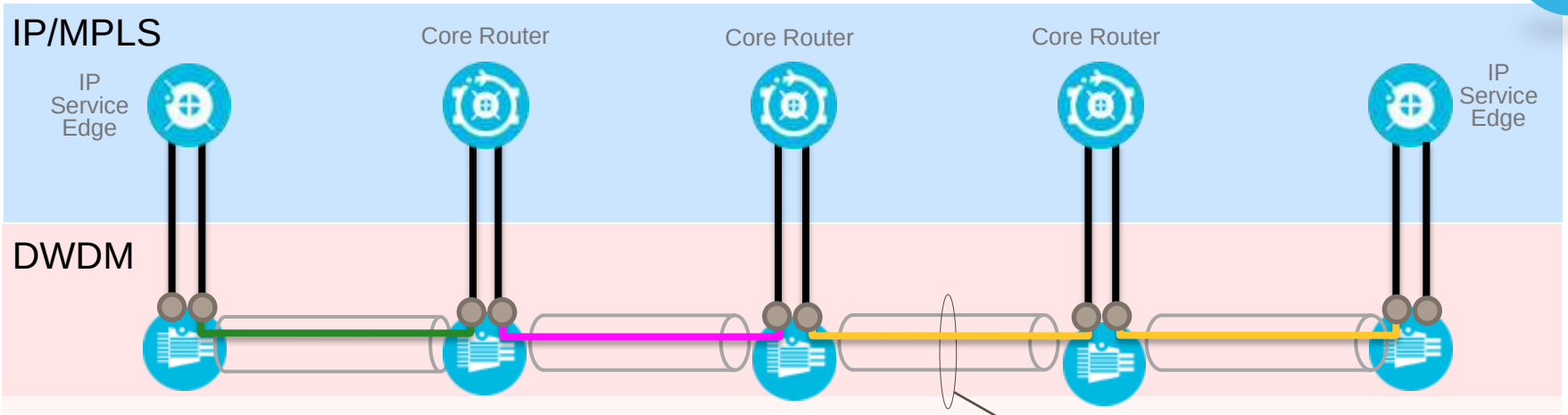
IP AND DWDM

TRANSPONDER INTEGRATED IN DWDM



Feature	Implementation
Grooming capabilities	Packet layer (statistical mulitplexing)
Router interconnect	ETH Black and white interfaces
Multi-layer Resiliency	IP/MPLS resiliency (e.g. FRR, LFA) WDM to WDM G.709 OTN layer
Control plane interconnection	Static (manager provisioned)
Granularity of connectivity	Port bitrate
TDM services	Packetized TDM (circuit emulation)

IP AND DWDM



Core Router interfacing

Requires optical transponders in DWDM
Many Electrical-Optical Conversions

Traffic grooming

Statistical multiplexing in the IP core
Fairly low fill grade (~50-60%)

Core Router Topology

Strongly meshed topology to minimize # of router hops. No bypass

Service protection

IP layer fast reroute
MPLS-mechanisms (e.g., FRR, LFA)

Service enablement

Native IP/MPLS-based services only

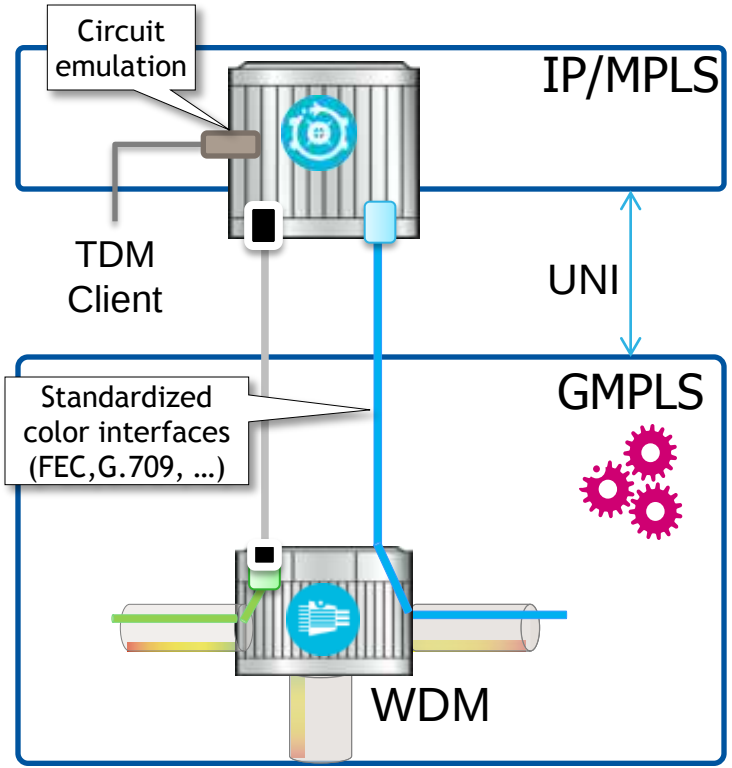
IP AND DWDM
APPLICABILITY

- Advantages
  - Low cost router optics
  - Minimal IP-optical interworking need

- Drawbacks
  - Scaling cost (meshing cost, low fill grade)
  - No "leased line" service support
  - Costly due to many E-O-E conversions
  - No IP visibility on transport performance
  - IP interfaces/links need to be manually mapped on photonic layer resources

