A Path for IP and Optical Integration

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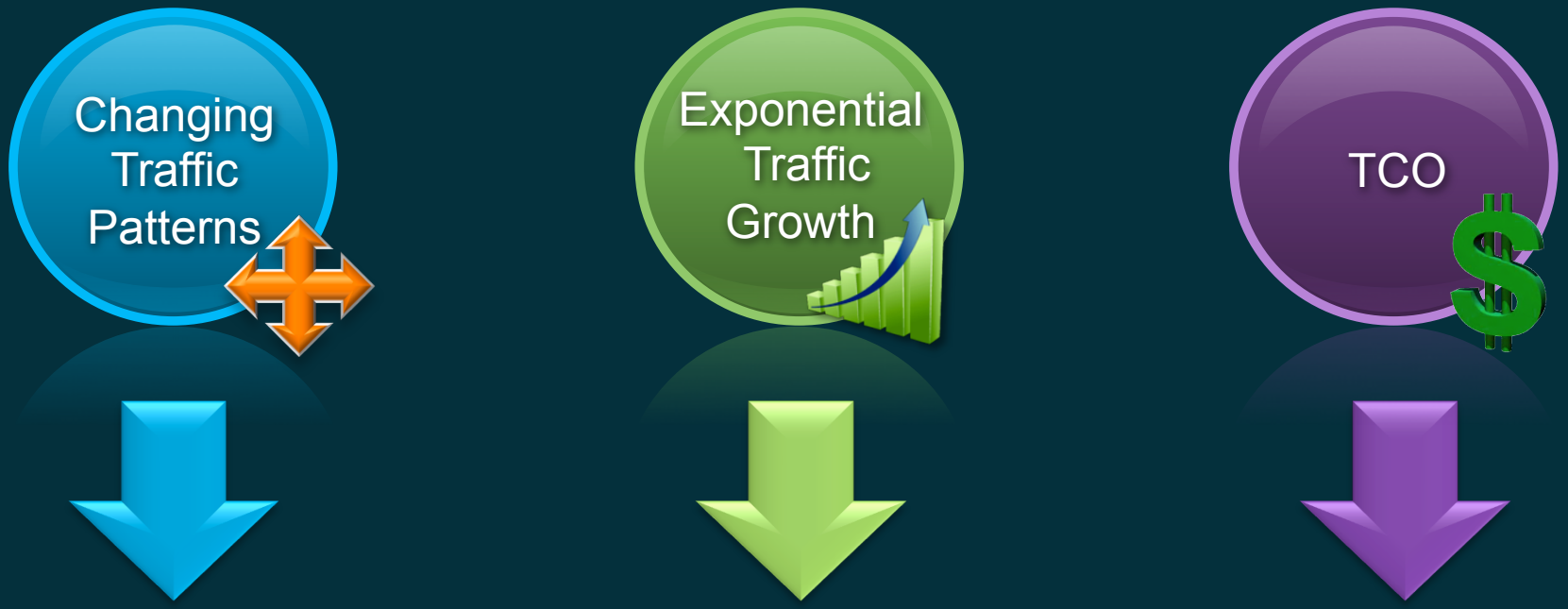
Impact of Video, Mobile, and Cloud Services

Networks in Transition



Agile Network Topologies

100G+ Capacity and Massive Scale

Architectural Convergence

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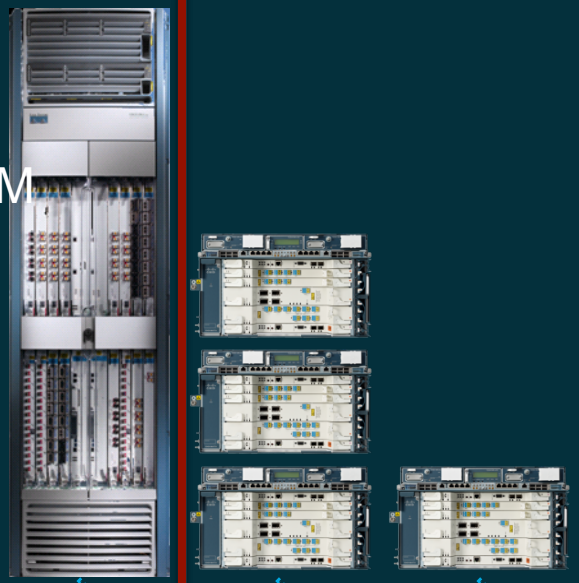
2 Separate Networks

