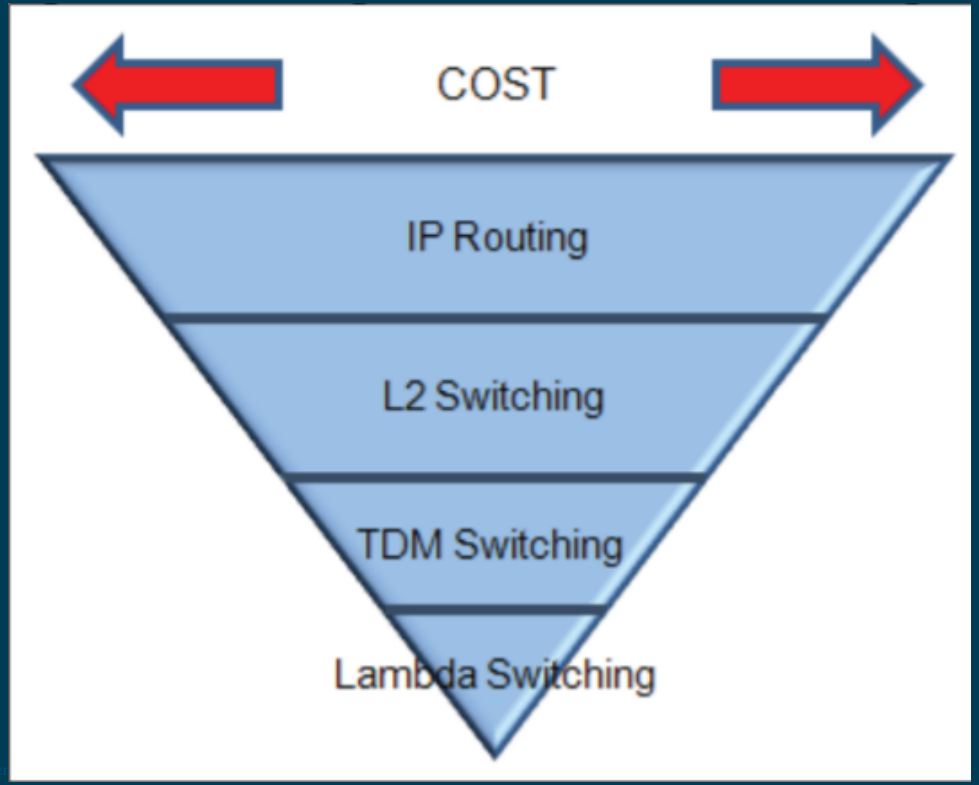
Are we finally getting ready for our next MPLS moment?

Oznog 2019 – blanedav@cisco.com

Historical Economics



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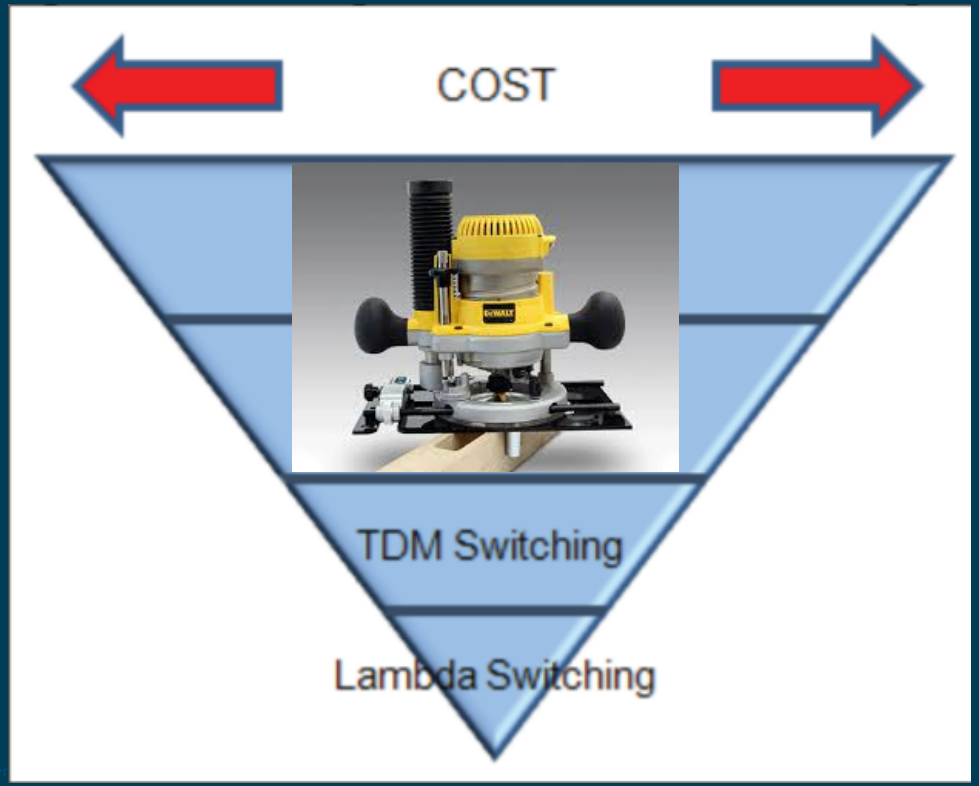
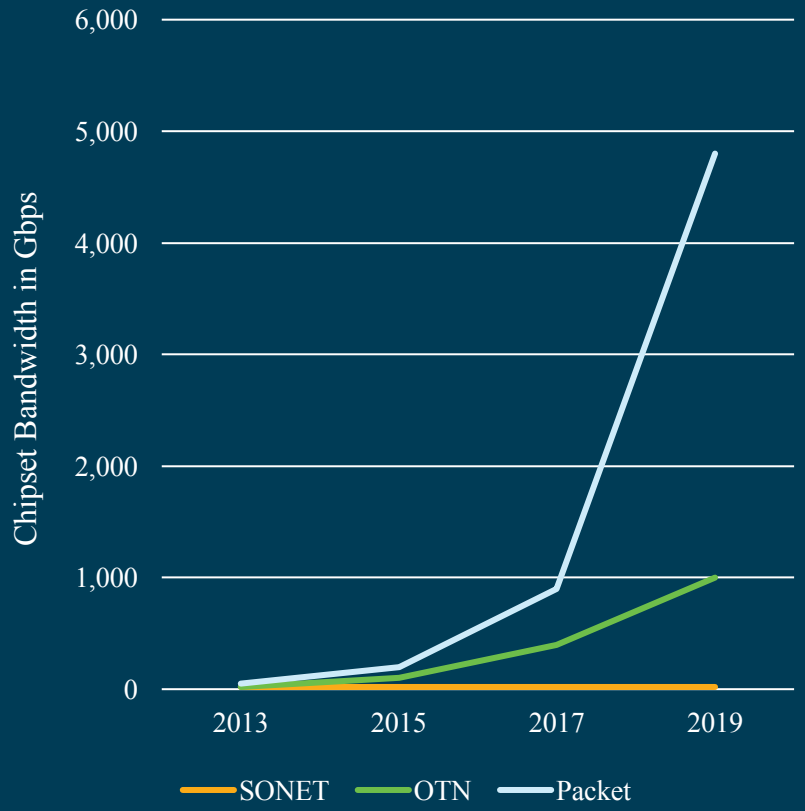
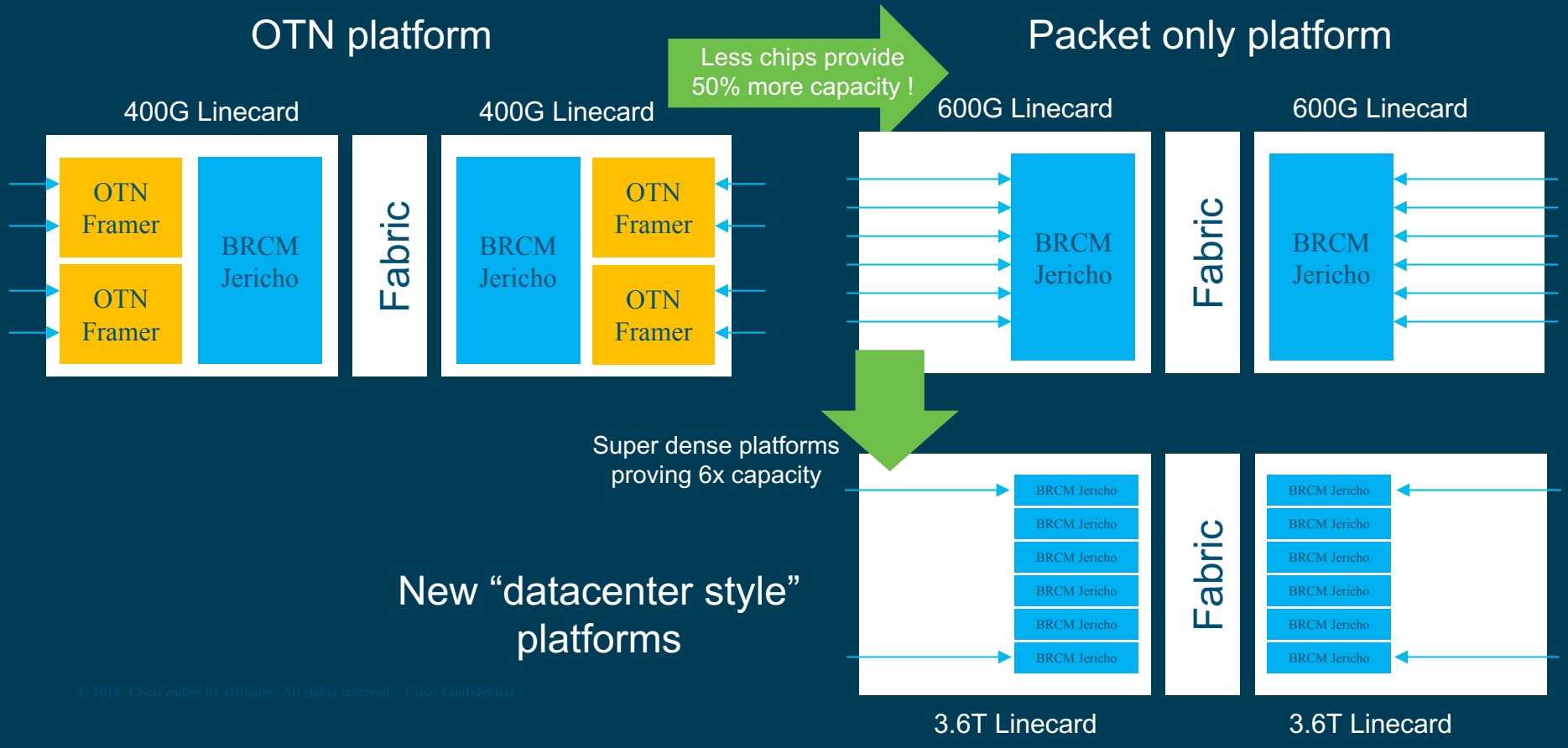


Technology Scale Evolution

- Investment in TDM chipsets have been declining.
- OTN's relevance as a switching layer is toast
- Pure packet chipsets enable superior scale and smallest power per bit
- Circuit emulation enables highly scalable and distributed TDM switching over a modernized packet network.