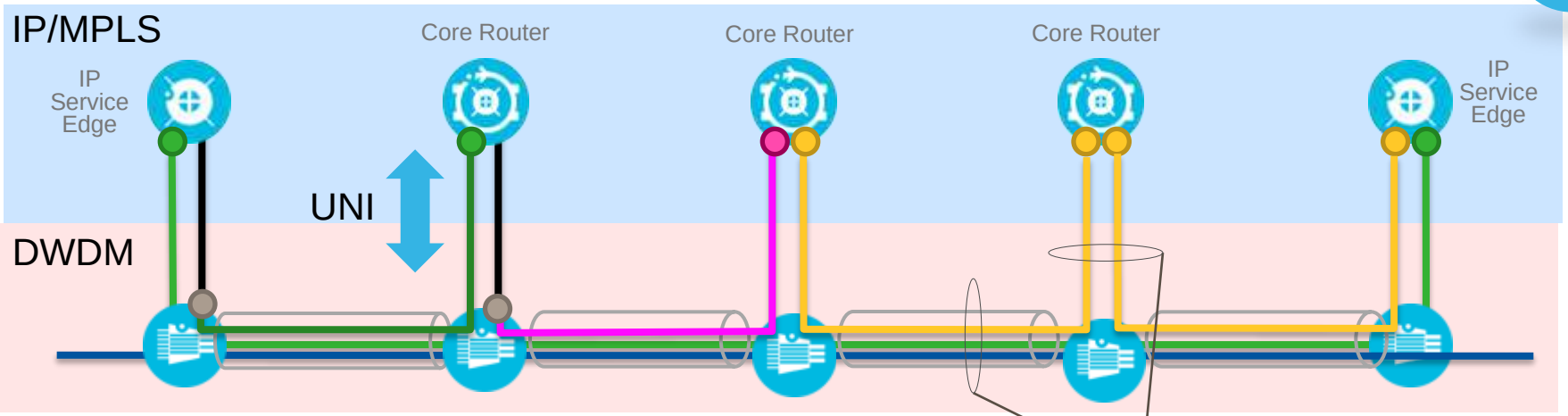
Simple but inflexible and costly to scale
Least amount of IP – optical integration

IP OVER DWDM
TRANSPONDER INTEGRATED IN ROUTER



Feature	Implementation
Grooming capabilities	Packet (statistical multiplexing) Lambda (wavelength switching)
Router interconnect	G.709 Tunable DWDM/G.709
Multi-layer Resiliency	IP/MPLS resiliency (FRR, LFA) Photonic control plane
Control plane interconnection	GMPLS UNI (signaled) Static (manager provisioned)
Granularity of connectivity	Port bitrate (10, 40, 100G)
TDM services	Packetized TDM (emulated TDM services) Lambda leased lines

IP AND DWDM



Core Router Interfacing

Colored interfaces into ROADM
Fewer Electrical Conversions

Traffic grooming

Statistical multiplexing in the IP core
Lambda switching in ROADM

Core Router Topology

Selective bypass as needed using 10, 40 or 100G optical shortcuts

Service protection

IP and MPLS fast reroute mechanisms
Optical layer protection mechanisms

Service enablement

Native IP/MPLS-based services
Lambda leased lines

IP OVER DWDM

APPLICABILITY

Advantages

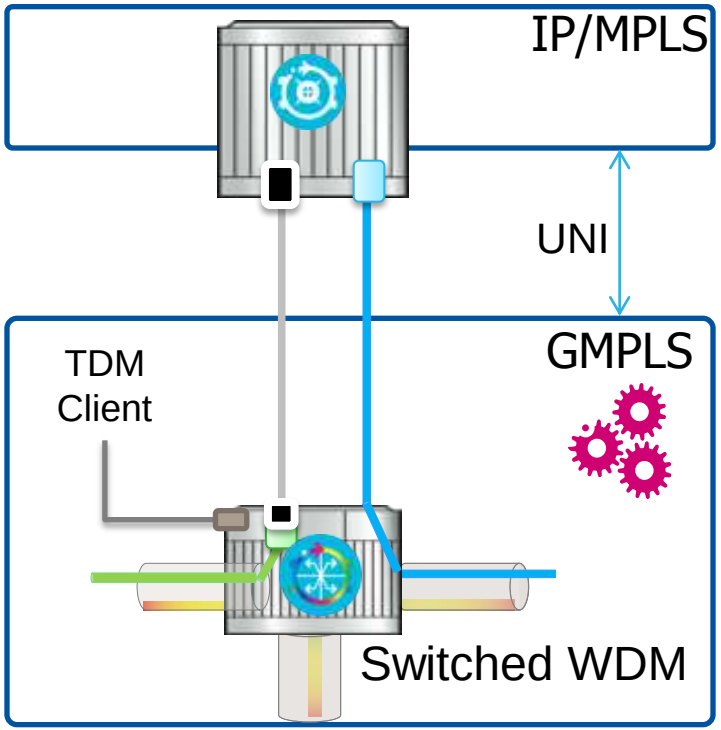
- Reduce need for EOE conversions
- IP layer has direct visibility on optical transport layer performance
- UNI allows IP layer to dynamically request lambdas in photonic layer
- Lambda leased line services

Drawbacks

- Colored router optics are more costly
- Must resolve IP-optical interworking challenges at data and control plane
- No native TDM (sublambda) service support
- Ties the capacity of the DWDM layer to the router speed port.