IP/MPLS Network

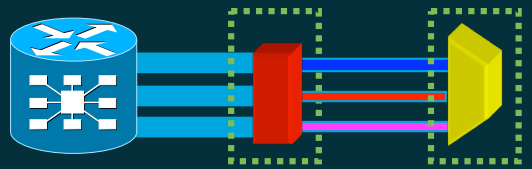
- Client Network
- Packet Based
- Unaware of the DWDM Layer



Optical Transport Network (DWDM)

- Multiplexing Network
- Analog World
- Circuit Based
- Normally NMS Centric (WSON is exception)
- Unaware of the L3 Layer

Router **Transponder** **ROADM**



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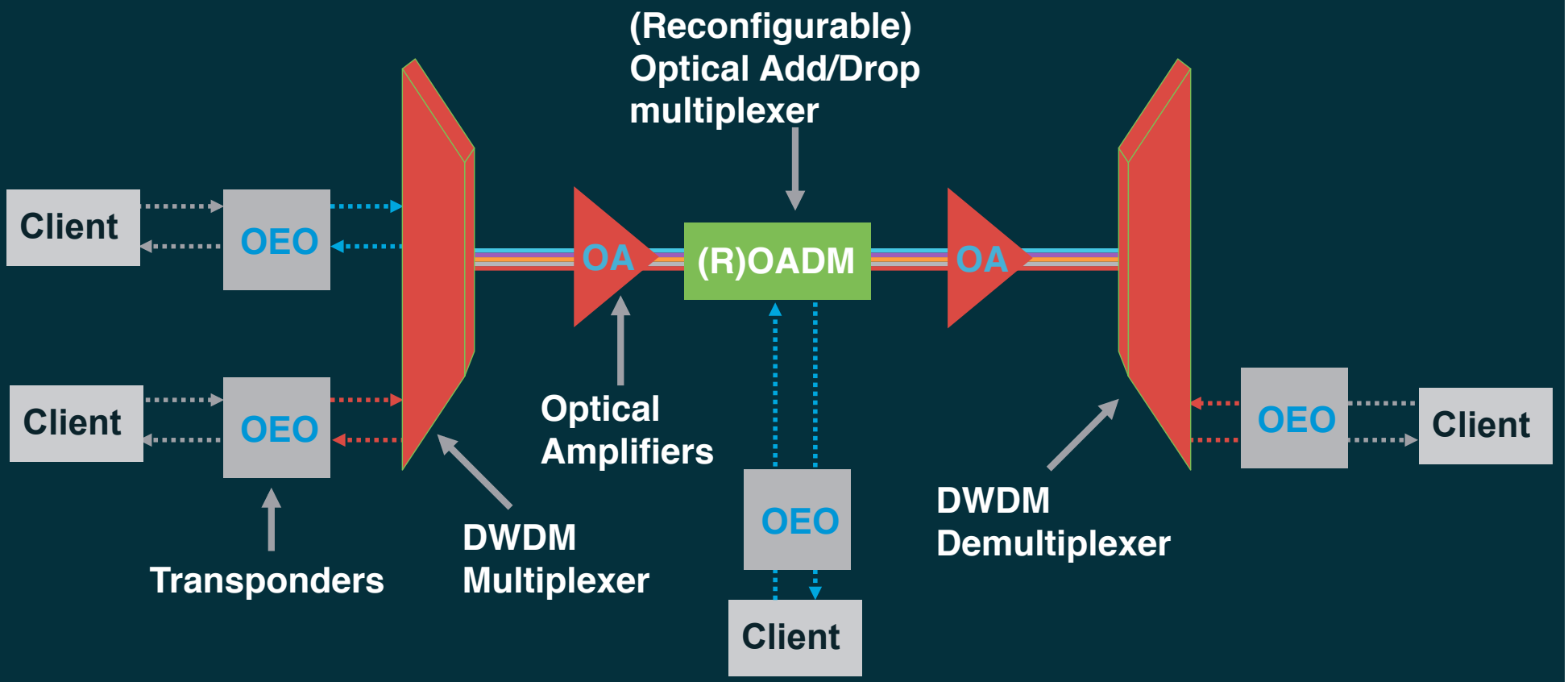
DWDM Building Blocks



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Cisco IPoDWDM
(Step 1)