Packet Transport providing lower Transport Cost



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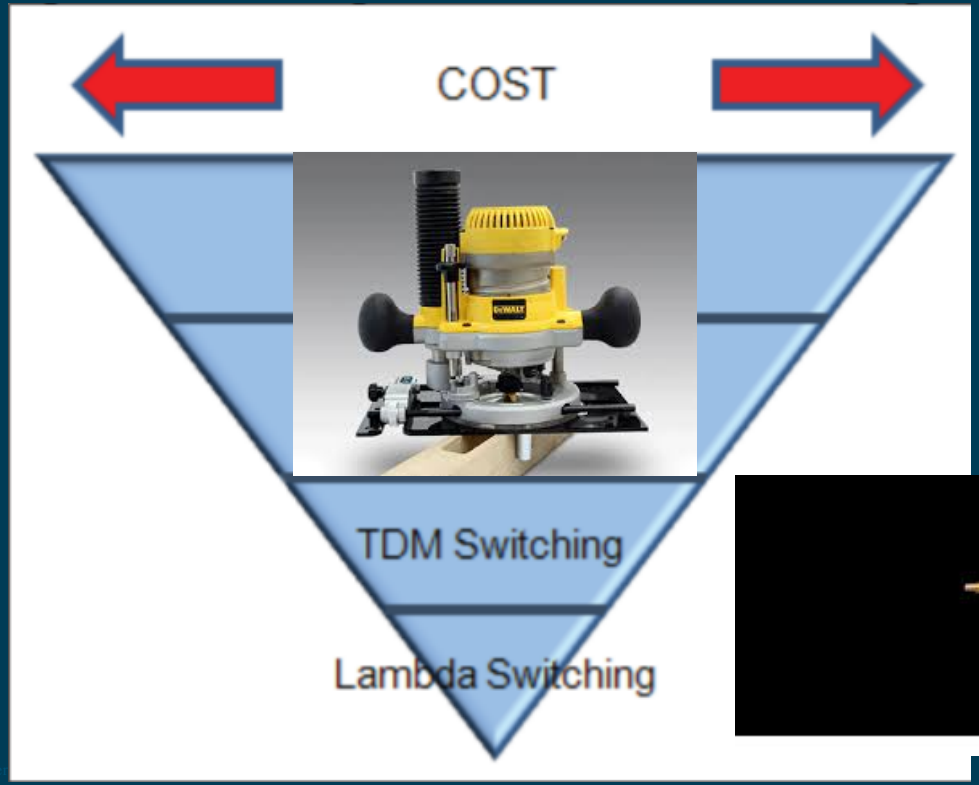

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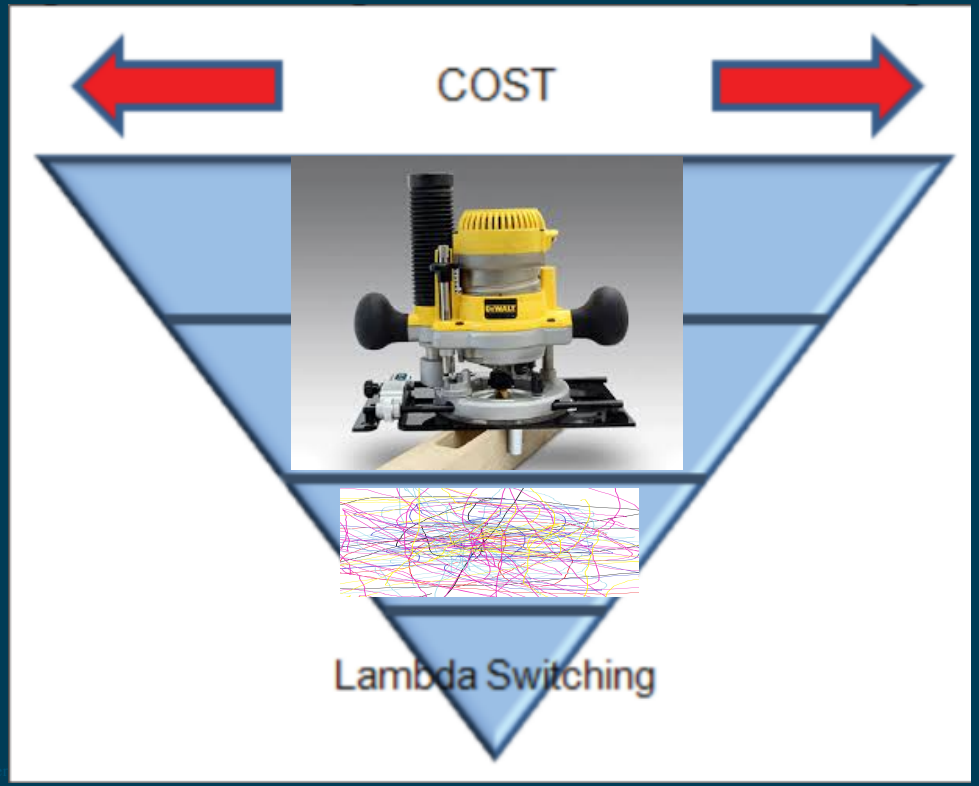

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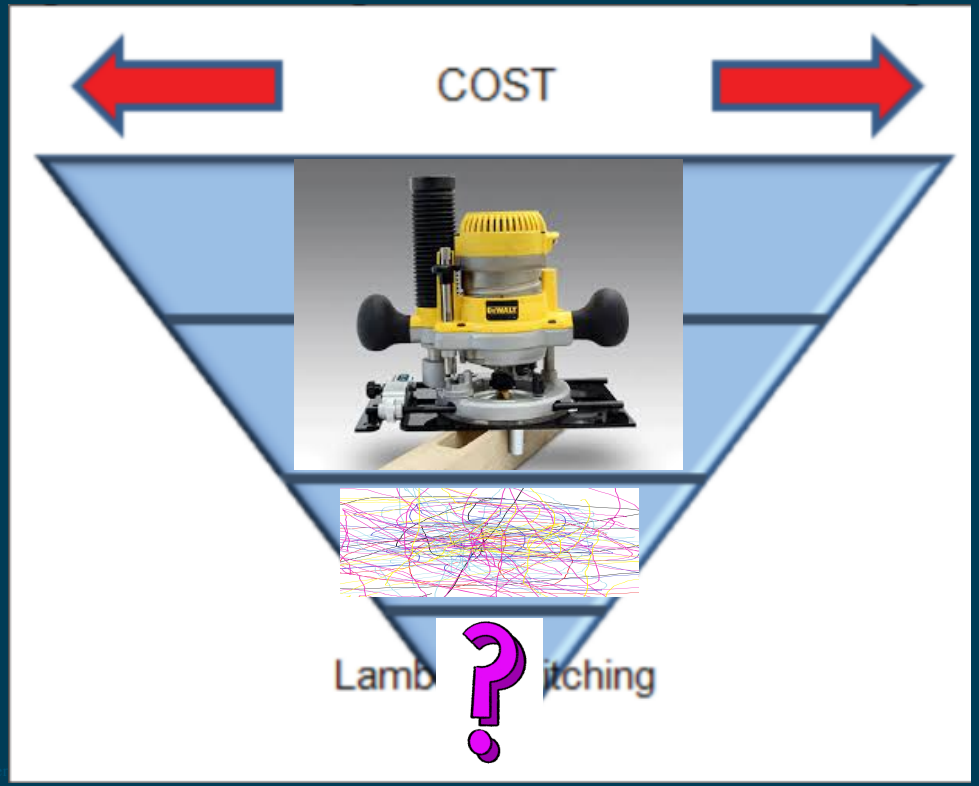
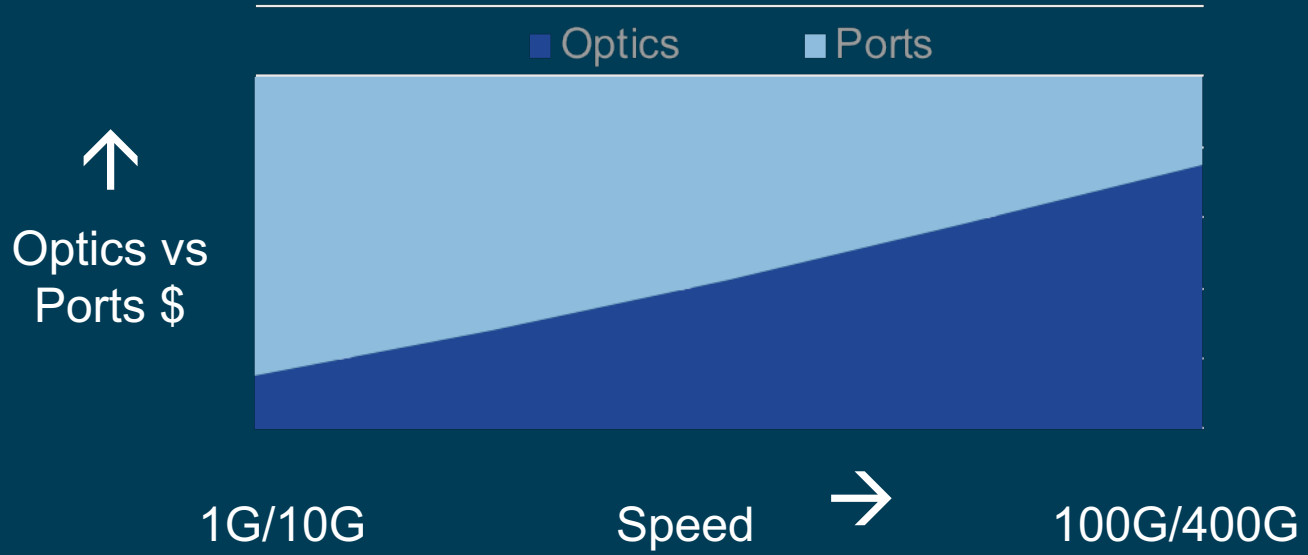
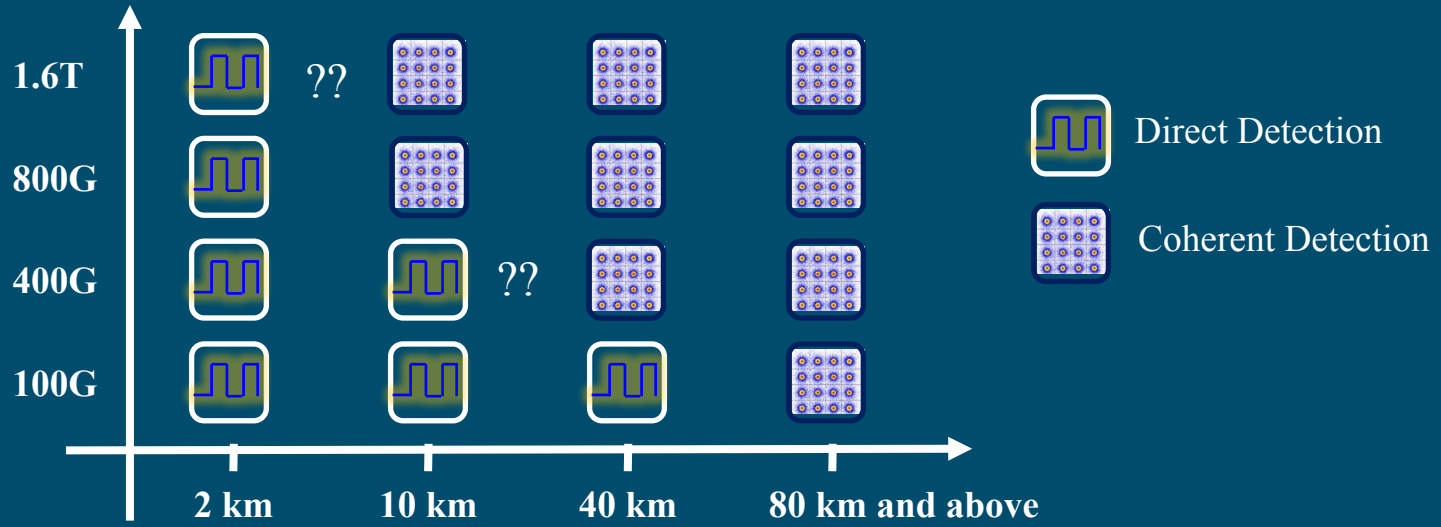


