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The bridge to possible

# The Journey Towards Routed Optical Networking

Moustafa Kattan, CTO and DA, Routing and Optical, Cisco

BRKOPT-2130



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# Agenda

- IP and Optical Networks Present Mode of Operations
- Routed Optical Networking and Key Benefits
- Routed Optical Networking Key Building Blocks
- The Journey and Phases for Routed Optical Networking
- Conclusion

# IP and Optical Networks Present Mode of Operations



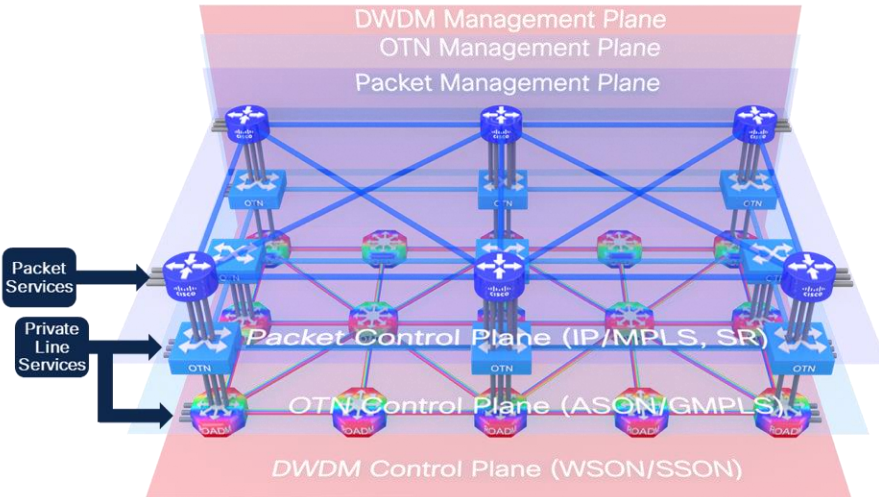
# The Journey Towards Routed Optical Networking





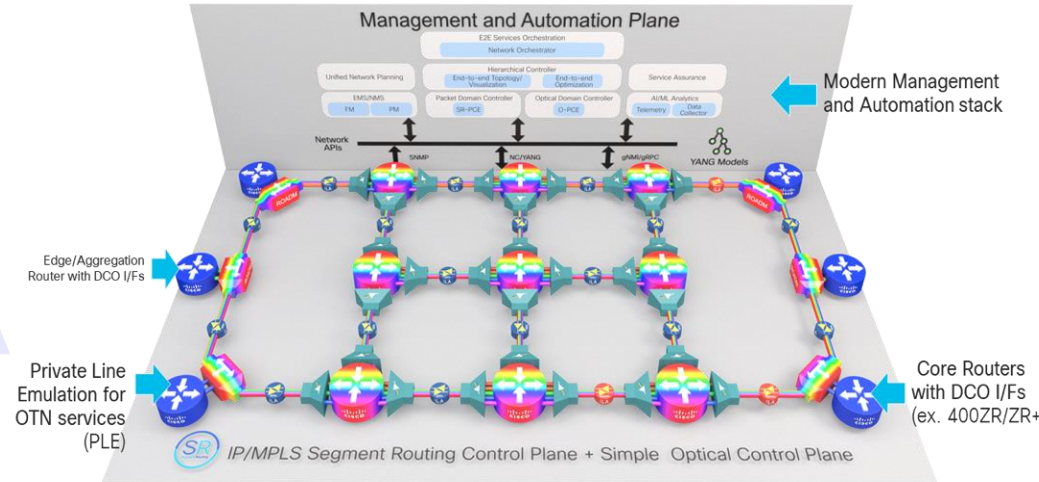
# What is the Routed Optical Networking Architecture ?

Today's Network



Layered Architecture

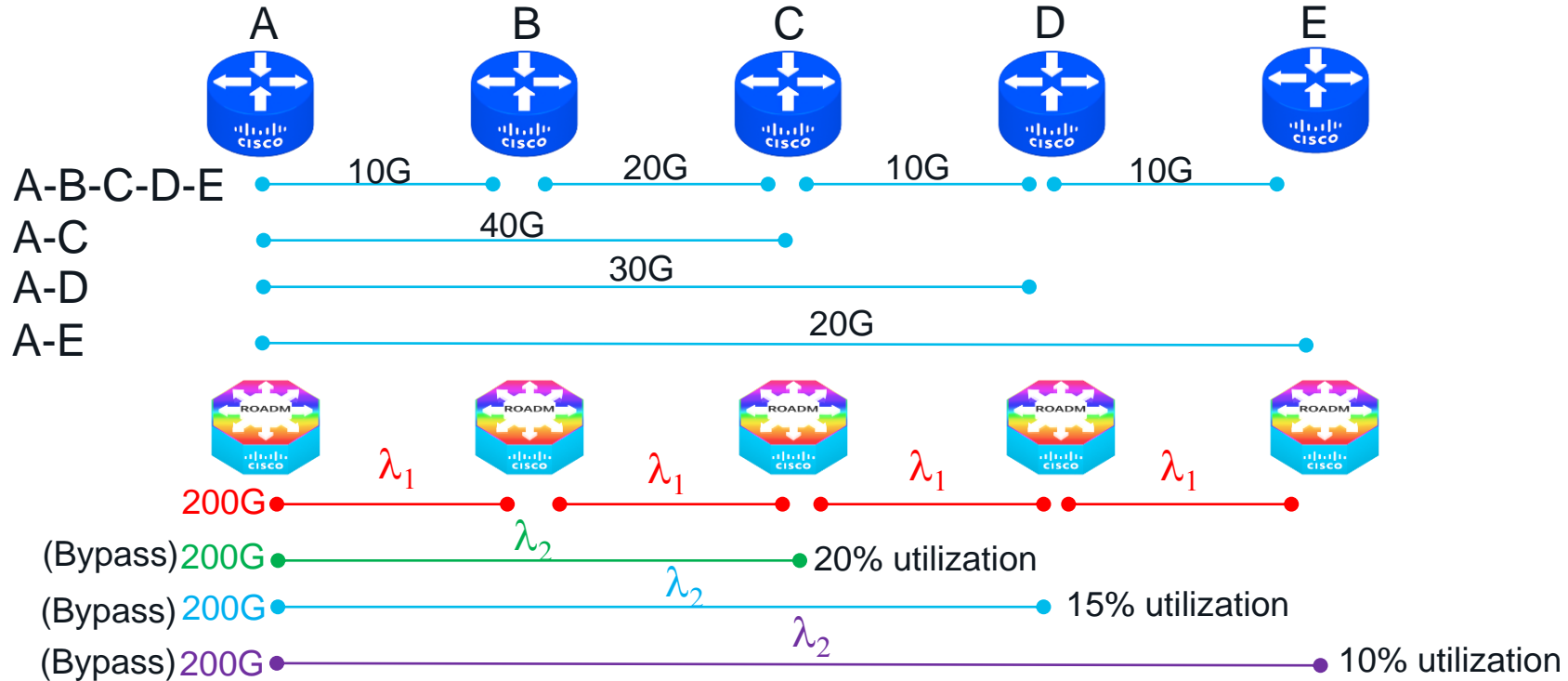
Internet for the Future



Simplified Flat Architecture

- Simplify the Network collapsing 3 layers into 1 ( 1x Switching Element, 1xCP, 1xServices Layer with a Single Pane of Glass)