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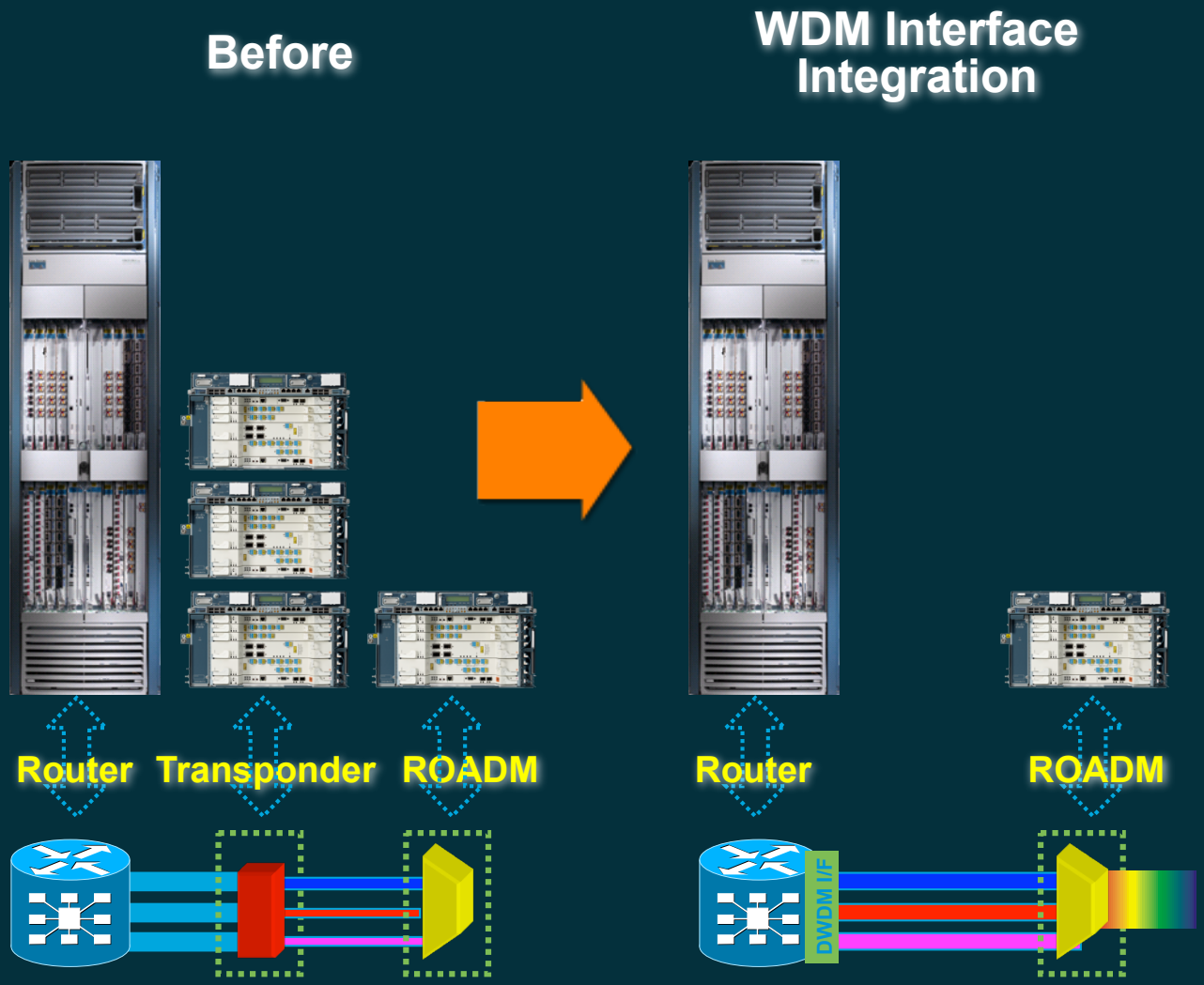
IP-over-DWDM Solution Benefits



- Lower CapEx
  - Elimination of client optics
- Lower OpEx
  - Space, power, management
- Enhanced Resiliency
  - Fewer active components
- Multi-Layer Interaction
  - Proactive Protection