The times they are a changin’



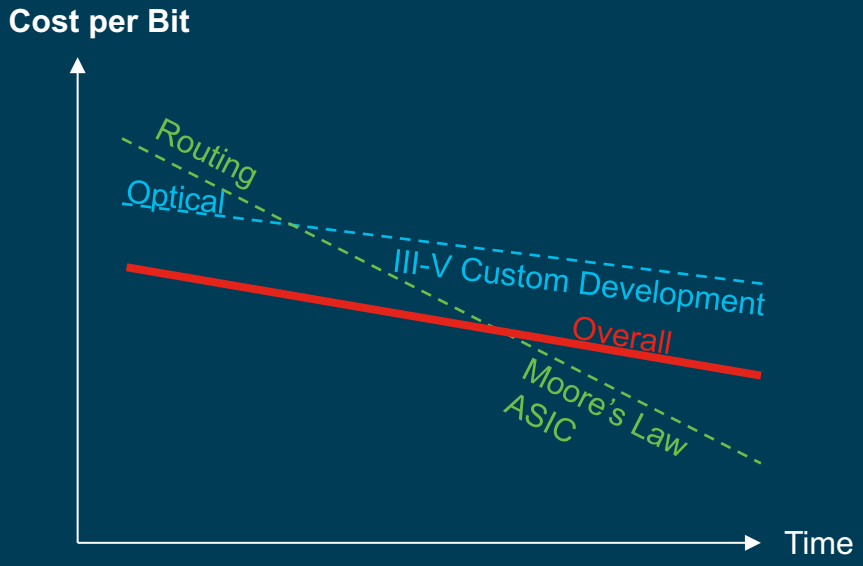
Host port costs are decreasing FASTER than optics technologies.
Optics complexity increases with speed.

Expanding Need for Coherent as Bit Rate Increases



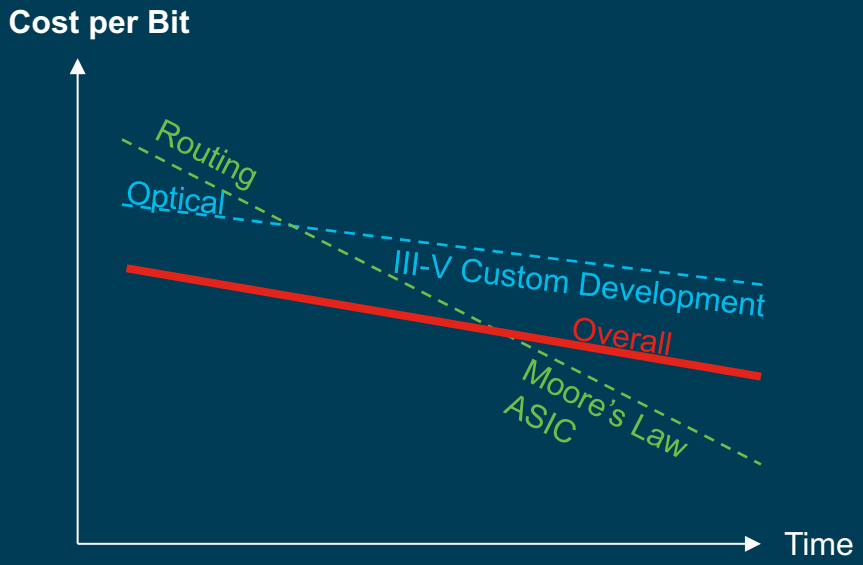
Reach limitations of “Direct Detection” at higher speeds will expand the need for coherent detection

What about the optical infrastructure?



Current trend: port cost stays the same
- no benefit from cost reduction

What about the Infrastructure?



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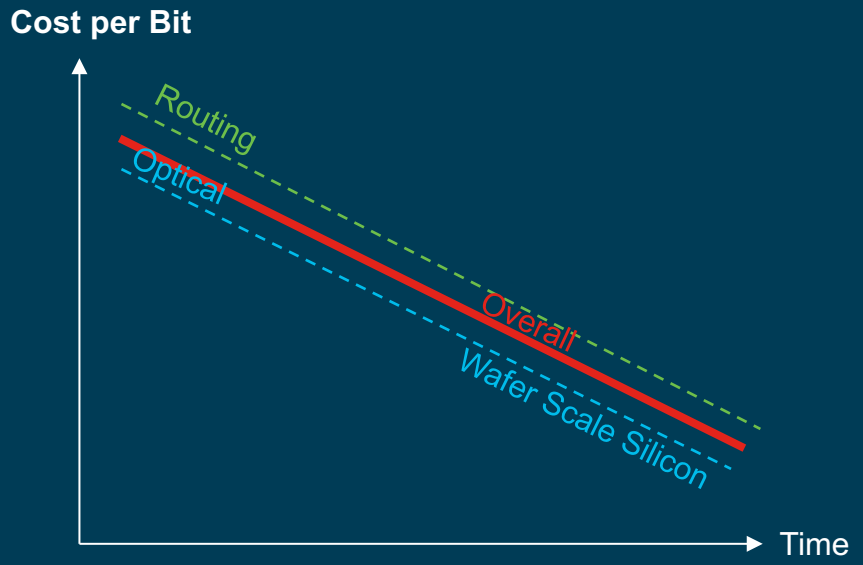


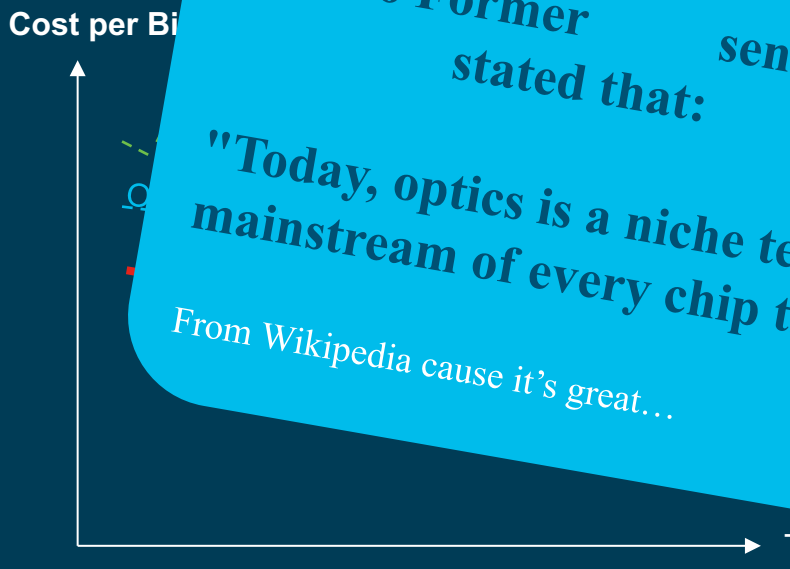
What if we switch it up a 'lil?
Leverage the market shifts – increase bandwidth within reasonable distances

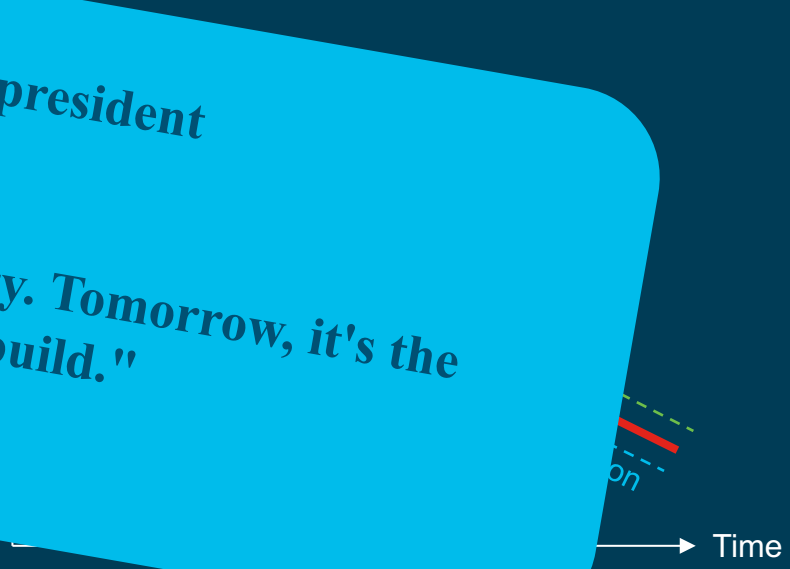
What about the Infrastructure?

In 2006 Former senior vice president stated that:

"Today, optics is a niche technology. Tomorrow, it's the mainstream of every chip that we build."