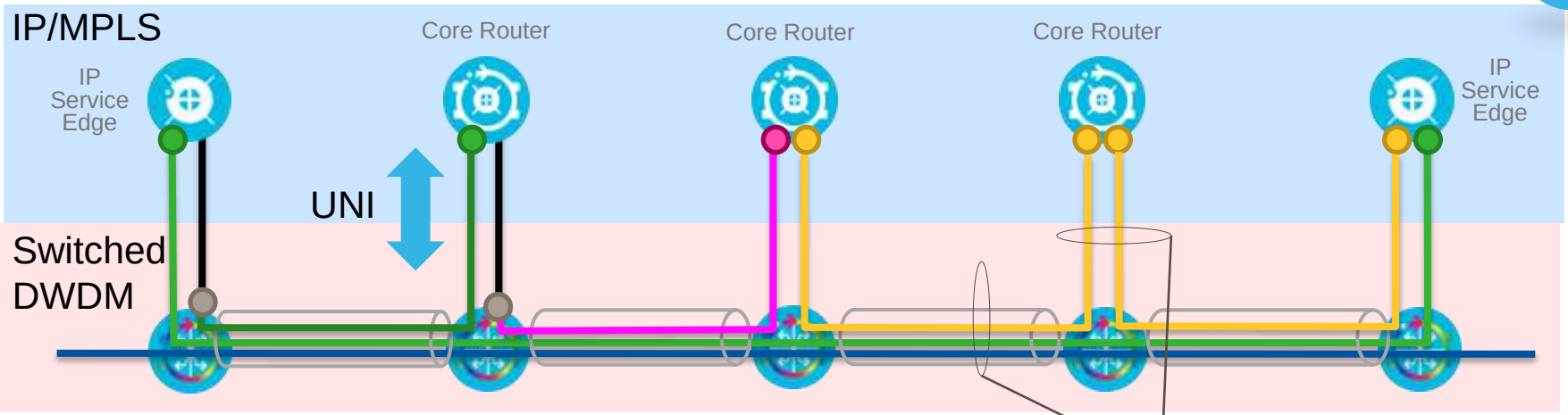
Better scale & flexibility but more exposed to IP – optical interworking issues

IP OVER OTN (OVER DWDM)
GRANULAR GROOMING AND TRUE TDM



Feature	Implementation
Grooming capabilities	Packet (statistical multiplexing) Lambda (wavelength switching) ODU grooming and switching
Router interconnect	ETH/VLAN Port based Lambda
Multi-layer Resiliency	ETH-OAM IWK IP/MPLS resiliency (FRR, LFA) ODU/Photonic control plane
Control plane interconnection	•GMPLS UNI (colored interfaces) •Static (black & white interfaces)
Granularity of connectivity	•Port bitrate •OTN flexible Electrical Grooming for efficient lambda filling
TDM client	Sublambda leased line Lambda leased line

IP AND DWDM



Core Router Interfaces

Colored interfaces or black & white
Fewer Electrical Conversions

Traffic grooming

Statistical multiplexing in IP layer and grooming at photonic/electrical layer

Flexible grooming

Core Router Topology

Selective bypass as needed through electrical or photonic layer

Service protection

IP and MPLS fast reroute mechanisms
Electrical/Photonic restoration

Service enablement

IP/MPLS-based services
Granular 1 – 100G Leased Line svc

IP OVER OTN
APPLICABILITY

Advantages

- IP layer has indirect visibility on digital transport layer issues
- UNI allows IP layer to dynamically request lambdas/circuits from Switched WDM
- Flexible, granular and highly efficient traffic grooming with selective IP shortcut options
- Sublambda/Lambda leased lines services

Drawbacks

- IP layer has direct visibility on optical transport layer issues
- Colored router optics are more costly
- EOE conversion to access sublambda layer
- Must resolve IP-optical interworking challenges at data and control plane

Best scale, flexibility and service versatility.
Most exposed to IP – optical integration issues.

FROM CONNECTIVITY TO TRACKING CAPABILITIES

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MANAGED PHOTONIC NETWORKING

PHOTONIC OAM

WAVELENGTHTRACKER™ TECHNOLOGY

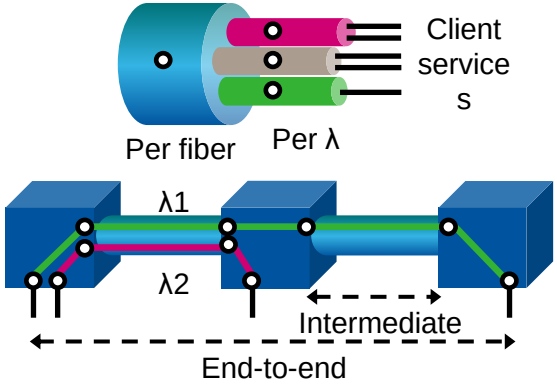
- Wavelength keyed to unique ID for every service in the network
- Individual service path tracing and view (including alien services)
- Collision and misconnection detection