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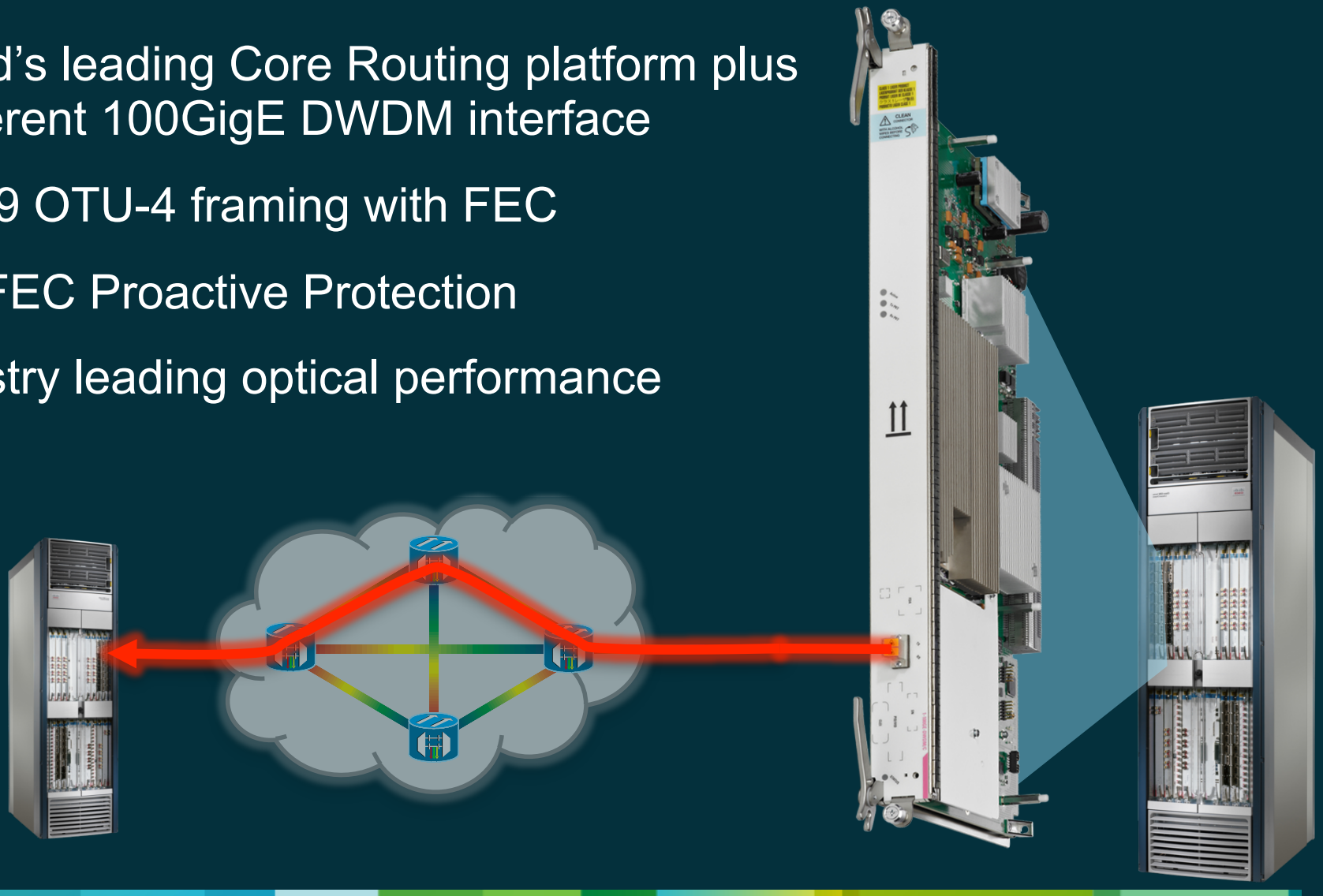
CRS-3 100G IP over DWDM PLIM

A Perfect Match

- World's leading Core Routing platform plus Coherent 100GigE DWDM interface
- G.709 OTU-4 framing with FEC
- Pre-FEC Proactive Protection
- Industry leading optical performance



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PRIVATE PROPERTY
KEEP OUT

Managing the SP “walls”: Virtual Transponders

- The major objection against IPoDWDM: the transport people want to manage “their” transponders
- The data/network people don’t want the transport people to touch “their” routers
- Virtual Transponders address this issue

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Cisco nLight Technology
(Step 2)

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Current optical agility
Deployment survey (as of 2012)

Provisioning cycle of a new wavelength	Months
Programmatic enforcement of latency/disjointness	none
Programmatic monitoring of latency/disjointness	none
Programmatic modification of latency/disjointness	none
Mean time to restore a wavelength failure	days
L3-aware automated restoration	none
L3-aware automated re-homing	none

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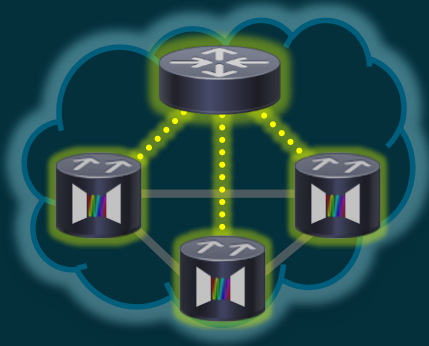
Cisco nLight Technology