From Wikipedia cause it's great…





Current trend: port cost stays the same
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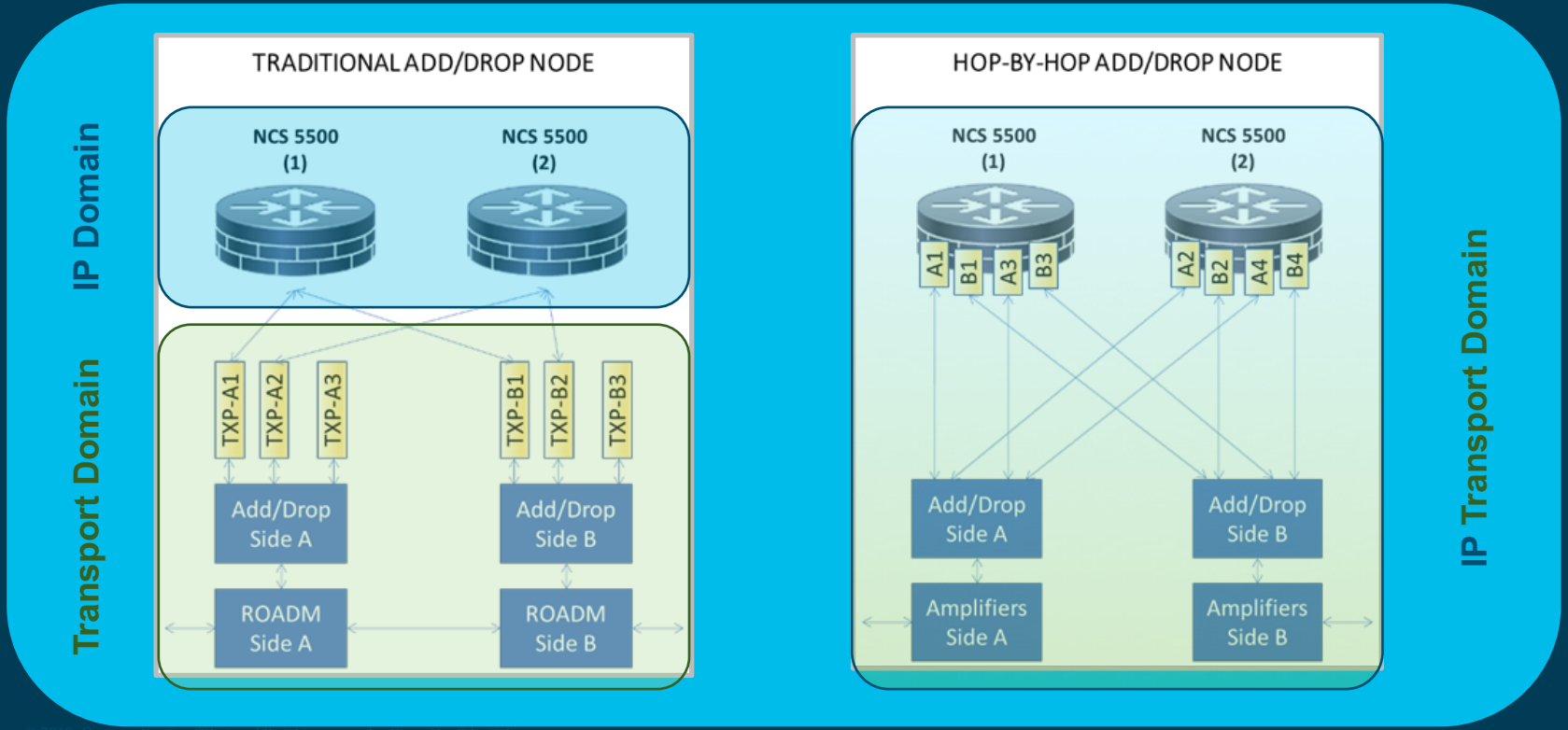
What if we change the game?
Leverage the market shifts – increase bandwidth within reasonable distances

Traditional vs. IPoEoF (Hop-by-Hop) Node Architecture



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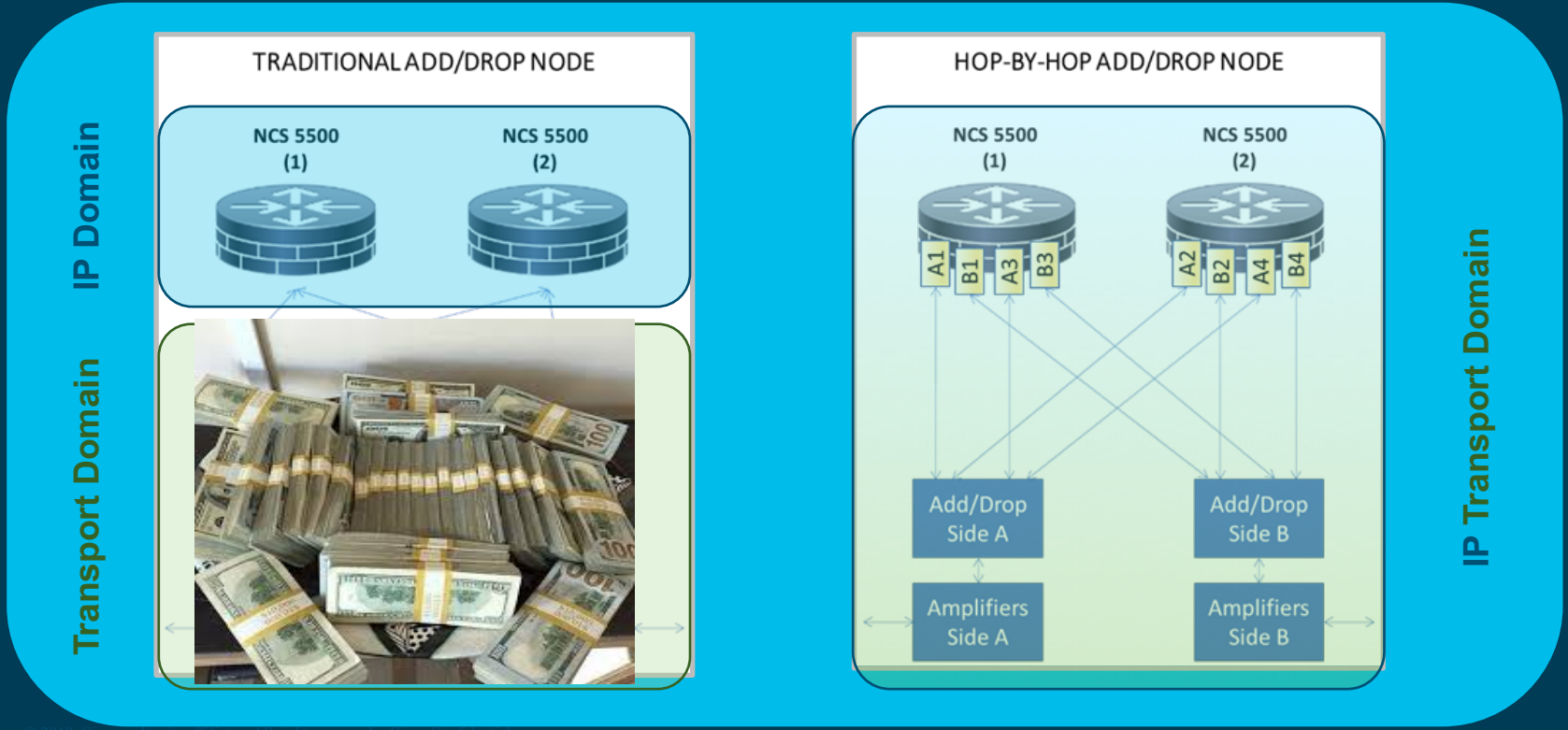
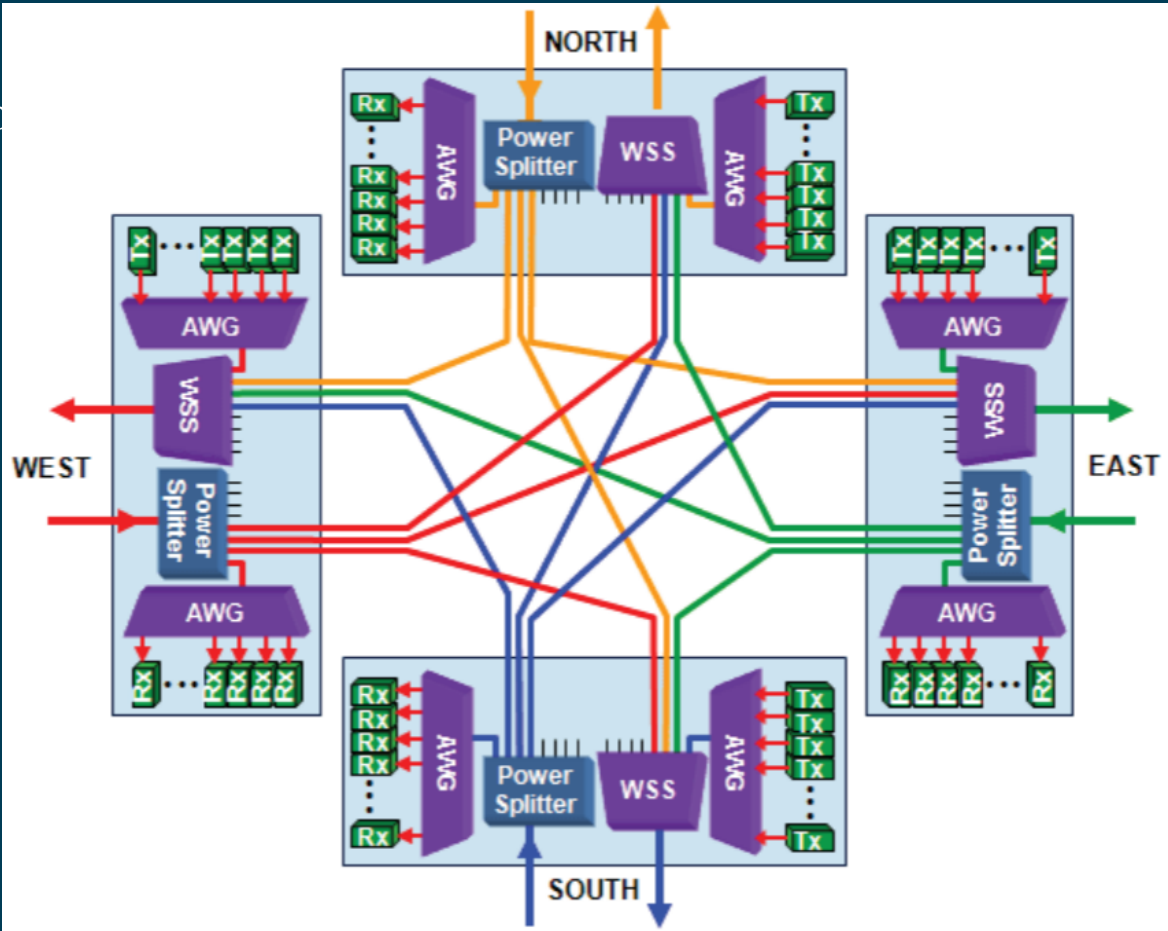