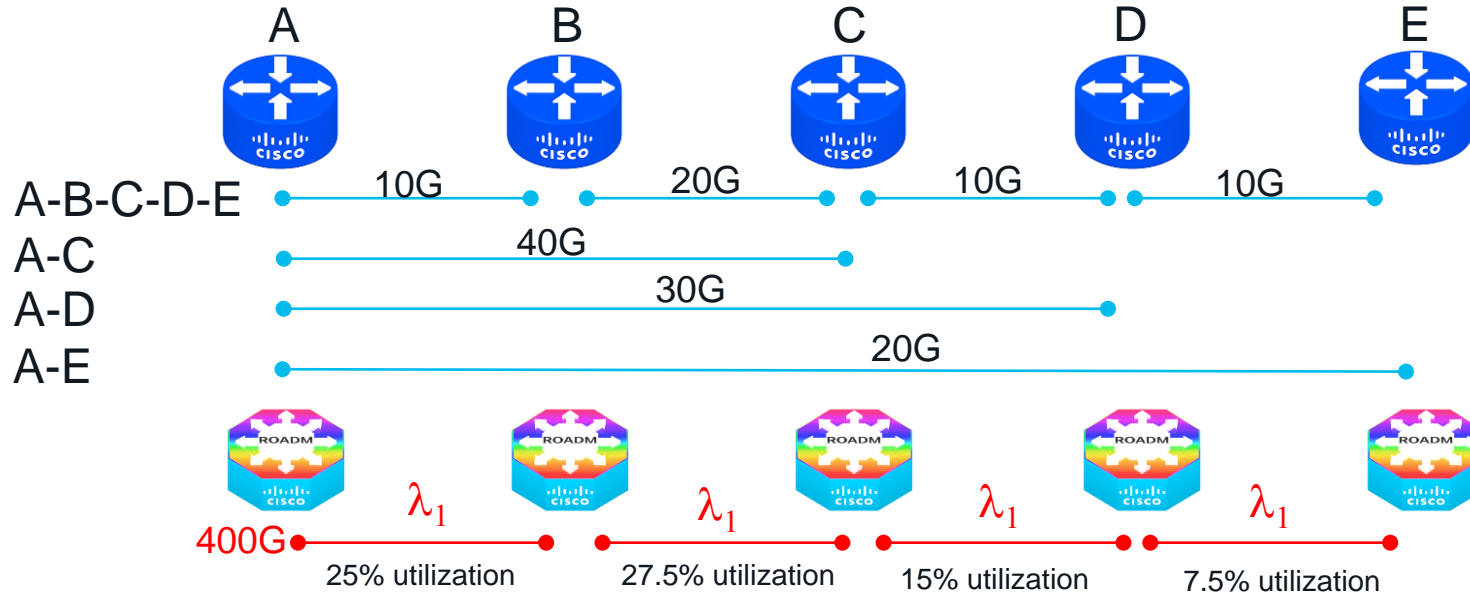
# Typical Network Demands mapped to Wavelengths





# Routed Optical Networking

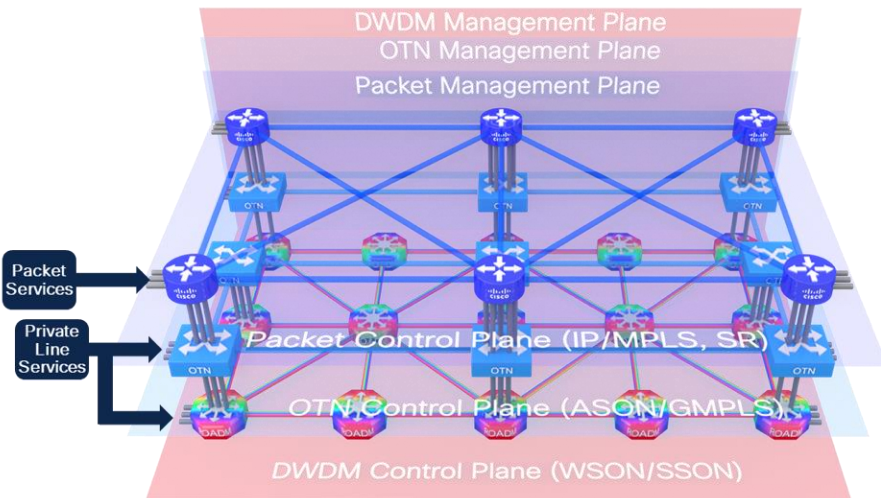
## Reduce/eliminate bypass wavelengths



# Routed Optical Networking Key Benefits

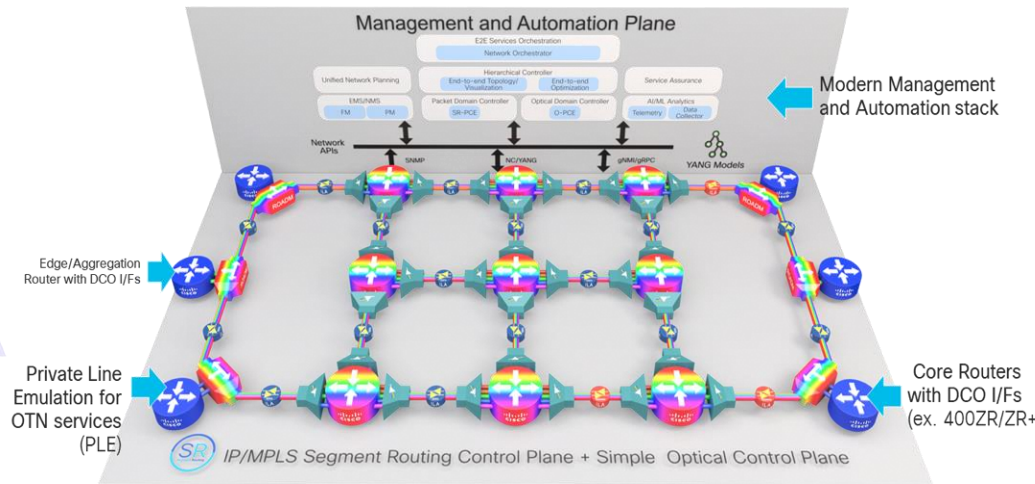
# IP and Optical Convergence Why now?