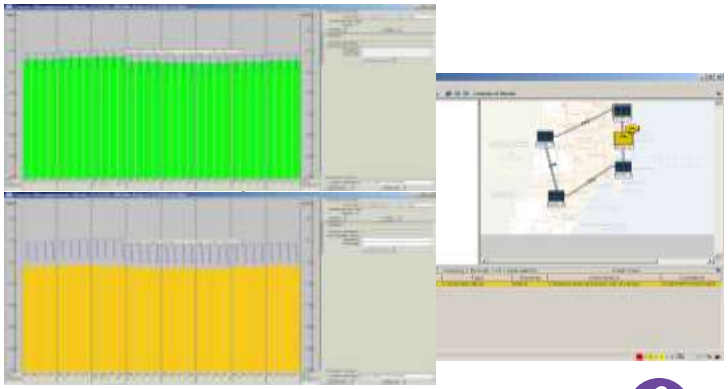
PER-SERVICE REMOTE OPTICAL POWER MEASUREMENT

- Accurate, continuous, ubiquitous monitoring everywhere in the network and within each node
- Threshold alarming
- Sophisticated fault isolation, no need for additional equipment

UNIQUE EMBEDDED OSNR MONITORING

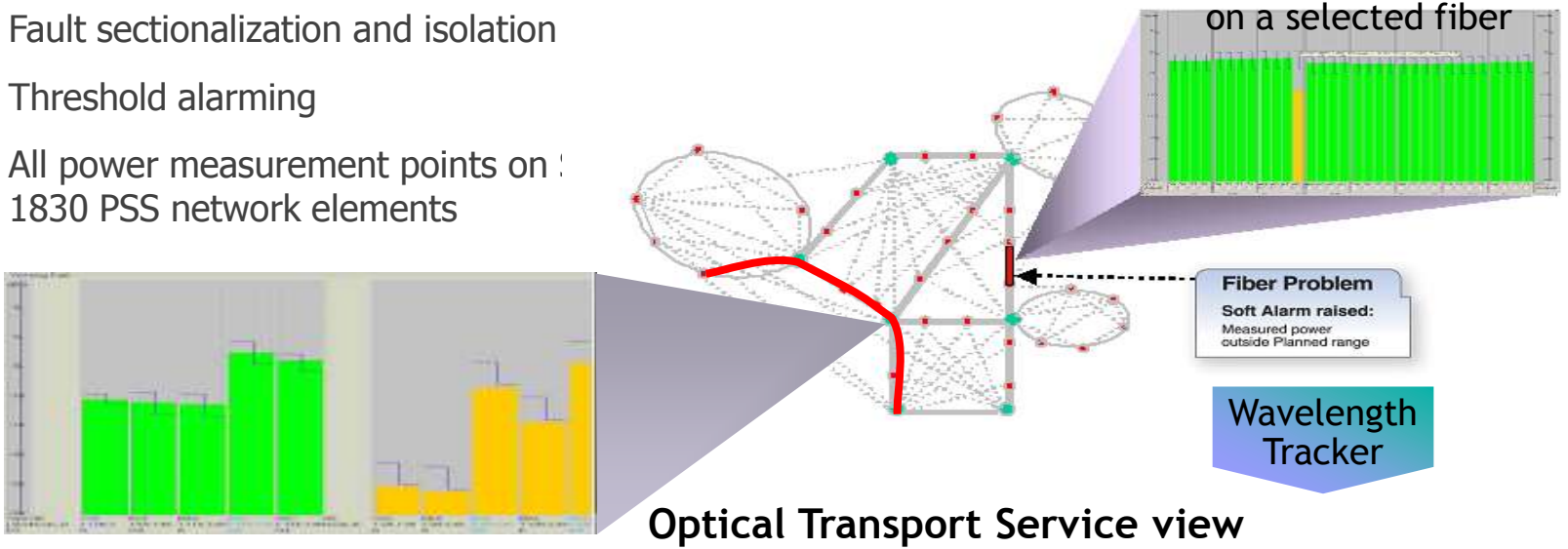
- Automatic control of power levels and channel OSNR
- Key for real-time link engineering and characterization
- Layer 0 latency monitoring





Photonic OAM
WaveTracker management – path and fiber view

- WaveTracker management provides visibility into the analog power levels of the photonic signals that make up the optical transport services
  - Optical Transport Service trace
  - Fault sectionalization and isolation
  - Threshold alarming
  - All power measurement points on 1830 PSS network elements



END-TO-END SERVICE DELIVERY AND MANAGEMENT

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Service activation time

~6 weeks

~2 weeks

1~2 weeks

1~3 weeks

1. 

Sales people generates the ticket

2. **Planning team**

Check if there is available network, fiber, wavelength. Feasibility calculation.

Network planning tool. Simple de-layered network

3. **Provisioning team**

Define the process of provisioning, required test, site access, maintenance window

Control plane introduction ASON/GMPLS from OTN

4. **Field team**

Go to the sites do installation commissioning testing…Finalize the service setup

OTN connections. Wavelength Tracker

0 weeks

0~2 day

0-3 day

0~7 days

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CONTROL PLANE INTEGRATION

REQUIREMENTS AND OBJECTIVES

Customers Requirements

Automation

control across IP and Optical network layers

Optimize

resource utilization between IP and Optical Network

High Availability

Enhanced resiliency/increase availability

Customer Benefits

Dynamic Connections

- Reduce the operational complexity between IP/Optical network layers
- Non-disruptive bandwidth modification and restoration