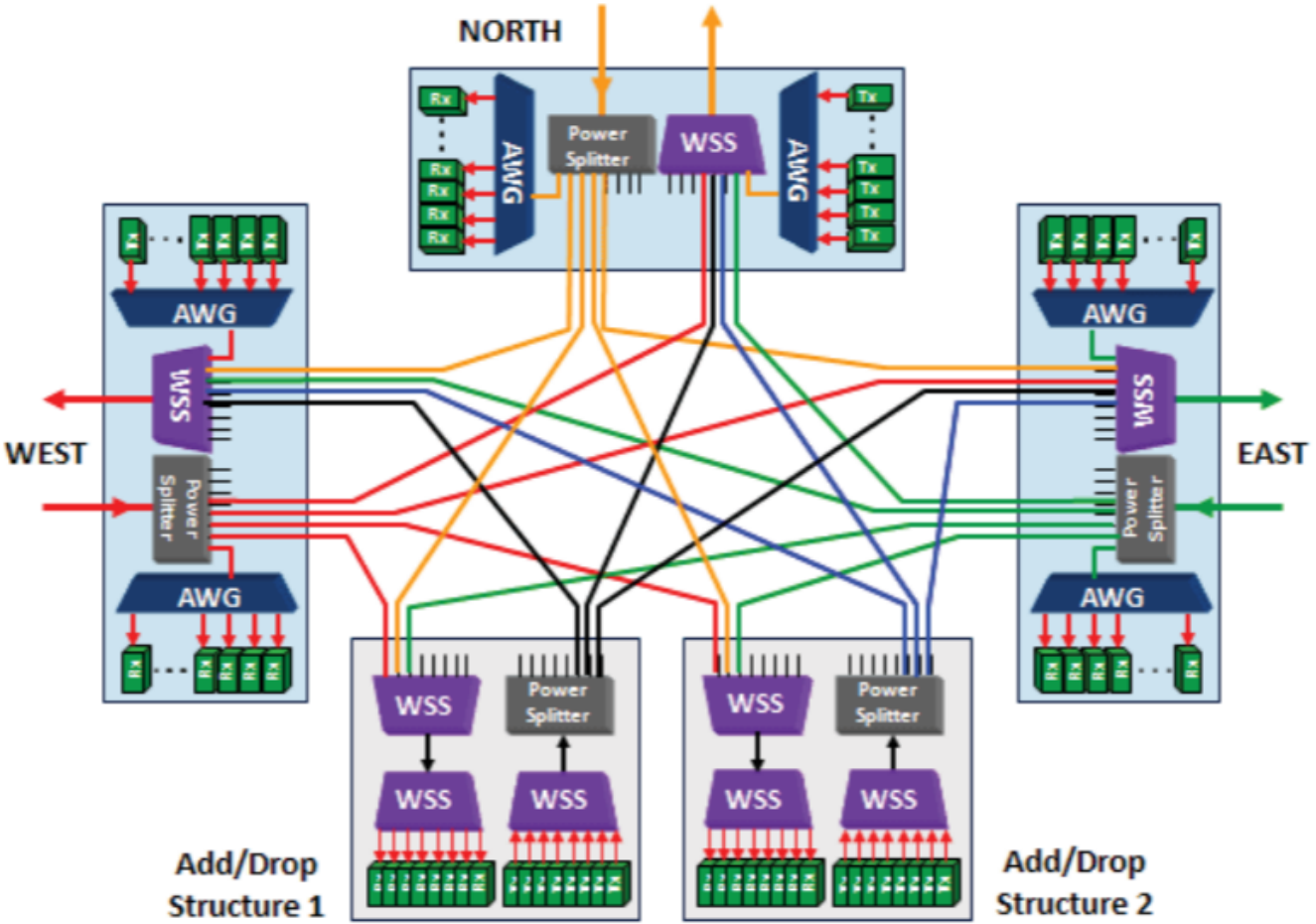
Here's why they're expensive

- ROADM's are pretty cool techno
- LCOS-based WSS
  Wavelength Selectable Switch
- Expensive part.
- More degrees, More $

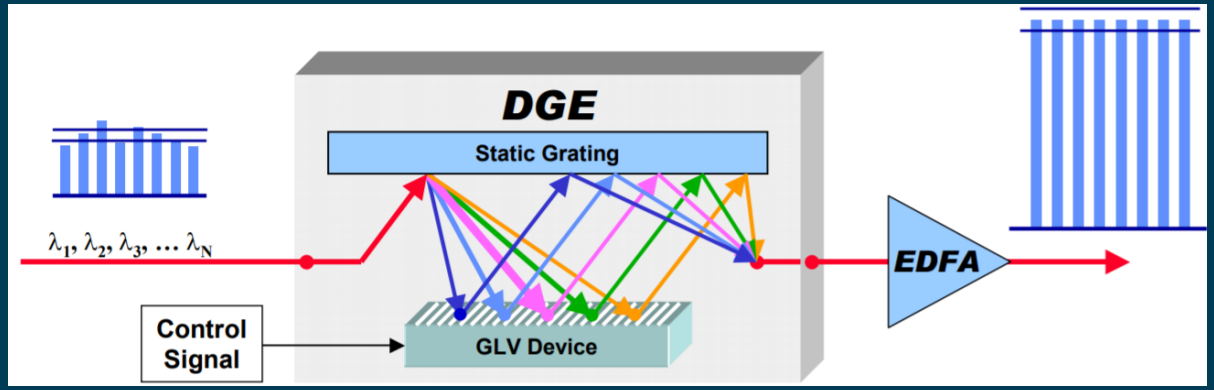


And more expensive

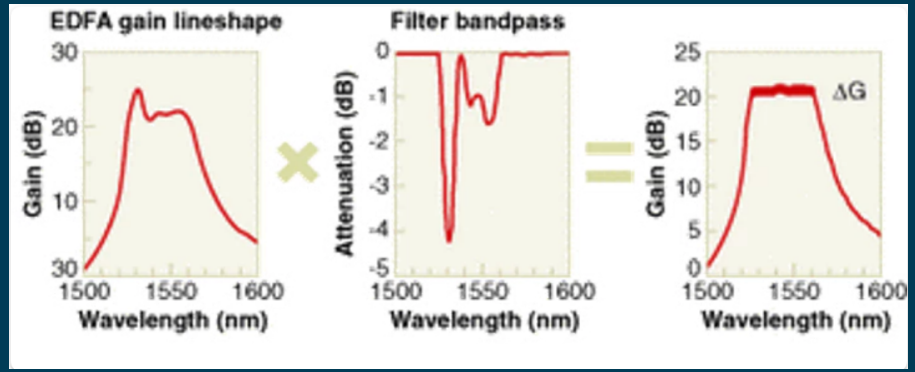
- If you want them to be flexible, you need more expensive parts
- And more of them…

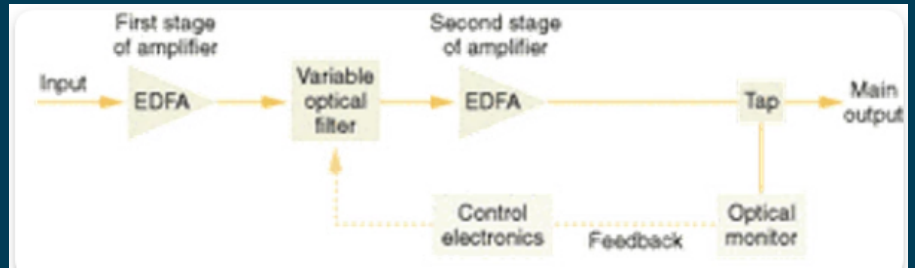


Gain Equalization



- Light needs to be amplified.
- Amplifiers induce ‘tilt’ cause physics is strange stuff
- While it’s compensated for within each amp, it’s not perfect and it adds up over time.
- DGE can be performed by ROADM’s or… coming soon(again?) amplifiers





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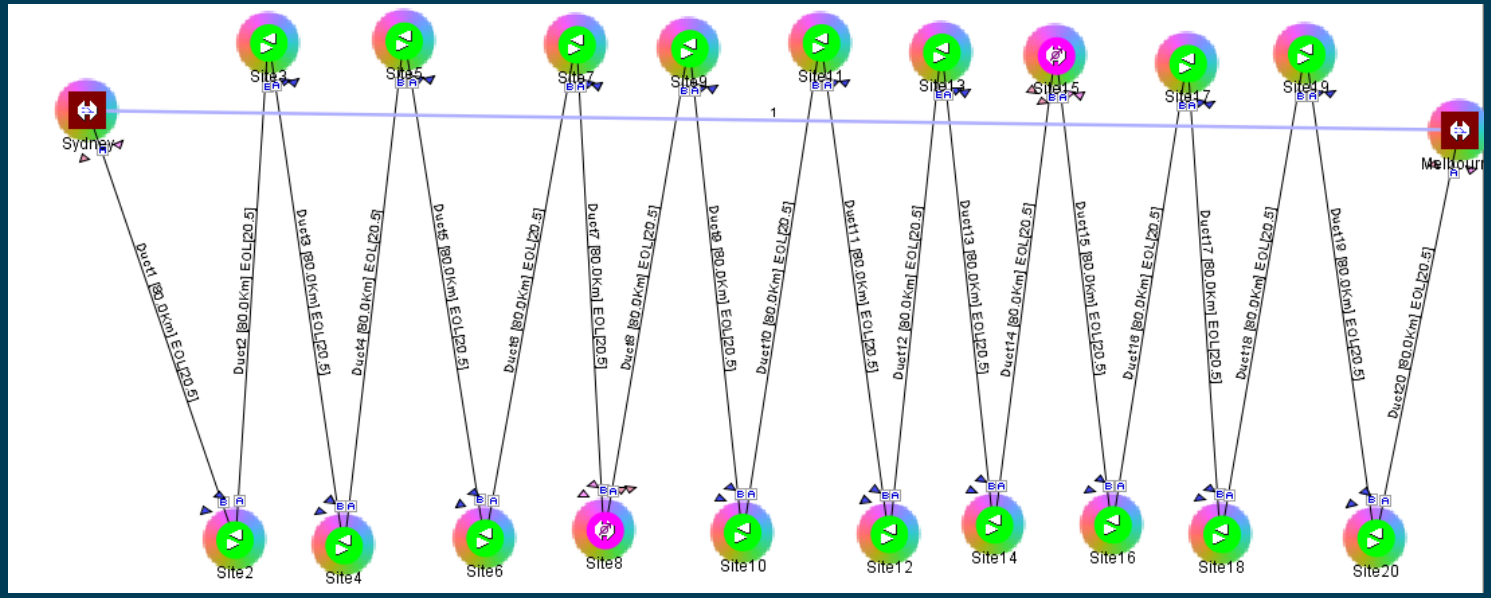
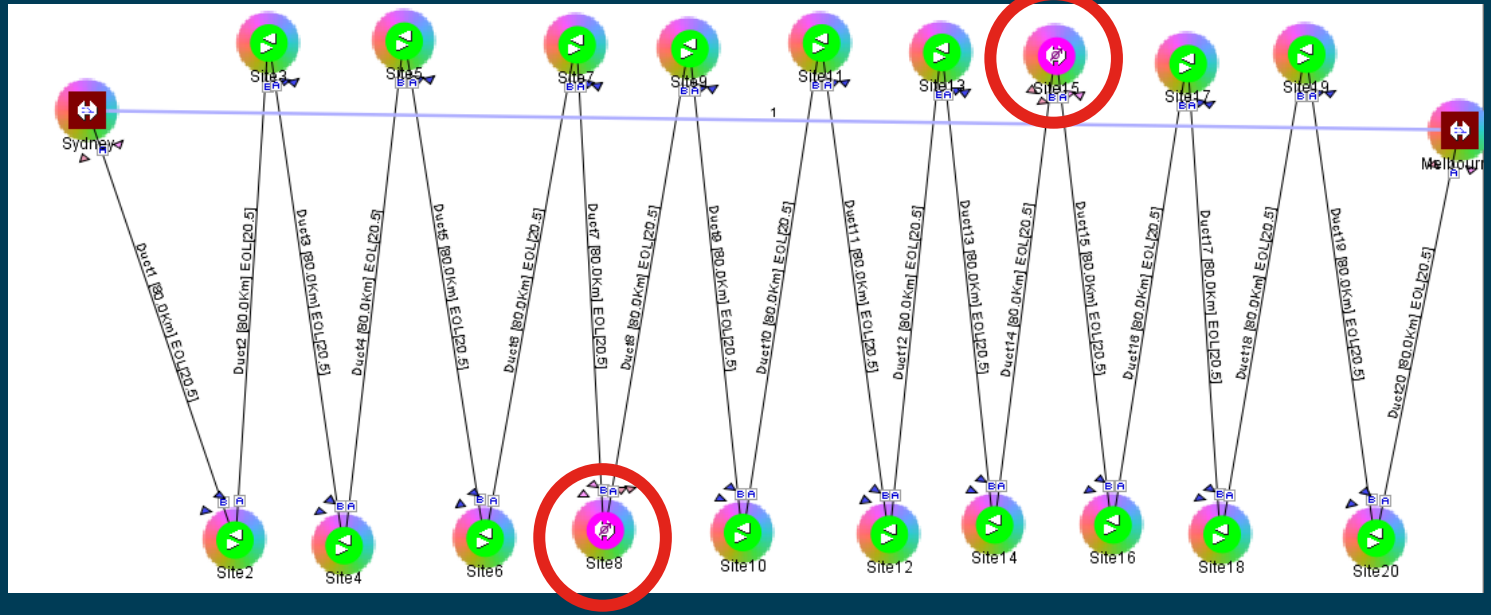


- Brisbane/Cairns ~1500km's, 80k spacing, = ~19amp's.
- DGE required after ~7 amp's, that's 2 pairs of ROADM's.