Today's Network



Layered Architecture

Internet for the Future



Simplified RON Architecture



leaba  
semiconductor

Massively  
Scalable Silicon



Acacia



Transponder → Pluggable  
Silicon Photonics



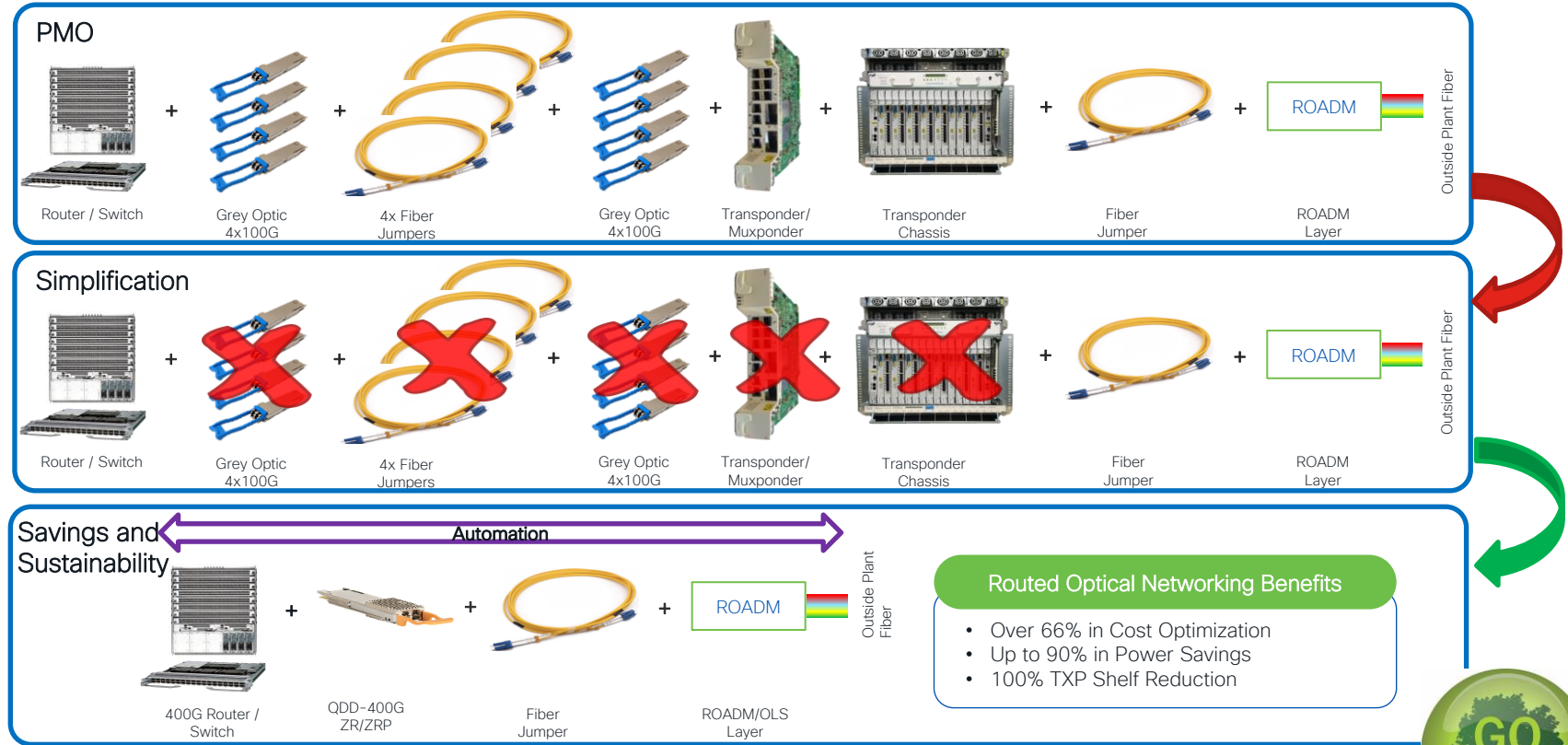
sedona  
systems

IP+Optical Automation



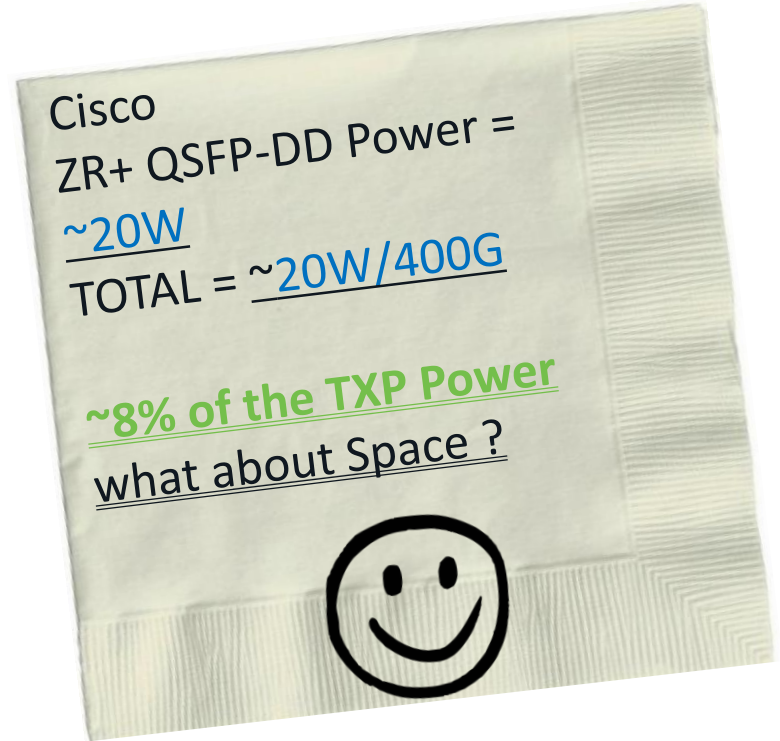
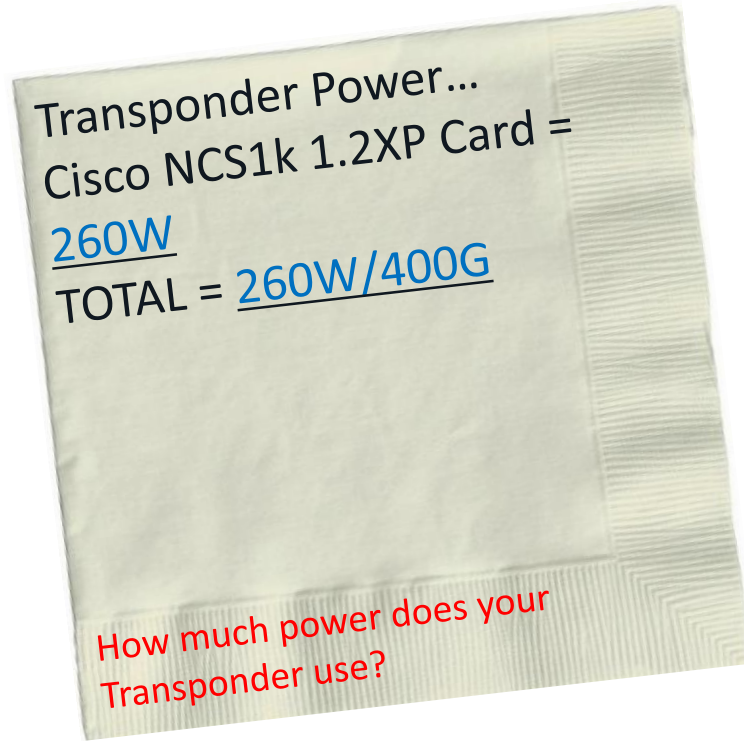
Open DWDM: Industry  
Standardization & Interop