Programmability, Convergence, and Scale

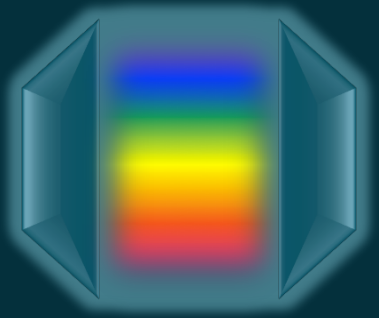
nLight
Silicon

100G and Beyond
Adaptive Rate
High Performance



nLight
Control Plane

Information Sharing
The Network is the Database
Automation to Optimization



nLight
ROADM

Complete Flexibility
No Manual Intervention
Massive Scale

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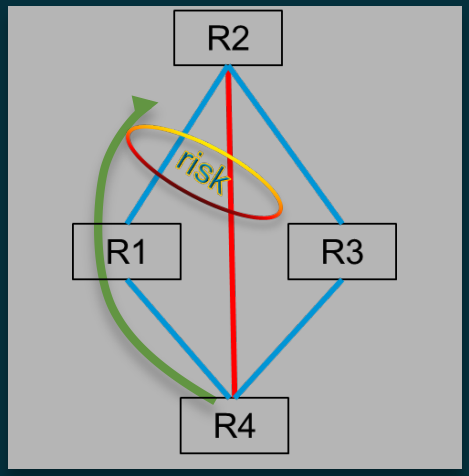
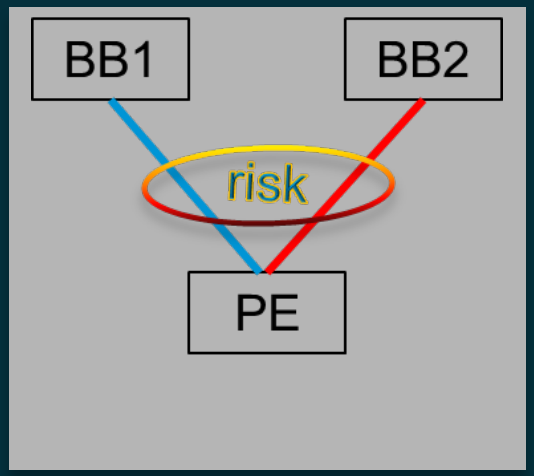
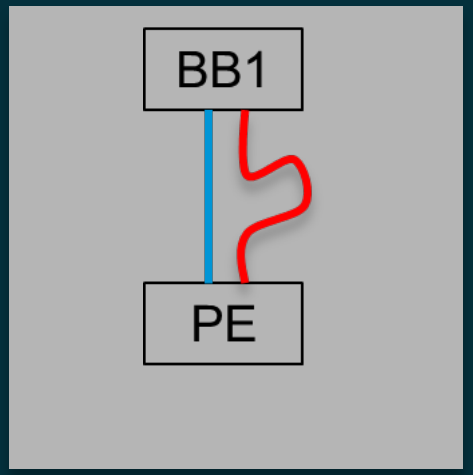
Inefficiencies



LFA/TE FRR Fate-Sharing from primary



WAN Disjointness for PoP



Homogenous Latency and Fate sharing Bundle

- Too little information is flowing
- Too limited interaction between the two layers