Gain Equalization



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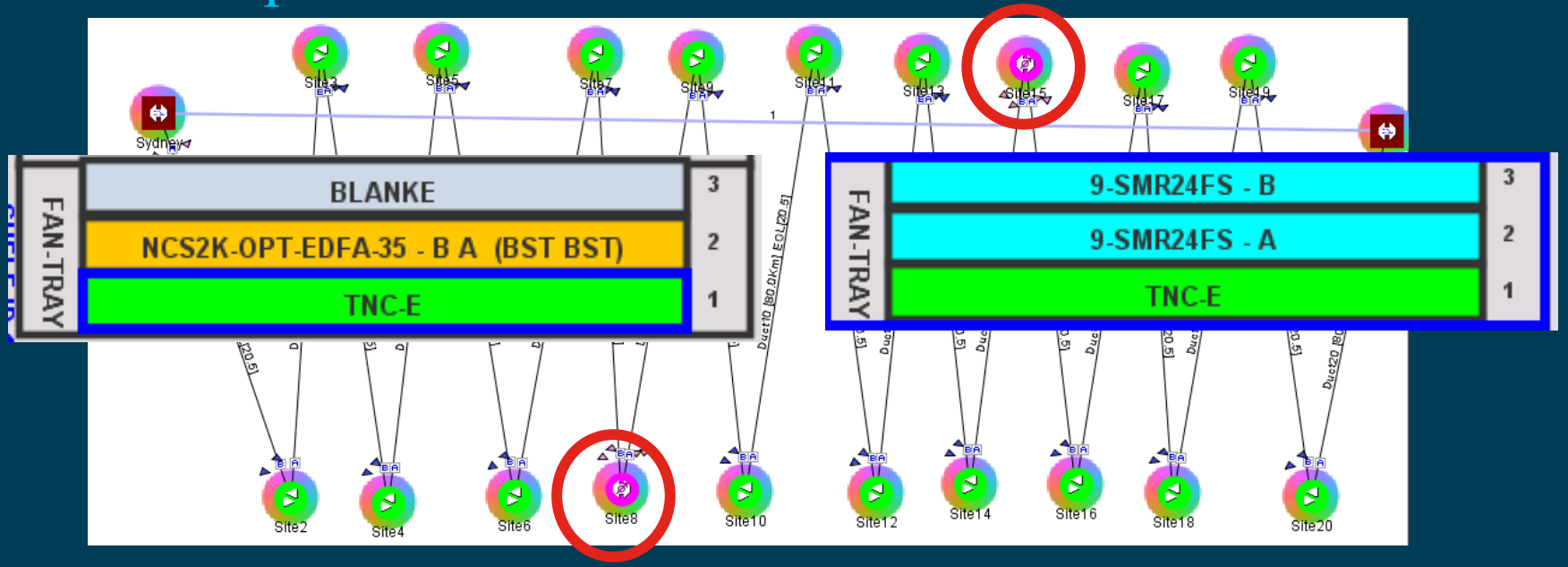

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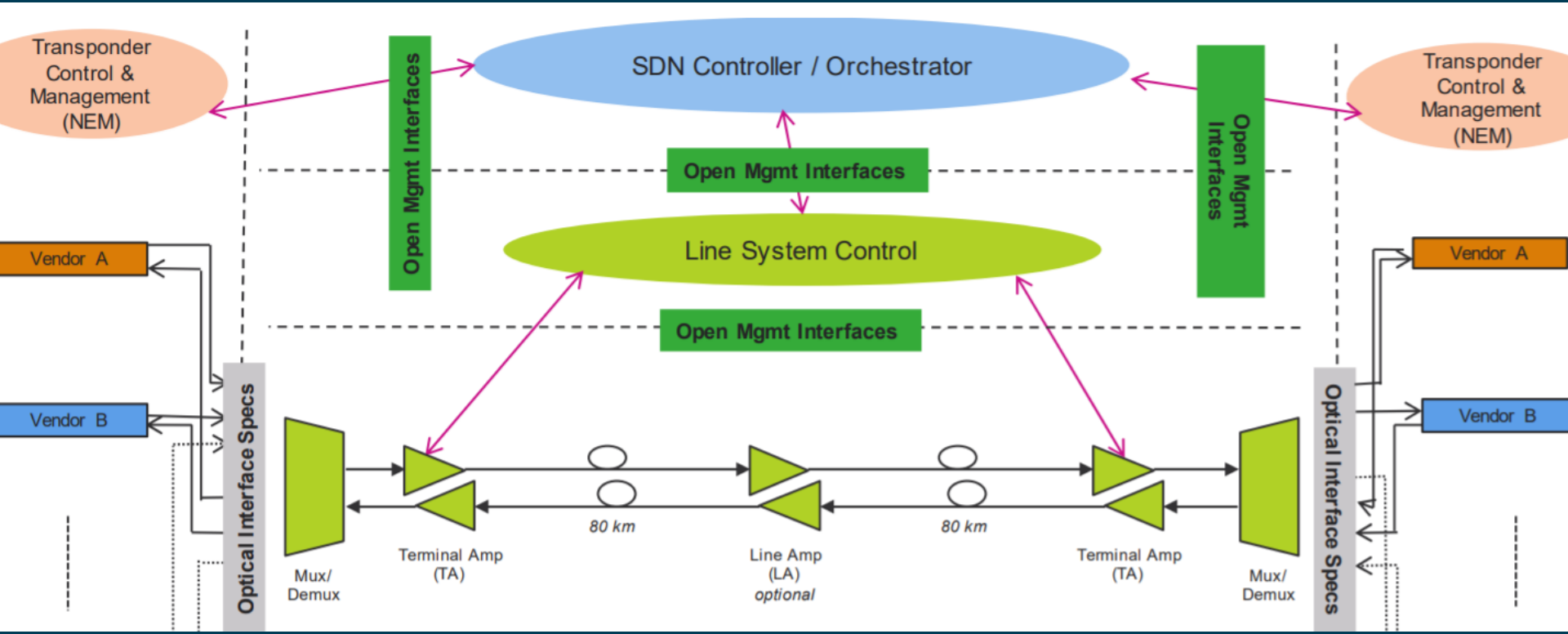
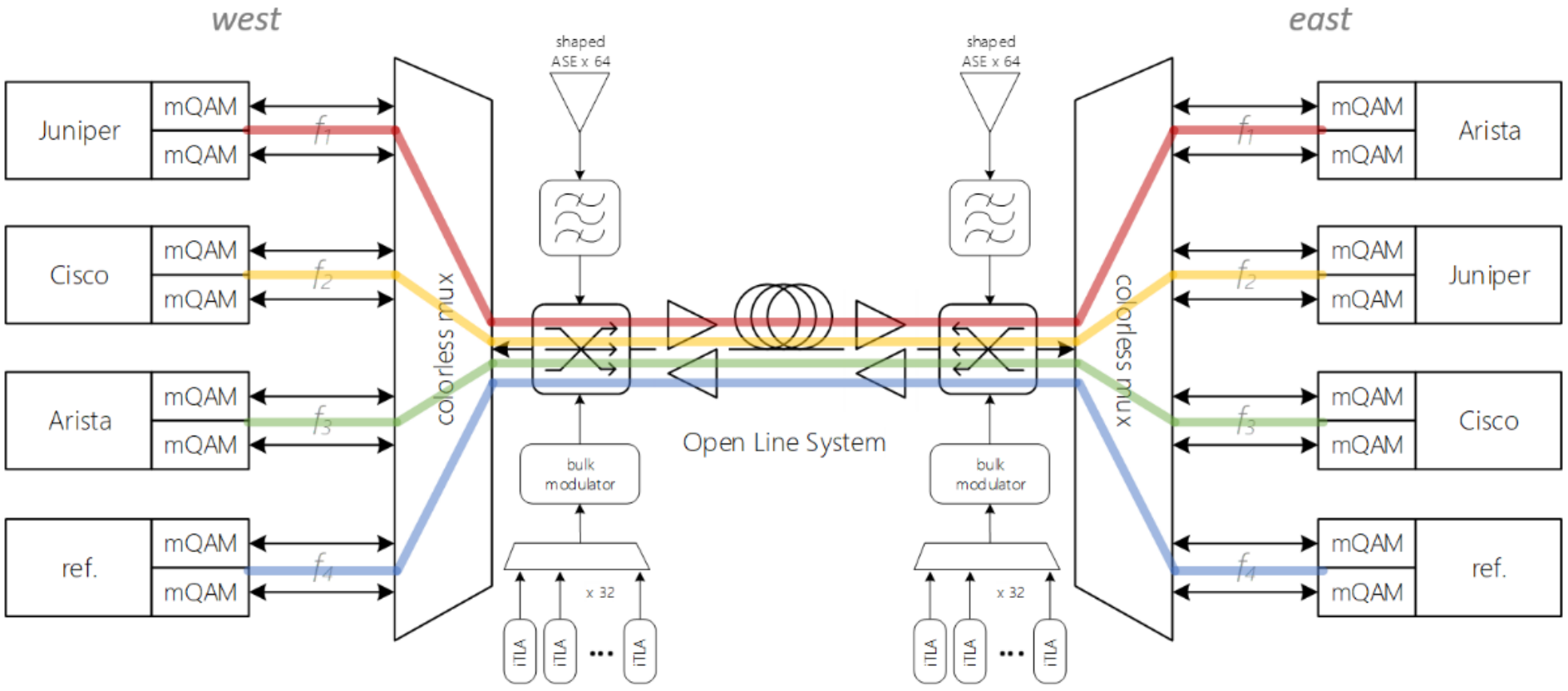
An architecture for lean line systems…