# The 3 Ss of Routed Optical Networking : Simplification, Savings and Sustainability

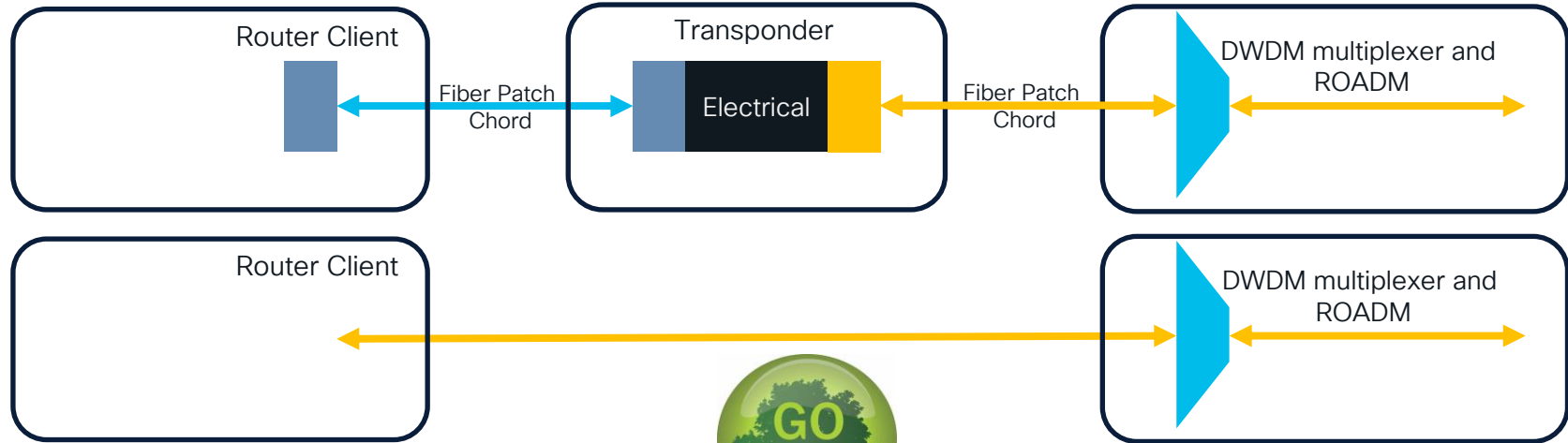
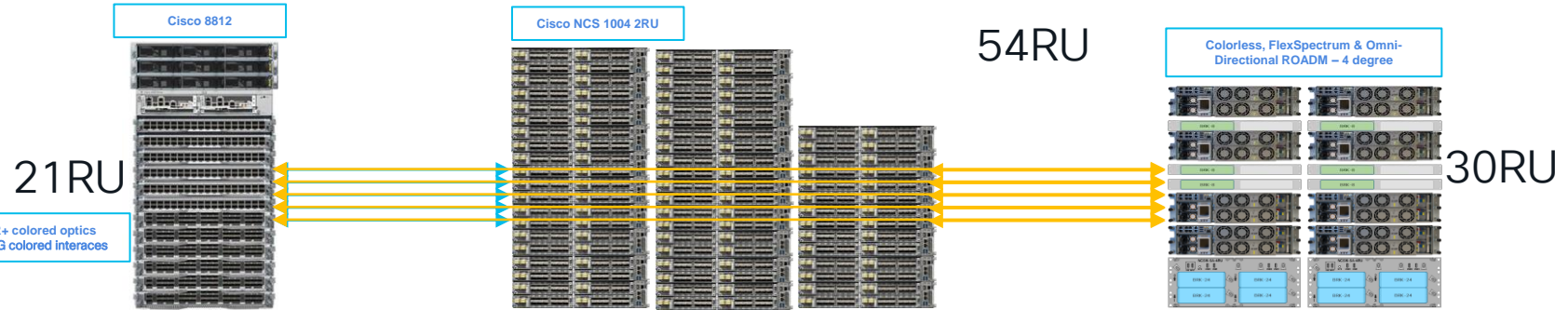


Increase –Simplicity, Savings and Sustainability

# Sustainability- Power Consideration

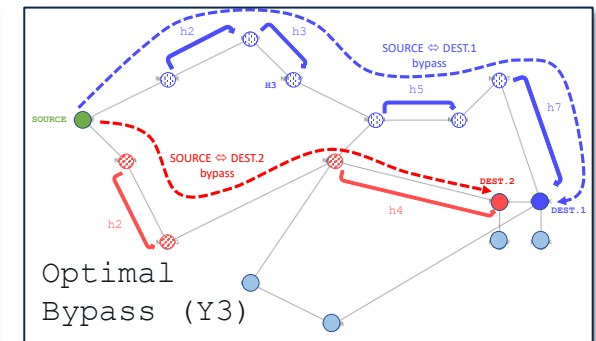
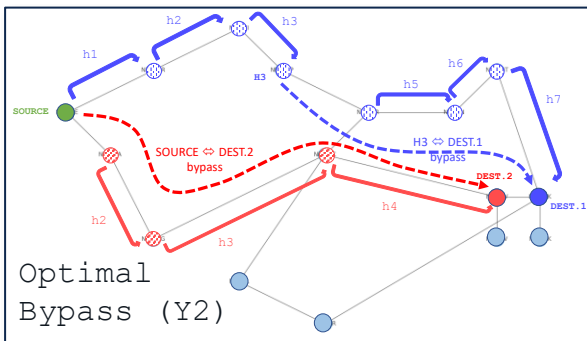
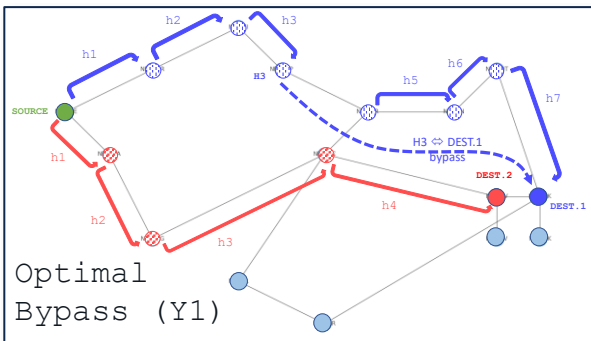
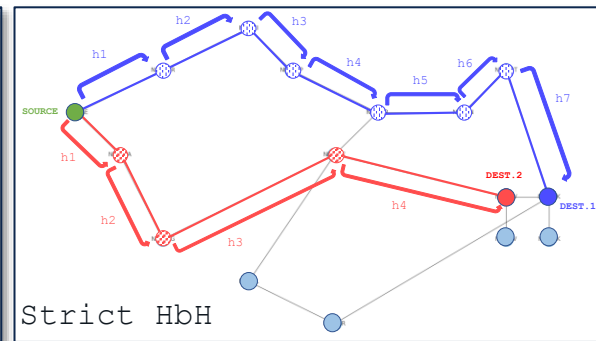
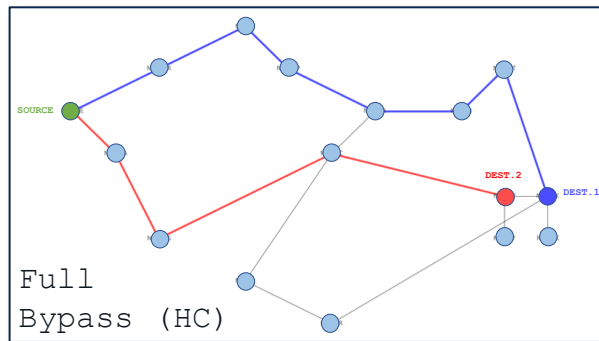
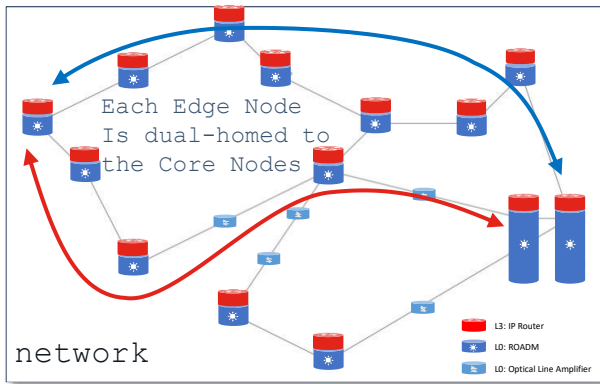