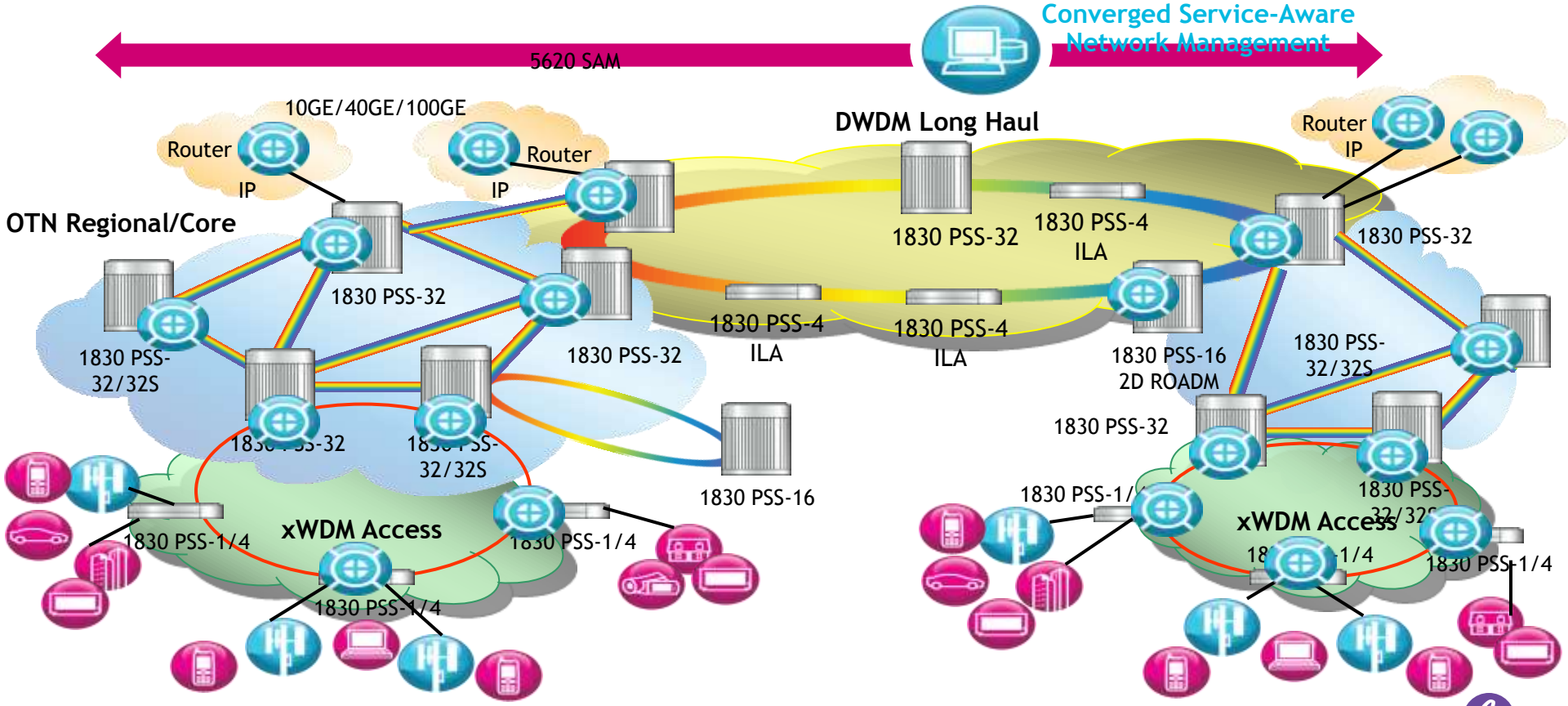
Optimized TCO

- Improve cost-effectiveness without reducing Service Level Agreements (SLA)