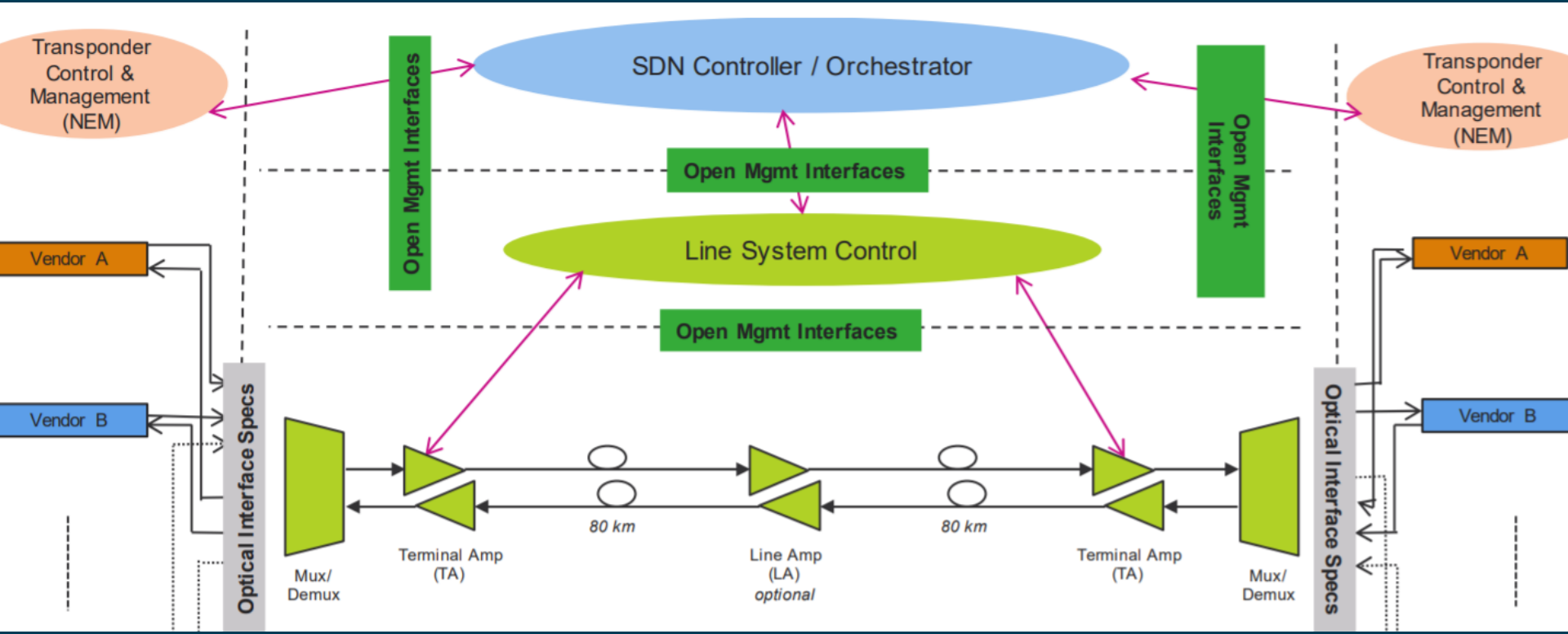


A leaner architecture…



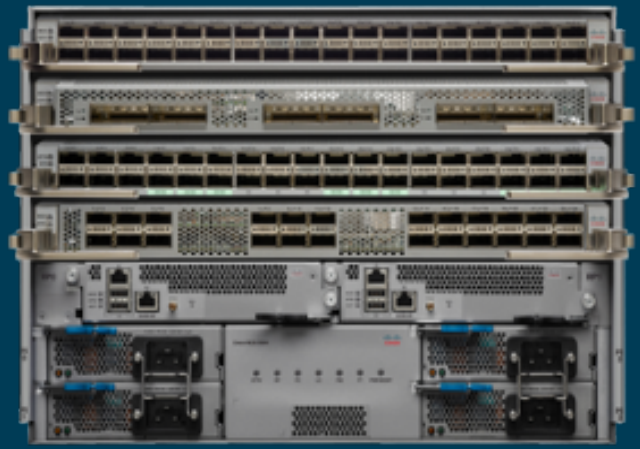
From a very public Microsoft paper on their work on IPoWDM & open line systems.

An architecture for lean line systems…



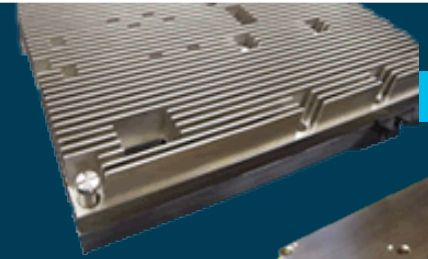
Haven’t we tried this before?

- In previous and current generations, we paid a substantial density price for including WDM on our linecards.
- In the example on the right, we turn a 3.6T slot into a .6/1.2T slot.
- Cause DSP’s are big and hot (and incredibly capable…)
- IPoWDM wasn’t compelling because the transponder was all we could replace. We were only addressing a small part of the overall picture and even that came at a huge density cost.

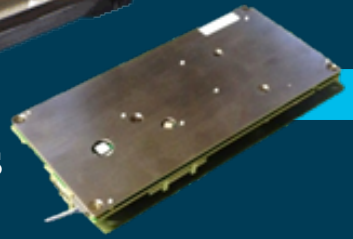


Coherent Optics Integration Innovation

2011 2014 2016 2018 2020



5x7 inches



3x6 inches

CFP2

CFP2 DCO*

QSFP-DD
DCO*

DCO* - Digital Coherent Optics
Has DSP + Coherent Optics

Coherent Optics Integration Innovation

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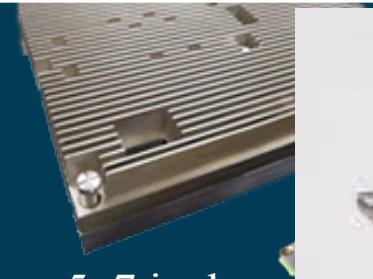

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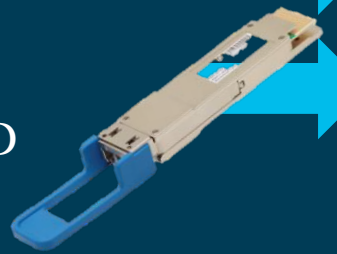
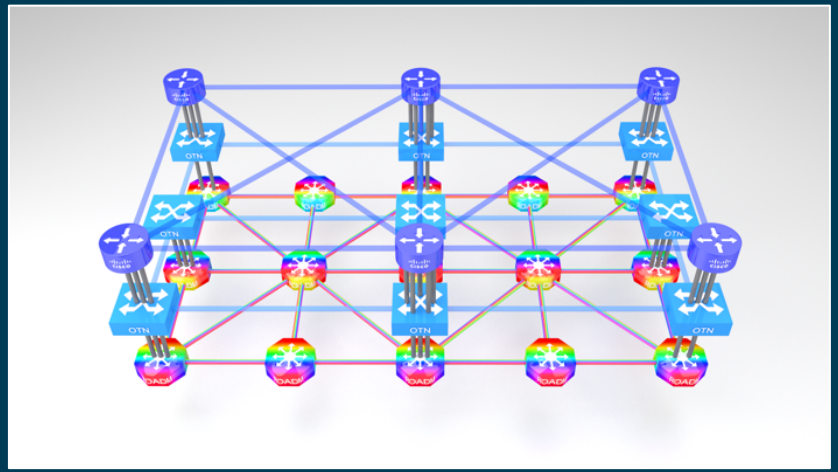
DCO* - Digital Coherent Optics
Has DSP + Coherent Optics

QSFP-DD
DCO*



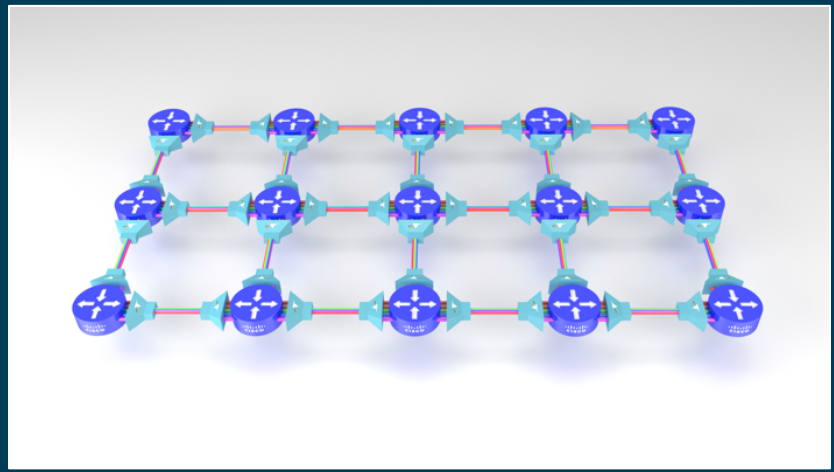
Comparing Network Architectures

Traditional Router + Transponder + ROADM Architecture



- **Expensive**
- **Operationally Complex**
- **Consumes more spectrum and can result in fragmented spectrum (difficult to recover).**

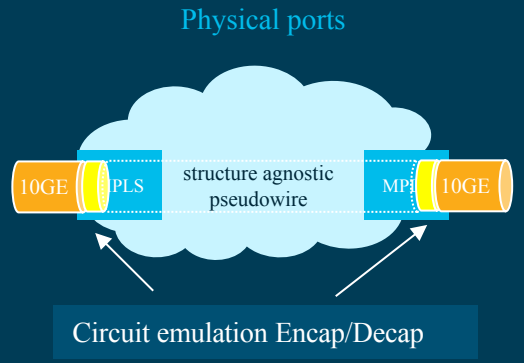
Router with Integrated Optics + Hop-by-Hop Terminal DWDM (“Digital ROADM”)

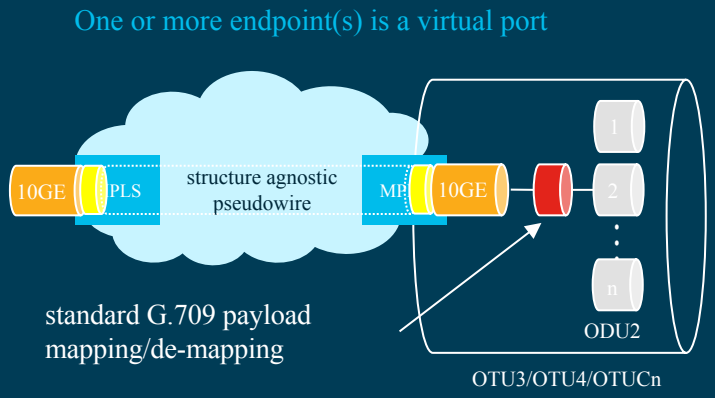


- **Simpler**
- **Greatest spectral efficiency**
- **Best performance, lowest cost and easiest to automate**
- **Single Control Plane**

But what about layer-1 wholesale services?