# Sustainability- Footprint Consideration





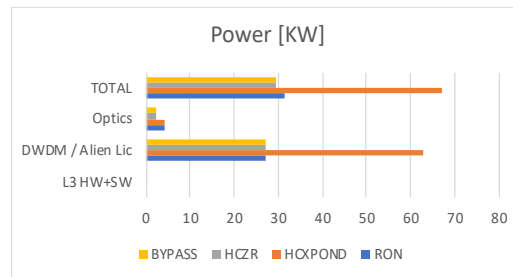
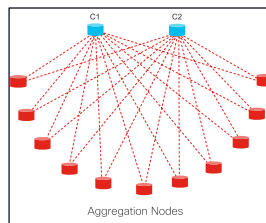
# Hollow Core vs. HbH vs. Optimal by-pass Comparison



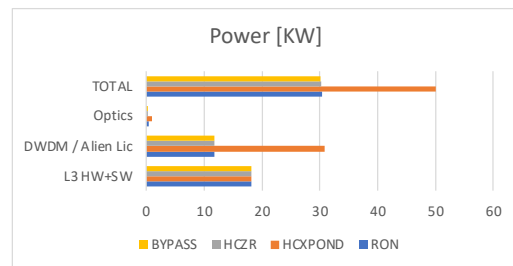
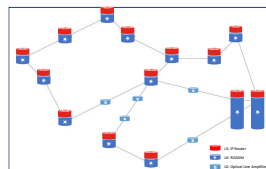
# Power Consumption Savings

- Power savings mostly come from integrating transponders into routers through QDD 400G ZR/ZR+ pluggables
- Up to 30% saving could be achieved across all use cases : Metro, Regional and LH

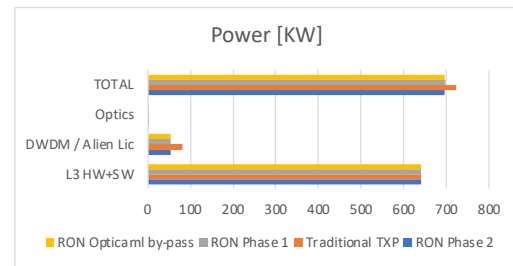
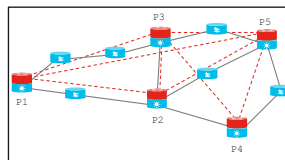
MAN  
Aggregation



Regional  
Aggregation



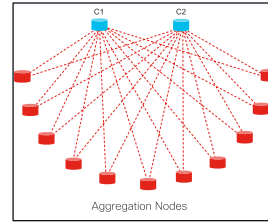
Core



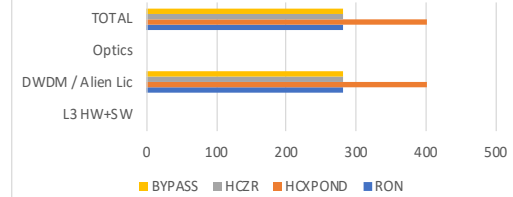
# Rack Units Savings

- Rack Units savings come from removing transponders
- As in the case of power, saving % depends on traffic density vs. installed HW

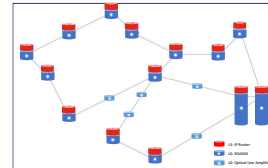
MAN  
Aggregation



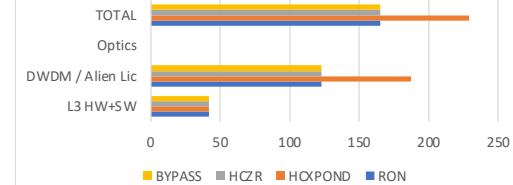
Rack Space [RU]



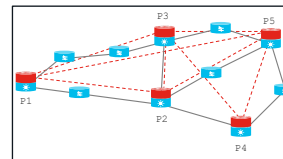
Regional  
Aggregation



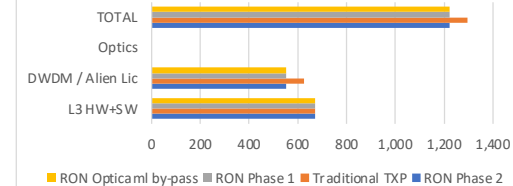
Rack Space [RU]



IP Core



Rack Space [RU]

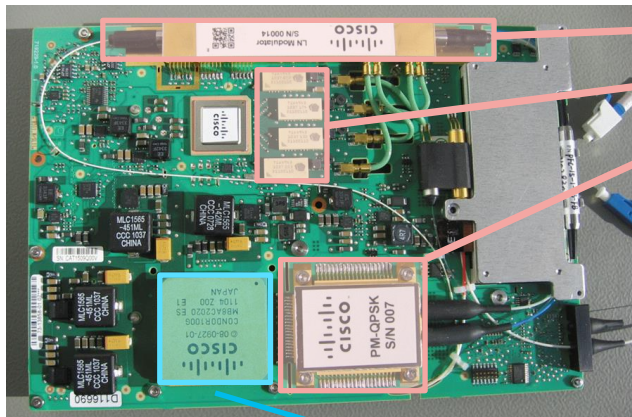


# Routed Optical Networking Key Building Blocks

# What are Digital Coherent Optics (DCO)?

## Traditional Transponder

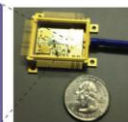
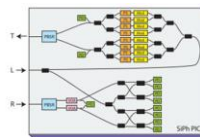
Cisco 100G Transponder line card