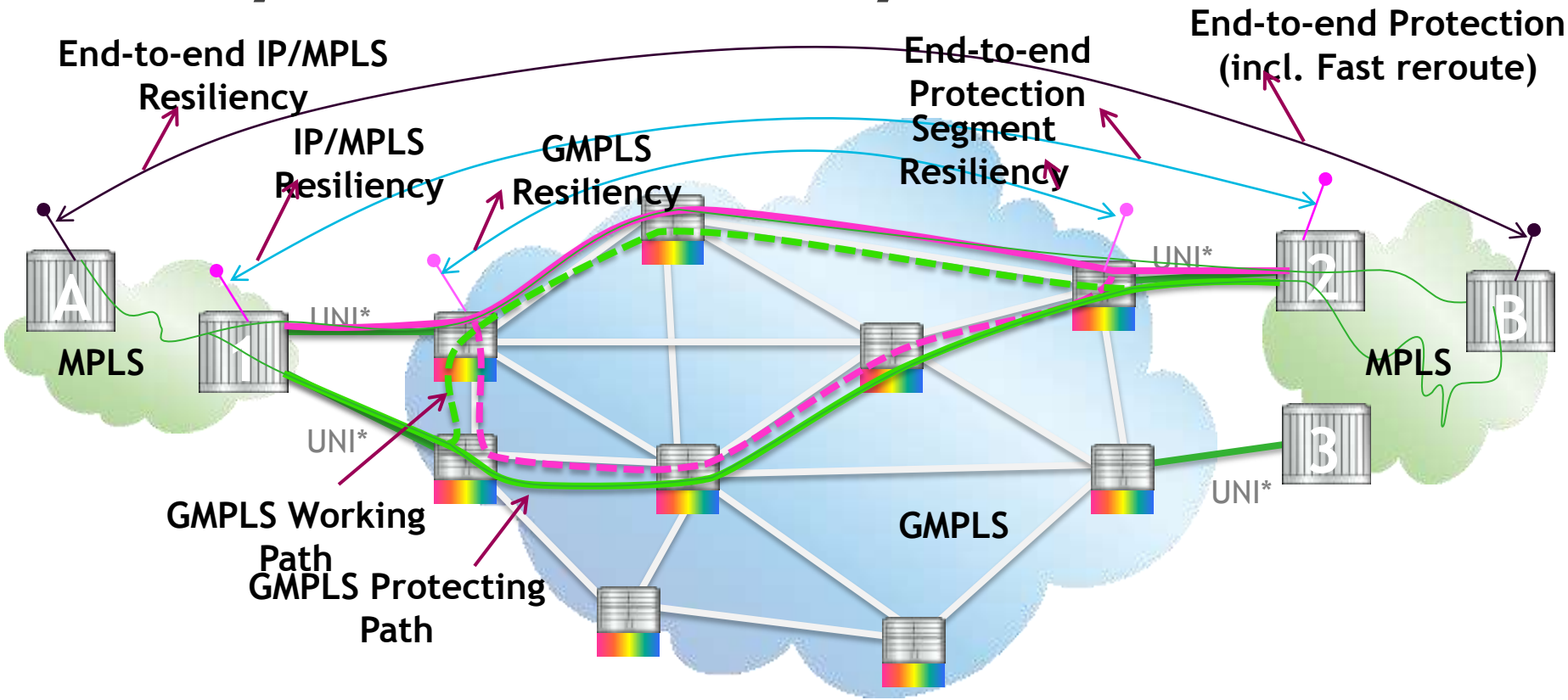
Increased service velocity

Providing full flexibility for service delivery without reduced functionality

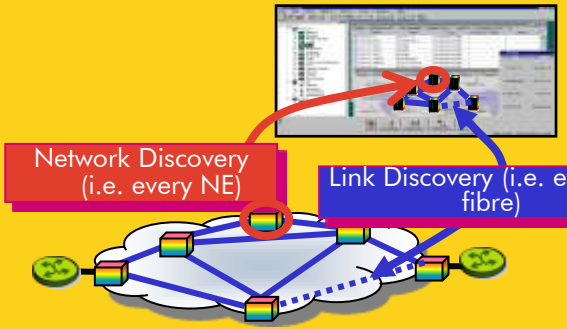
5620 SAM-1830 PSS – Applications coverage
Access, Metro/Regional, Core, Long Haul, TOADM, ROADM, FOADM