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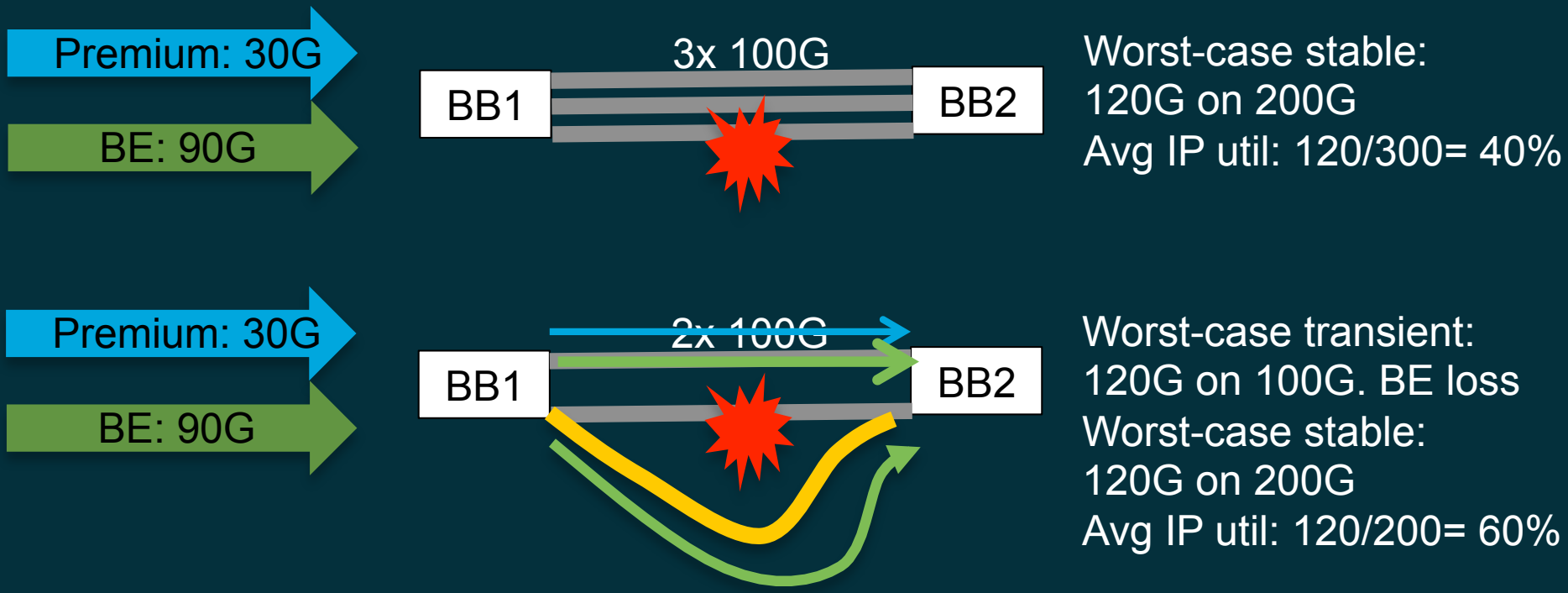
MLR for optical failures



In a real SP network: 26% less interfaces

(less router ports, less transponders, less wavelengths, less power, more scale)

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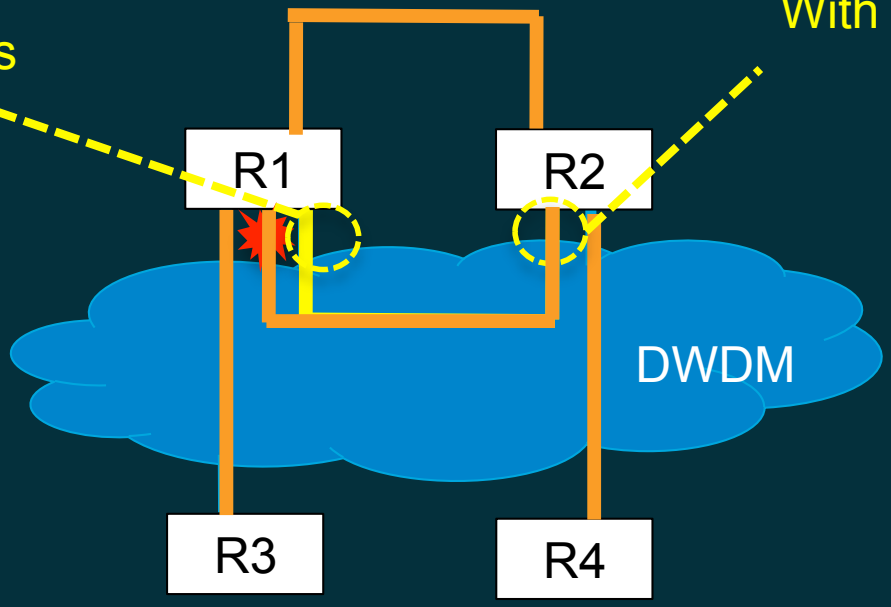
MLR – IP Port failures

This standby capacity is not dedicated N+1

With nLight we reuse it



8% less IP+DWDM interface

(less spare capacity, higher average utilization)

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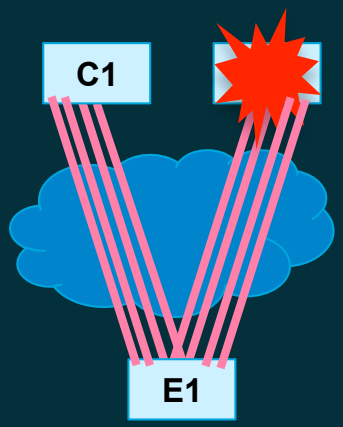
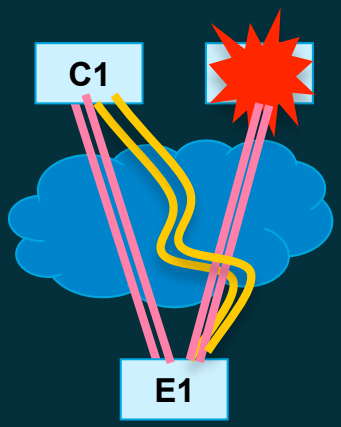
MLR – IP Aggregation Node