Discrete Optics

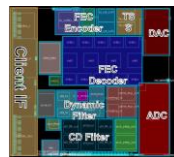


Packaging/  
integration



PIC with  
Multi-chip Packaging

Digital Signal  
Processor



28nm

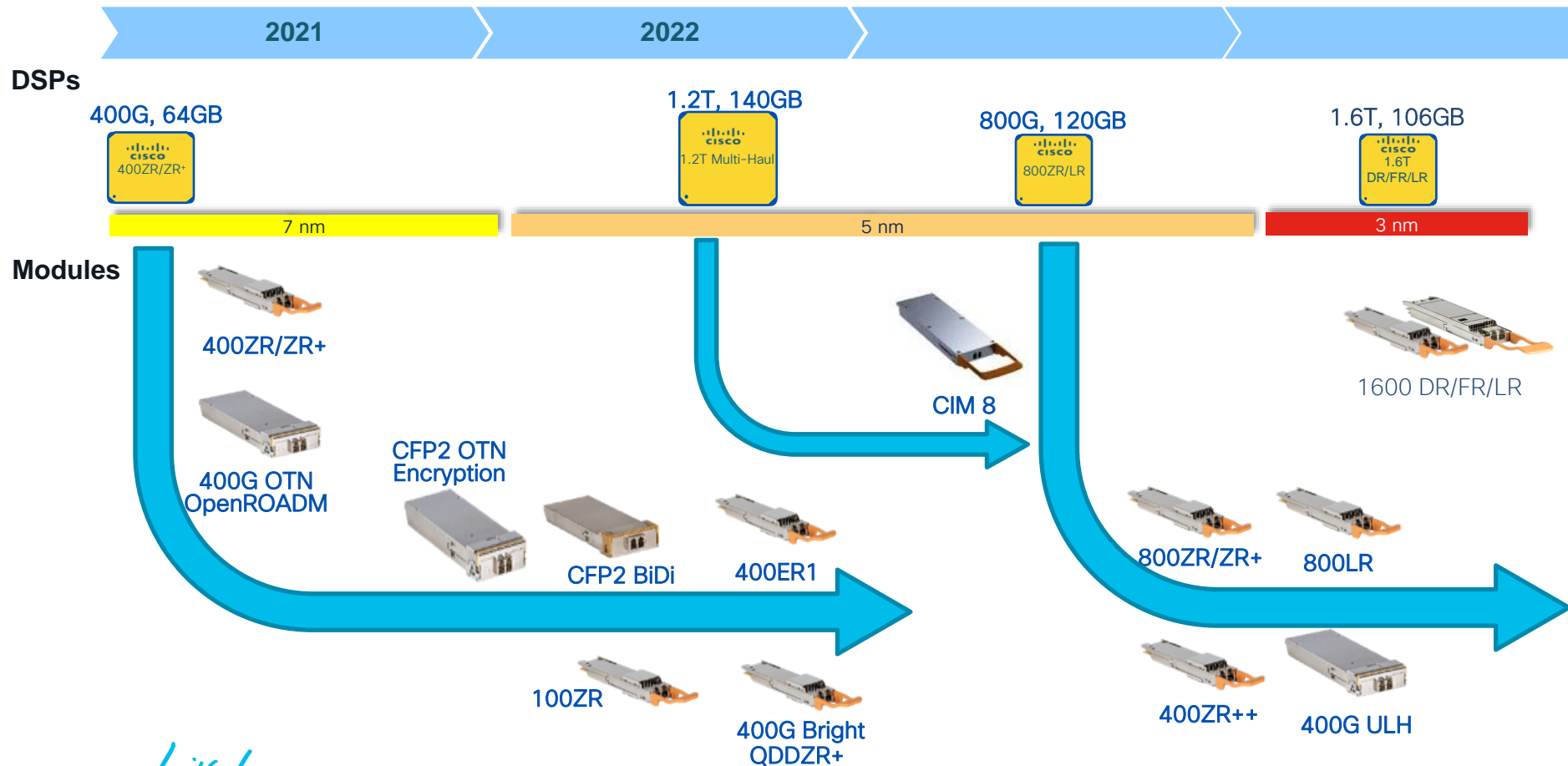
Moore's Law



7nm

10x Power  
Reduction

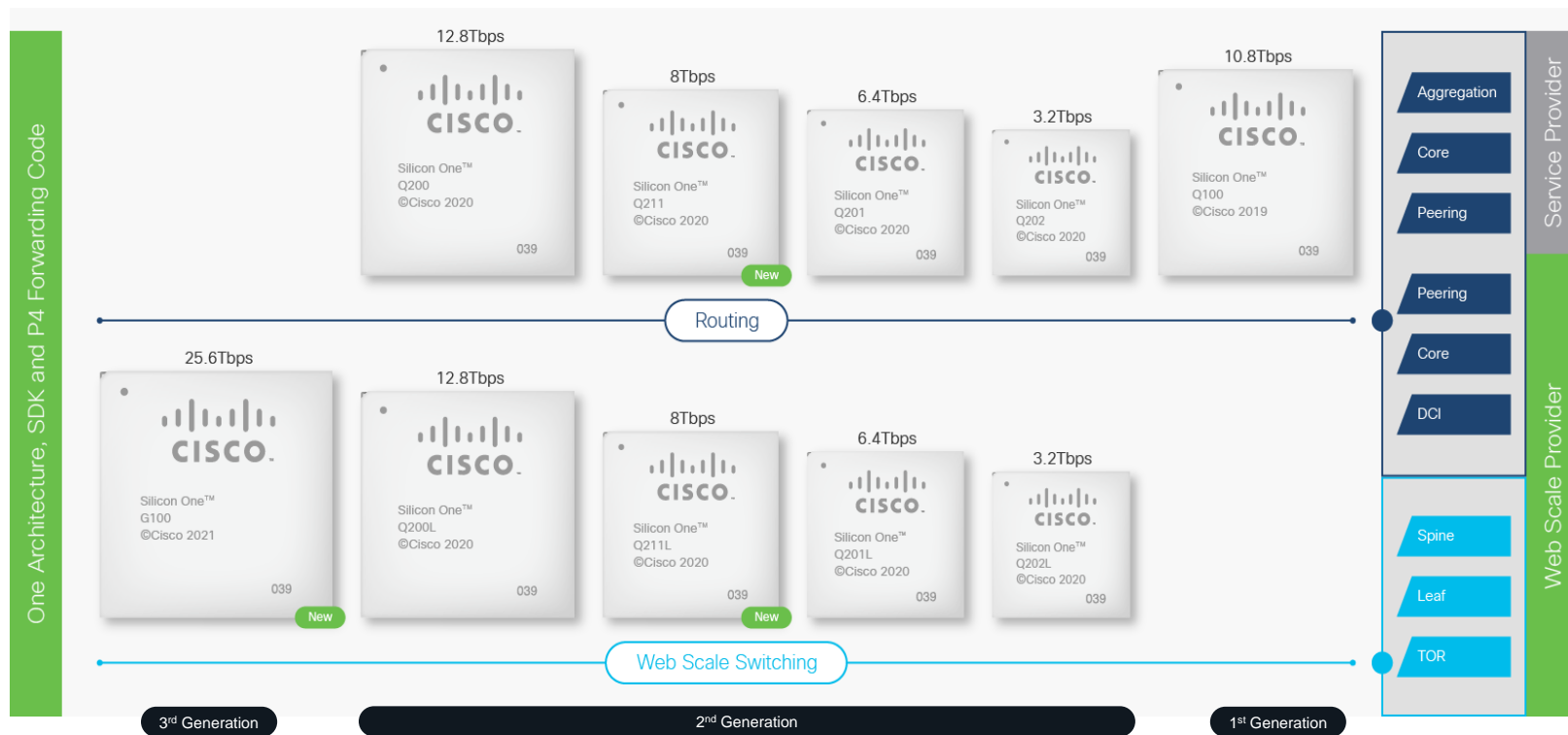
# Coherent Optics Evolution





# Cisco Silicon One Example

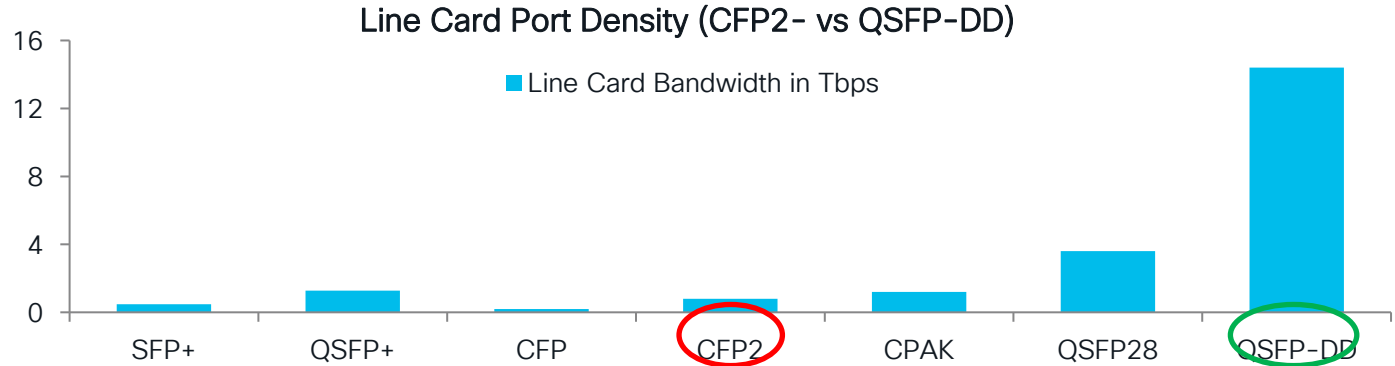
## One Architecture, Multiple Devices.



# Routed Optical Network Differentiation

1

Better DWDM  
port density



2

Standards based  
multi-vendor  
interoperability



# OpenZR+

Combination of two standardization efforts



Campus, Metro, DCI



Simplified functionality  
Edge optimized FEC (C-FEC)

## OpenROADM

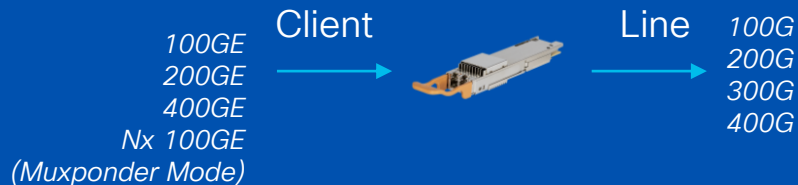
SP Metro, Regional, LH



Flexible Client Mapping +  
High Performance FEC (oFEC)



Metro, Regional, LH

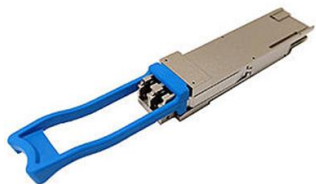


Simplified functionality +  
High performance FEC (oFEC)

Enables high performance pluggable modules that  
provide multi-vendor interoperability

[Cisco Blog: OpenZR+ Delivers 400G Coherent Optics for Multi-Haul Networks](#)

# 400G QSFP-DD ZR & ZR+ Specifications



- **Supported Trunk Rate:**
  - 200G, 300G and 400G (OpenZR+) 60.1 GBaud
  - 400G (ZR) 59.8 Gbaud
  - 100G (OZR+) 30.16Gbaud
- **TX Power Range:**
  - ZR and ZR+ w/o Nyquist shaping:
    - -8.5dBm typical; -10 dBm (EoL Worst case)
  - ZR+ w/ Nyquist shaping:
    - -11dBm typical; -13 dBm (EoL Worst case)
- **DGD Compensation:**
  - 200G, 300G, 400G: 60ps
  - 100G: 80ps
- **Channel Spacing:**