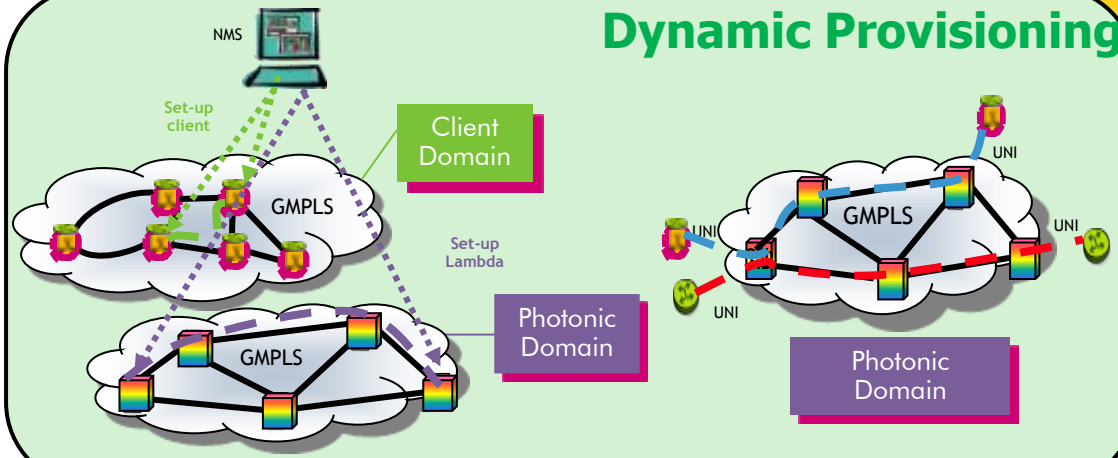
Multi layer network resiliency



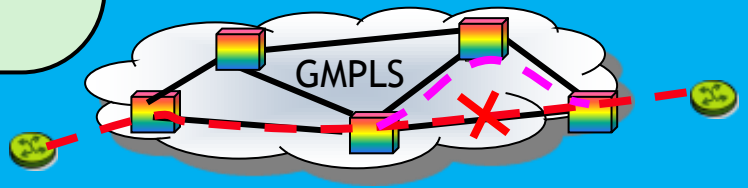
Network and Resource Discovery



Dynamic Provisioning



Distributed Automatic Restoration



ALCATEL-LUCENT 5620 SERVICE AWARE MANAGER

PROVISIONING	ASSURANCE	TROUBLESHOOTING

SERVICE MANAGEMENT

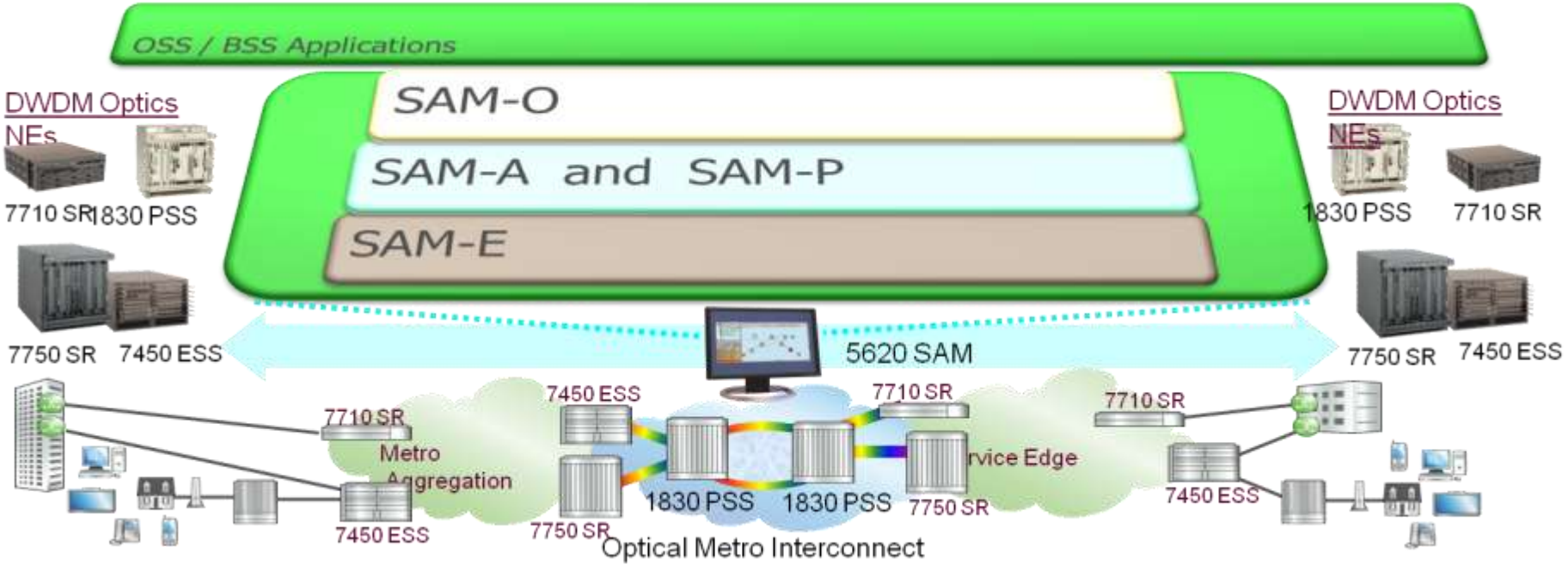
NETWORK MANAGEMENT

ELEMENT MANAGEMENT

- Service-oriented management
  - Service provisioning
  - Service alarms and state cause
  - Service topology map
  - Service assurance
- Network-oriented management
  - Physical topology maps
  - Network topology maps (tunnels, LSPs)
  - Network commissioning (tunnels, LSPs)
- Nodal-oriented management
  - Equipment inventory and configuration

INTEGRATED ELEMENT + NETWORK + SERVICE MANAGEMENT FOR ALCATEL-LUCENT HIGH LEVERAGE NETWORK

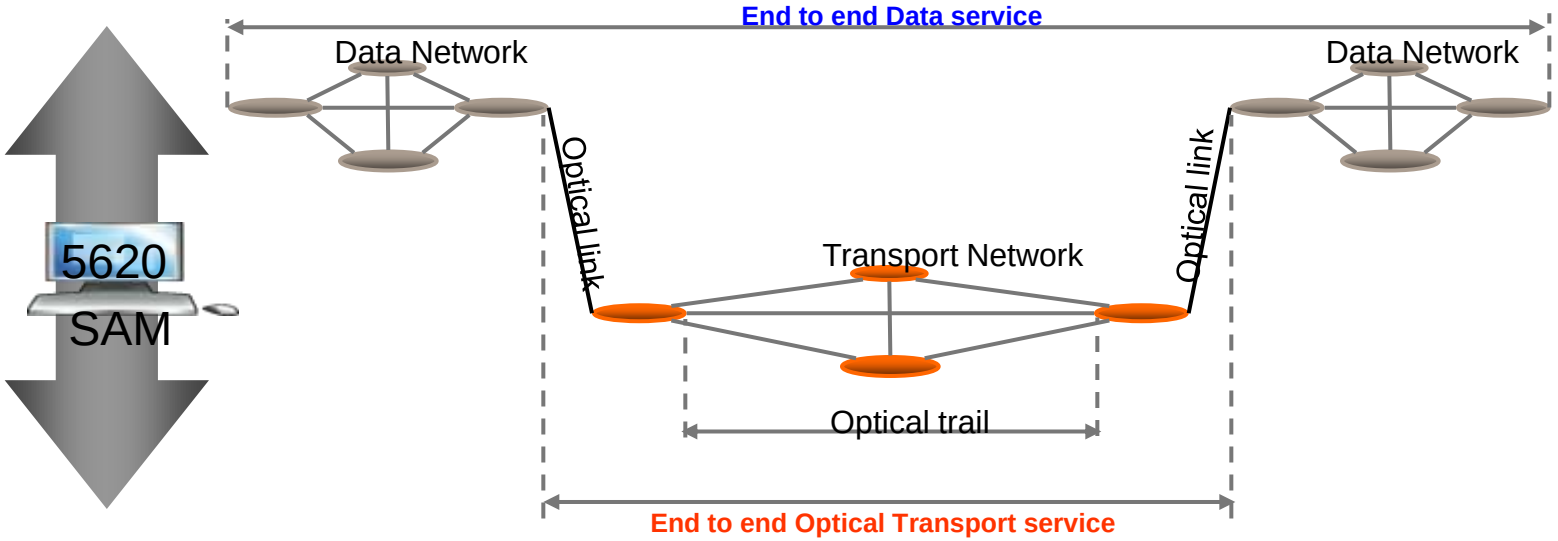
Extending the 5620 SAM's reach with management for DWDM Optics