400G

Each edge site has 4x100G



400G

Each edge site has 4x100G

25% less IP+DWDM edge interfaces

(not accounting for core interface gain)

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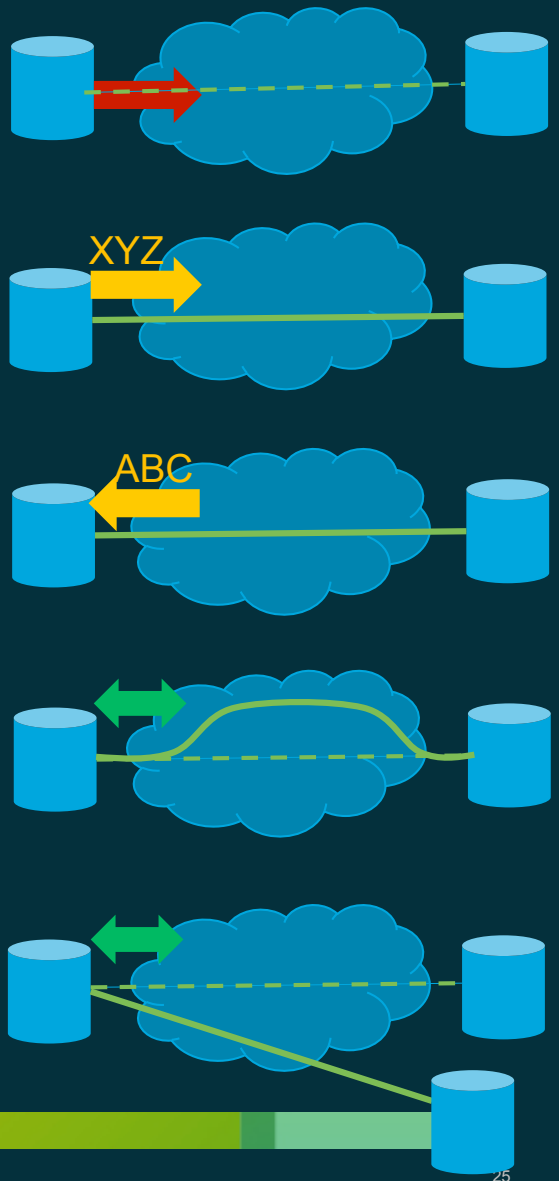
nLight summary

1. Ability to set up an L0 path from L3
2. Share L3 path constraints with L0
3. Report properties of L0 path to L3
4. Change L0 path for an L3 link due to local failures or re-opt opportunities
5. Change the L3 topology due to large failures or re-opt opportunities



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What is the Value Prop?

1. Ability to set up an L0 path from L3 — Opex
2. Share L3 path constraints with L0 — Opex, Avail
3. Report properties of L0 path to L3 — Opex, Avail
4. Change L0 path for an L3 link due to local failures or re-opt opportunities — L0+L3 Capex, Opex, Avail
5. Change the L3 topology due to large failures or re-opt opportunities — Avail (DR), L0+L3 Capex, Opex