  - 75GHz (Min)
- **ZR+ CD Compensation:**
  - 100G: +/- 80,000ps/nm (config up to 160,000)
  - 200G: +/-50,000ps/nm (config up to 100,000)
  - 300G: +/-26,000ps/nm (config up to 100,000)
  - 400G: +/-13,000ps/nm (config up to 52,000)
- **Power Consumption @400Gbps:**
  - ZR : Typical 18.0 W; Worst case EoL 20W
  - ZR+: Typical 21.6 W; Worst case EoL 23.6W

Line Rate	Mode	Modulation Format	FEC	OSNR [dB] Typical	OSNR [dB] Worst case EoL	RX Sensitivity (Optimum OSNR)	Min RX Sensitivity
400G	ZR	16QAM	CFEC	26	26	-12dBm	-20dBm
400G	ZR+	16QAM	OFEC	22.3	23.1	-12dBm	-21dBm
300G	ZR+	8QAM	OFEC	18.8	19.5	-15dBm	-23dBm
200G	ZR+	QPSK	OFEC	14.7	15.0	-18dBm	-28dBm
100G	ZR+	QPSK	OFEC	11.0	11.8	-20dBm	-28dBm

# Pluggable Optics Innovations



## Bright QDD ZR+

- 400G ZR+ QDD pluggable with up to +2dBm TX Power
  - Allows interoperability with all deployed Add/Drop architectures
  - Enhances by about 12dB the un-amplified reach
- Optical specs aligned with current QDD ZR+ ones
- Two different versions
  - Ethernet only (for Routers and Switches)
  - OTN (with optional support of L1 Encryption, available in Full Feature and Licensed versions)



## QDD OLS

- Bi-directional EDFA amplification integrated into pluggable QDD
  - Up to 17dBm Output Power
  - 7dB to 25dB Gain Range for Booster EDFA
  - 2dB to 25dB Gain Range for Pre-amplifier
  - 2.4THz C-band range
- Can be used in conjunction with 64chs Mux/Demux to support up to 32 wavelengths (75GHz grid)
- Passive 8chs Coupler/Splitter integrated in a cable available as well for low-end applications