- Chuck em in a psuedowire and push it over SR-TE ‘circuits’ which can behave exactly like transport-TDM pipes.
- We did it for TDM.
- It’s happenin’ for OTN





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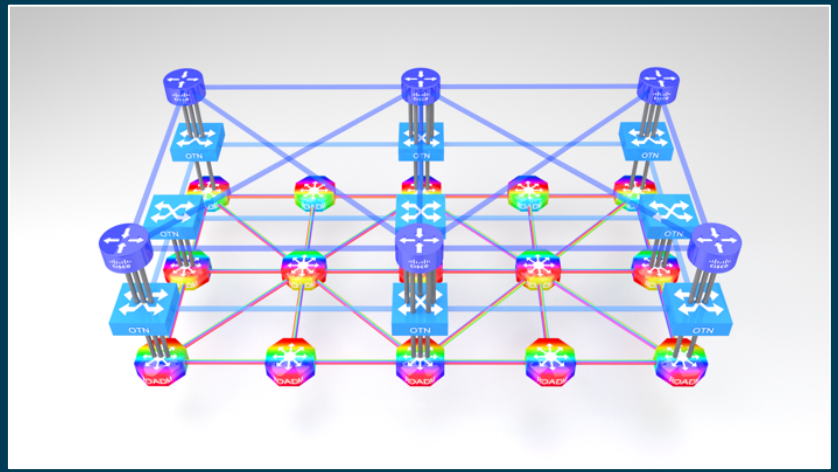

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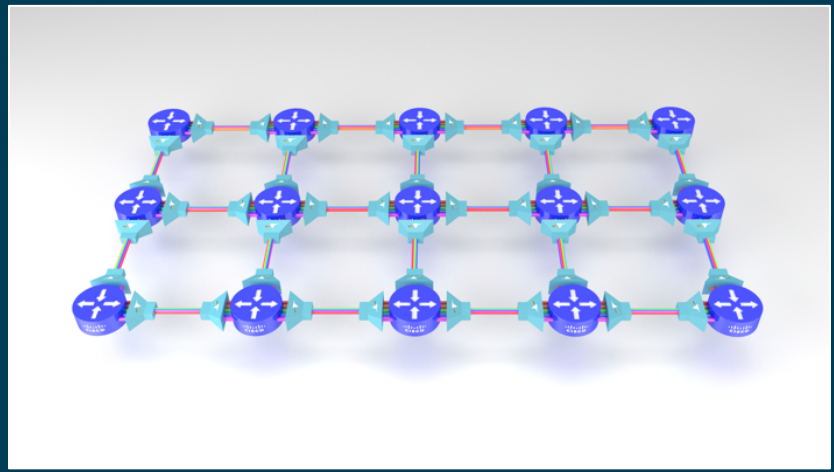

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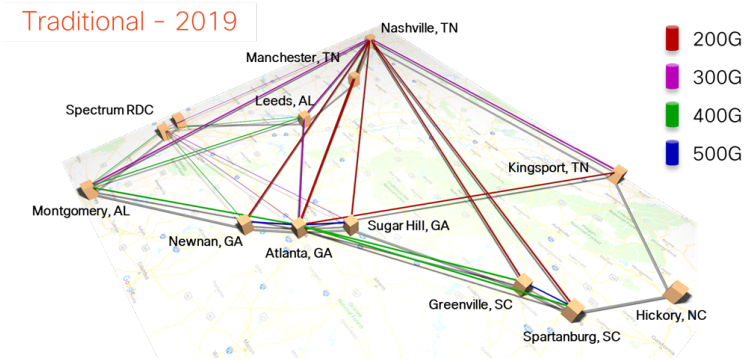
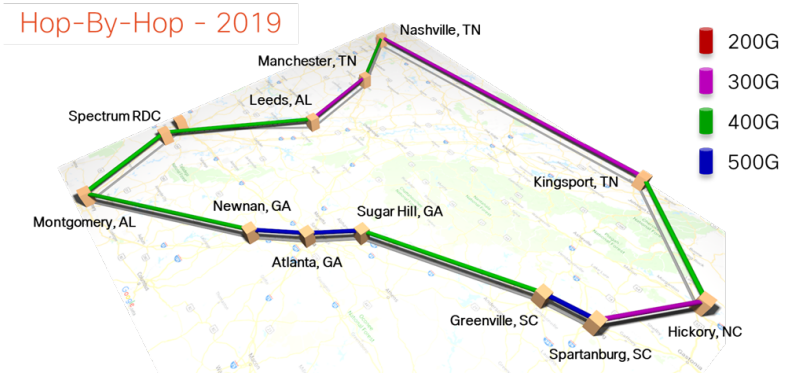
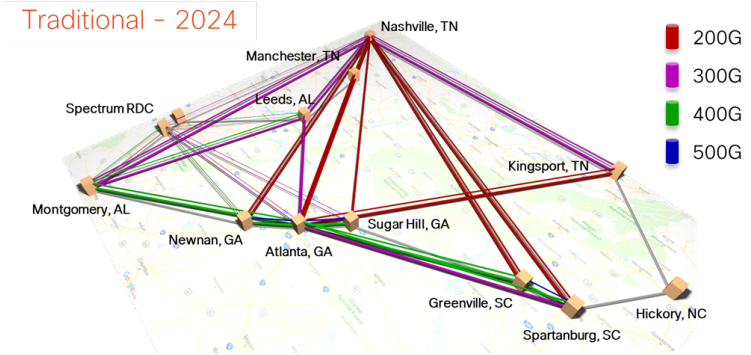
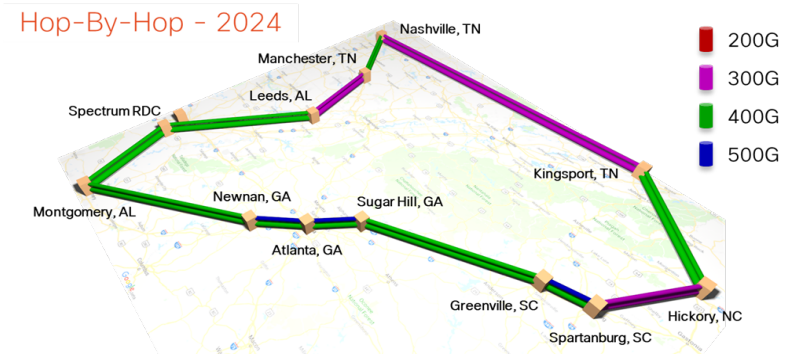
Capacity Gains!

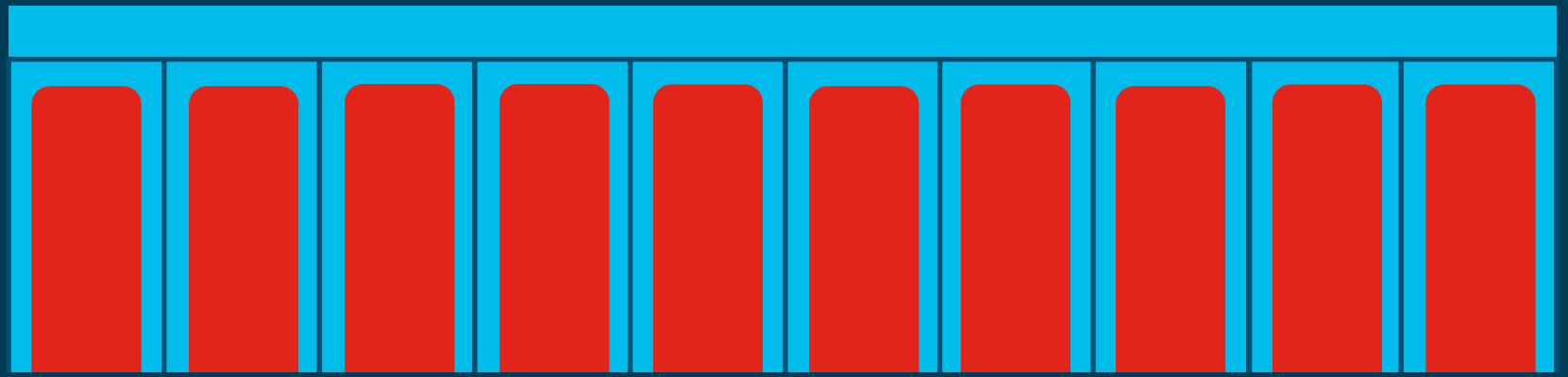




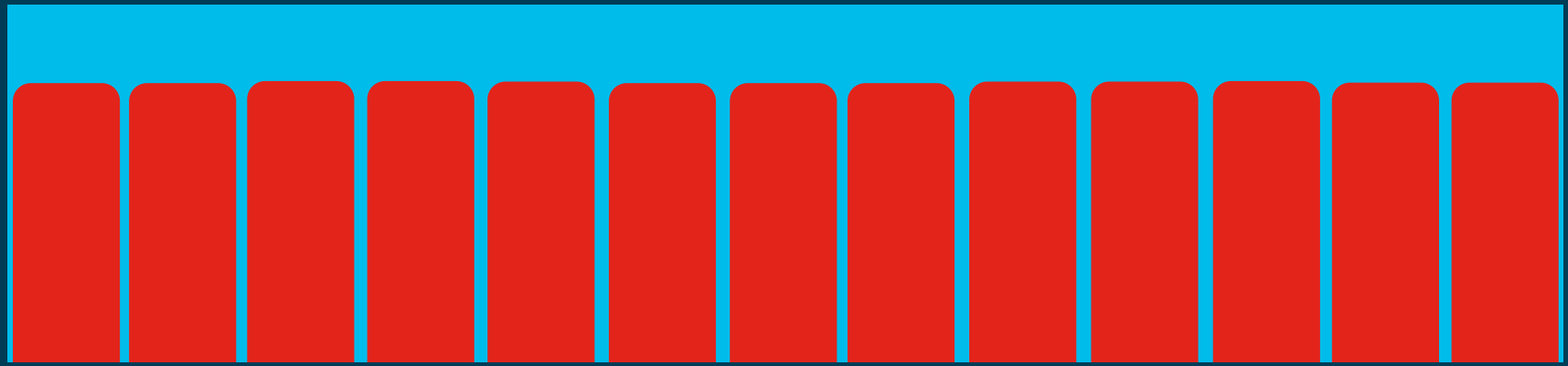




Guard Bands



Fewer Guard Bands = more channels



What's not to like?

- Pay as you Grow
- More Capacity On Fiber
  - More WL per Fiber
  - Shorter Un-regenerated WL
  - More BW per WL
- Sub-Lambda Grooming
- Simplified Optical Design
- Elimination of ROADM
- No WL Contention

- Single protection layer
- More Resilient
- Infinite Degree Scale
- Infinite Node Scale
- Simpler Multi-Layer Optimization
- Adopt Packet Mgmt Model
- Adopt Packet Cap Mgmt Tools

Open Questions?

- Latency
  - Real world – non issue?
    - Difference is (switching delay & FEC encap) x number of hops @ 400G serialization delay
  - Magic-money land…
    - Hibernia Express – High frequency trading?
- Anything else?

Thank you!