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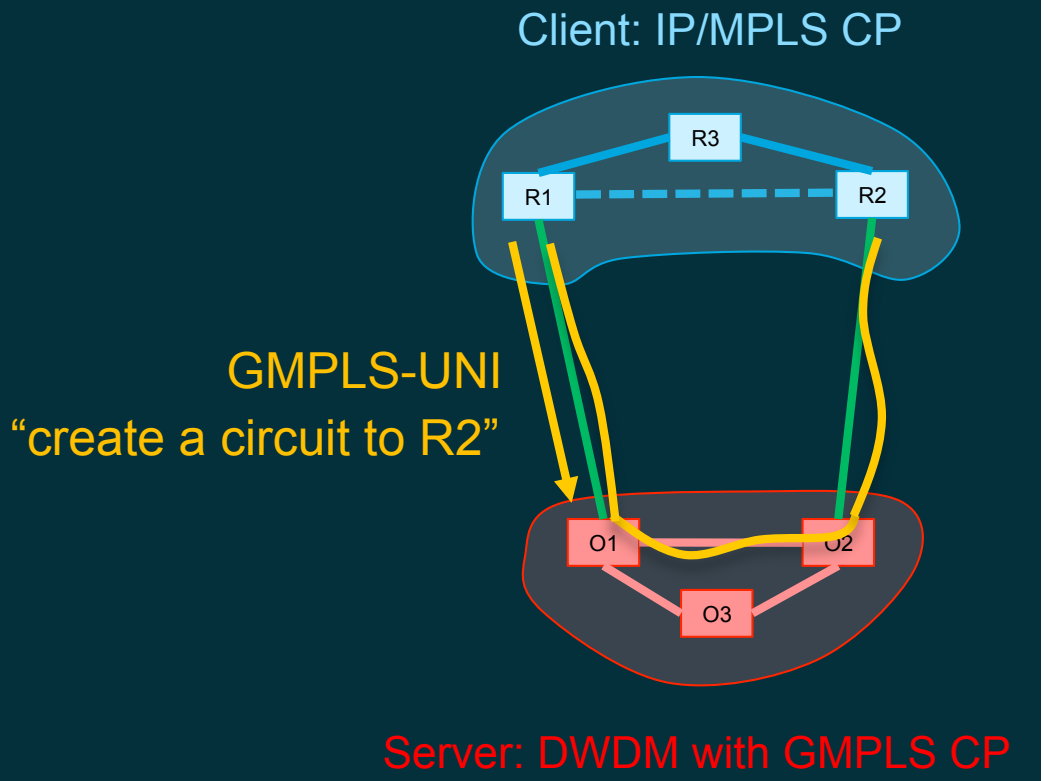
GMPLS-UNI Overlay

- Overlay benefits
  - Scale
  - Operational expertise
  - Organizational segmentation
  - Faster provisioning
    - Minutes instead of months



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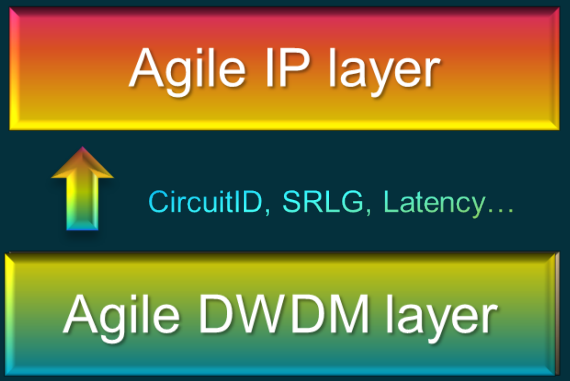
nLight extended UNI - Information flow

- For each circuit it signals, a client may be informed of
  - Circuit-ID – unique identifier in server context
  - SRLG's along the circuit
  - Latency through the server network
  - Optical cost for the circuit
  - Path through the server network
    - Information continuously refreshed
- A client may be informed of server topology/resource
- Policy Controlled by the Server Layer



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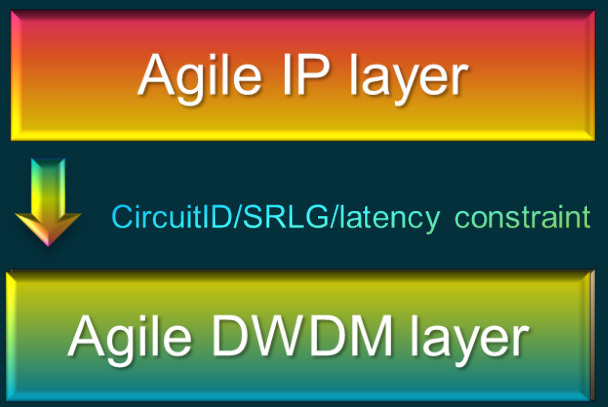
nLight extended UNI - Information flow

- When signalling a circuit, a client may request
  - server SRLG's to be excluded or included
  - the path to follow another Circuit-ID
  - the path to be disjoint from another Circuit-ID
  - an optimization or bound on latency
- Policy Controlled by the Server Layer



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nLight Architecture – recap

Information sharing across layers

ML restoration for optical failures

Coordinated optical path optimization

Coordinated optical layer maintenance

ML Planning

cariden

GMPLS-UNI

Impairment aware DWDM CP (WSON)

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Goal: Decrease Network TCO

accomplished via...

Automation ..... Provisioning, Restoration Maintenance, Optimization

implemented in a...

Control Plane ..... GMPLS / nLight CP

enabled by an...

Intelligent, Touchless Optical Layer ..... WSON, nLight ROADM

made possible by...

Software Integration ..... Virtualized Management

and

Hardware Integration ..... IP-over-DWDM

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Thank you.