# The Journey Towards Routed Optical Networking

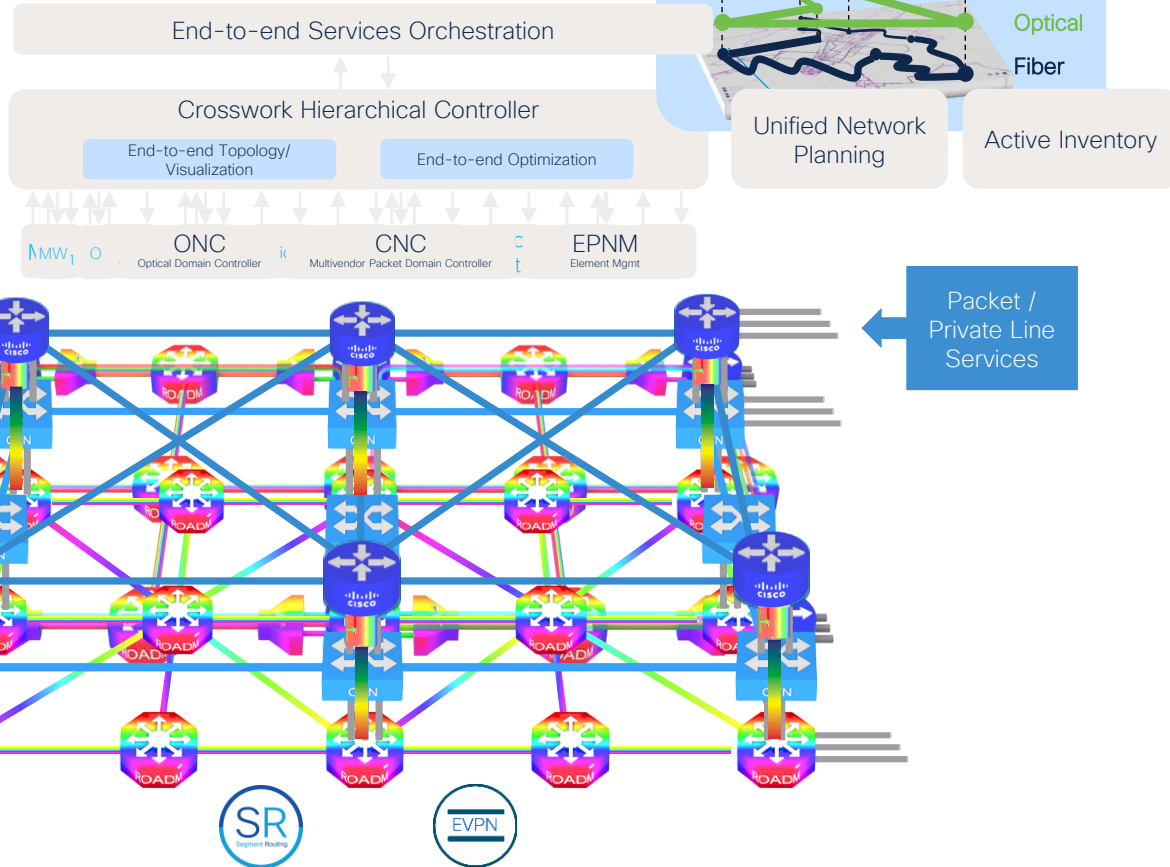




3

# Designing Next-Generation Optical Services

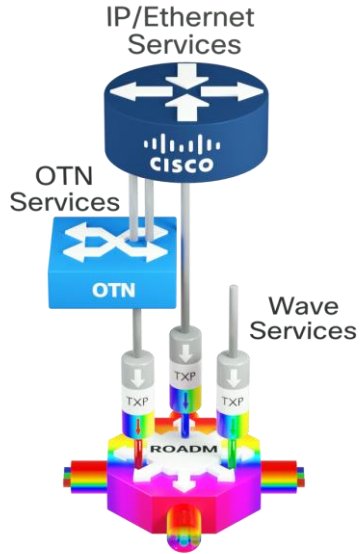
We grow over a simplified **flattened architecture** as the basis for the simplified single control plane harnessing in full the advantage of Routed Optical Networking (RON)...



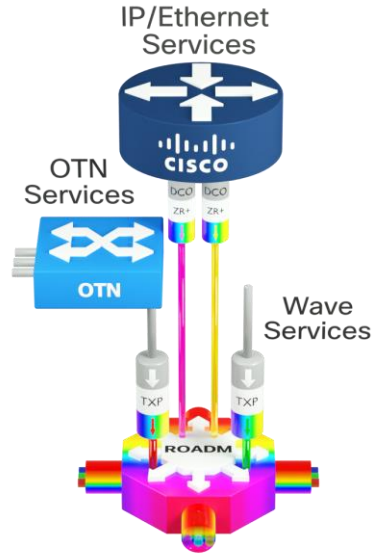
# Network Infrastructure Evolution

Present

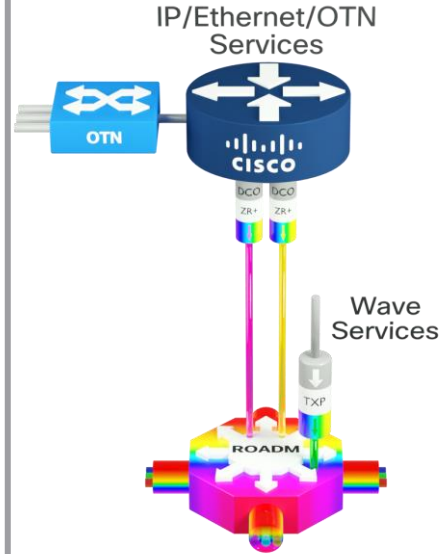
Future



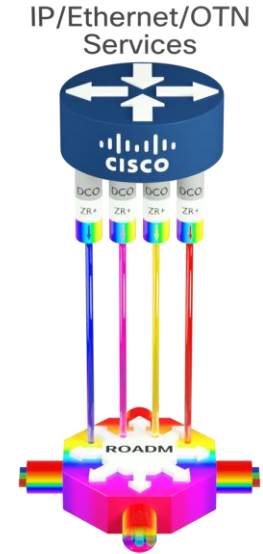
Multi-Layered



Transponder Integration



Services Convergence

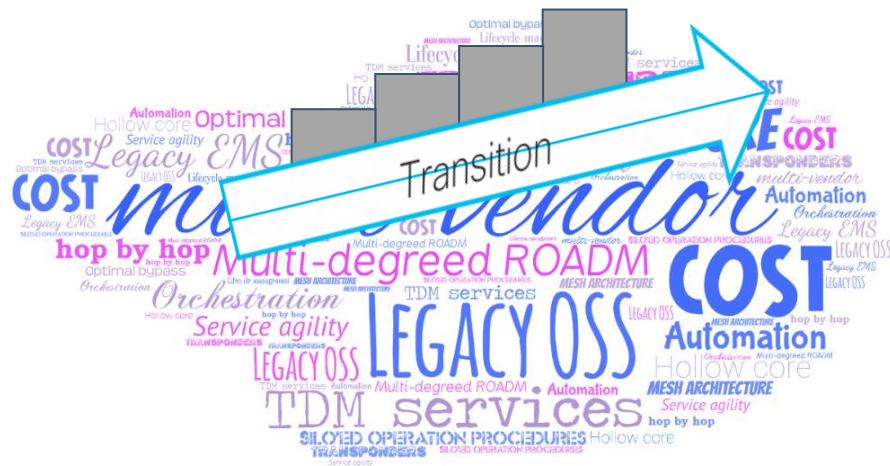


Full Network Convergence

# RON Journey Key Considerations

## Considerations

- Greenfield vs Brownfield
- H2H vs Bypass (ROADM)
- 3<sup>rd</sup> party and multivendor interop and integration
- OTN, FC, PLS ?
- Protection and Restoration (1+1+R)
- Automation, simplification and convergence of operations and services



# Routed Optical Networking Journey Call to Action

1

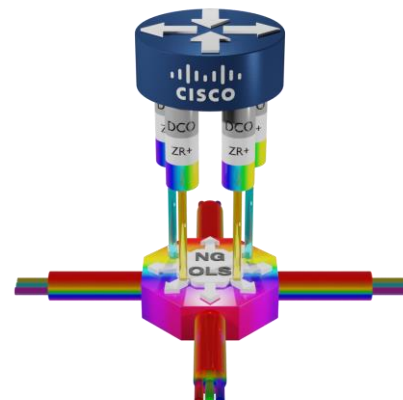
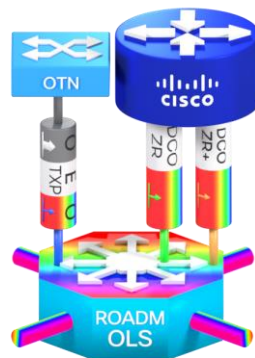
Integrate Transponders  
in routers with ZR/ZR+  
today !

2

Address both Greenfield  
and Brownfield Networks  
(3rd Party ROADM)

3

Converge services over a single  
layer and Automate IP/Optical  
networks



**OpenZR+**  
MULTI-SOURCE AGREEMENT



ARISTA



FUJITSU



Ensure Openness

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The bridge to possible

# Thank you

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