5620 SAM IP/Optical management
Cross-domain management applications

TWO Domains + ONE model + ALL relationships = X-domain applications

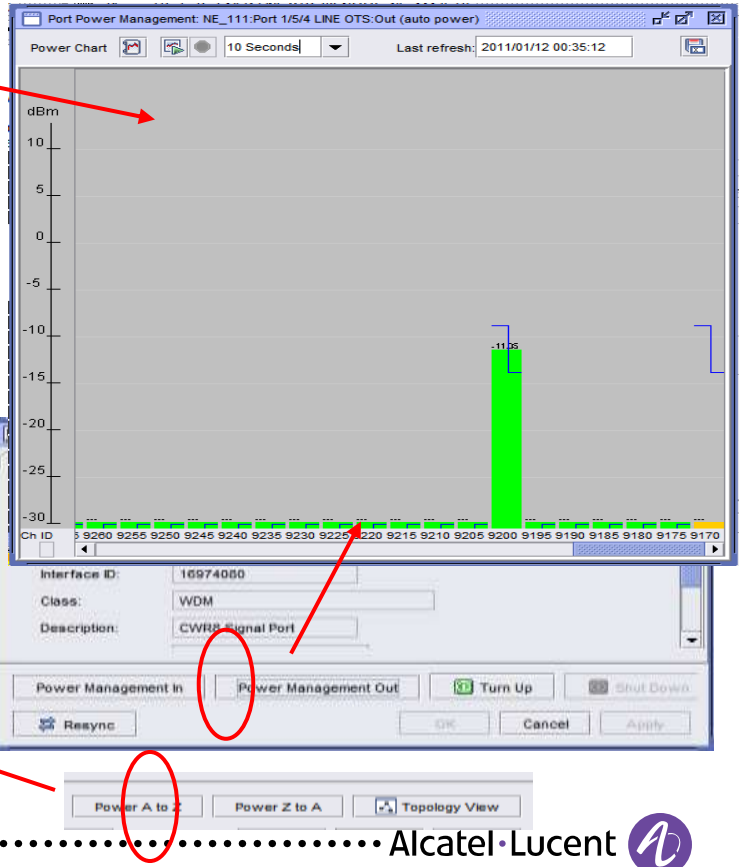
- Visualization
- Trouble shooting
- Multi layer Service Provision
- Power management
- .... More to come



Photonic OAM
WaveTracker management – path and fiber view

- WaveTracker power readings for Port shows the power levels of all channels on the port

- WaveTracker power readings for a service shows all the power levels as the WT measurement points on the service on multiple



ALCATEL-LUCENT E-E NETWORK MANAGEMENT PROPOSAL
KEY BENEFITS

Automatic Network and Resource Discovery	**KEY BENEFITS** • Eases the installation and commissioning process • Simplifies the network activation
Dynamic Provisioning	**KEY BENEFITS** • Allows to offer bandwidth-on-demand services & end-to-end provisioning • Simplifies the network planning • Eliminates the need of expensive and error-prone manual interventions and assures a in time return to service
Distributed Automatic Restoration	**KEY BENEFITS** • Enabler to maximize network resources utilization in the network • Increase network availability • Provides cross network layer resiliency optimisations

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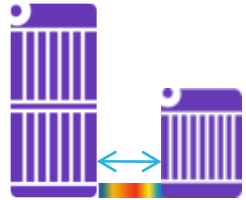
CONCLUSION

IP – OPTICAL CONVERGENCE STRATEGY

EVOLVING TO HIGH LEVERAGE NETWORKS

PHYSICAL NETWORK EVOLUTION

Progressive integration of IP and optical technologies on a few common, but versatile hardware platforms



7950 XRS OTN/WDM

LOGICAL NETWORK EVOLUTION

Modular product architecture to only include functional layers that services need, in a pay-as-you-grow model

OPERATIONAL WORKFLOW OPTIMIZATION

Cross-domain interaction and UNI control plane to orchestrate operations across IP and Optical domains

CORE IP-OPTICAL CONVERGENCE

ALCATEL-LUCENT VALUES

BEST IN CLASS INNOVATIVE IP AND OPTICAL

- LEVERAGE INNOVATIVE PLATFORMS FLEXIBLY SUITED FOR FULL RANGE OF NETWORKING SOLUTIONS AND APPLICATIONS
  - IP-Optical 100G/400G Leadership
  - Full flexible OTN grooming choices and wavelength filling

EASY DESIGN, INSTALLATION AND INTEROP

- MULTI-LAYER AND CROSS-LAYER
  - IP-Optical Pre-Integrated Market Validated Solutions
  - Wavelength tracking, spanning from IPoWDM to WDM

MEETING SLA AND EFFICIENT OPERATIONS

- Field-proven and widely deployed GMPLS for differentiated optical SLA
- Converged Network Management, adapting to operator's operations structure (IP-Optical single or separated)

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