IMPLICATIONS OF 100 GE

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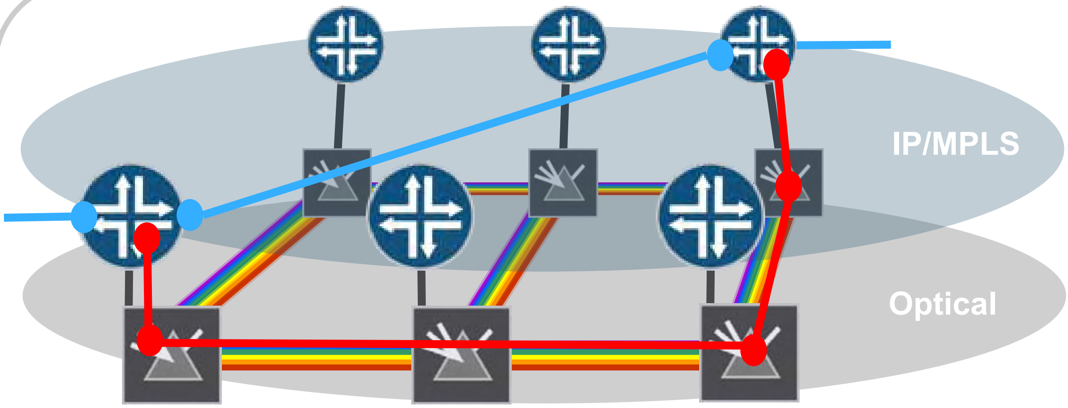
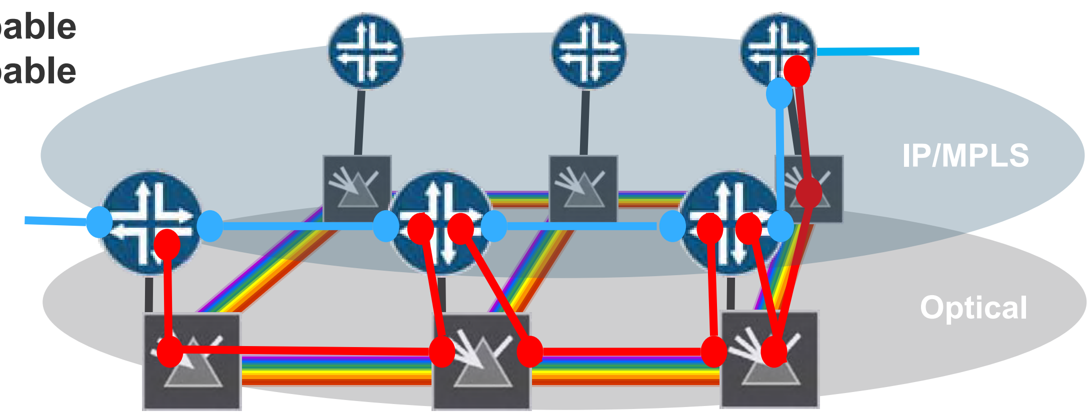
Juniper Networks

Design Alternatives for Multi Layer Transport



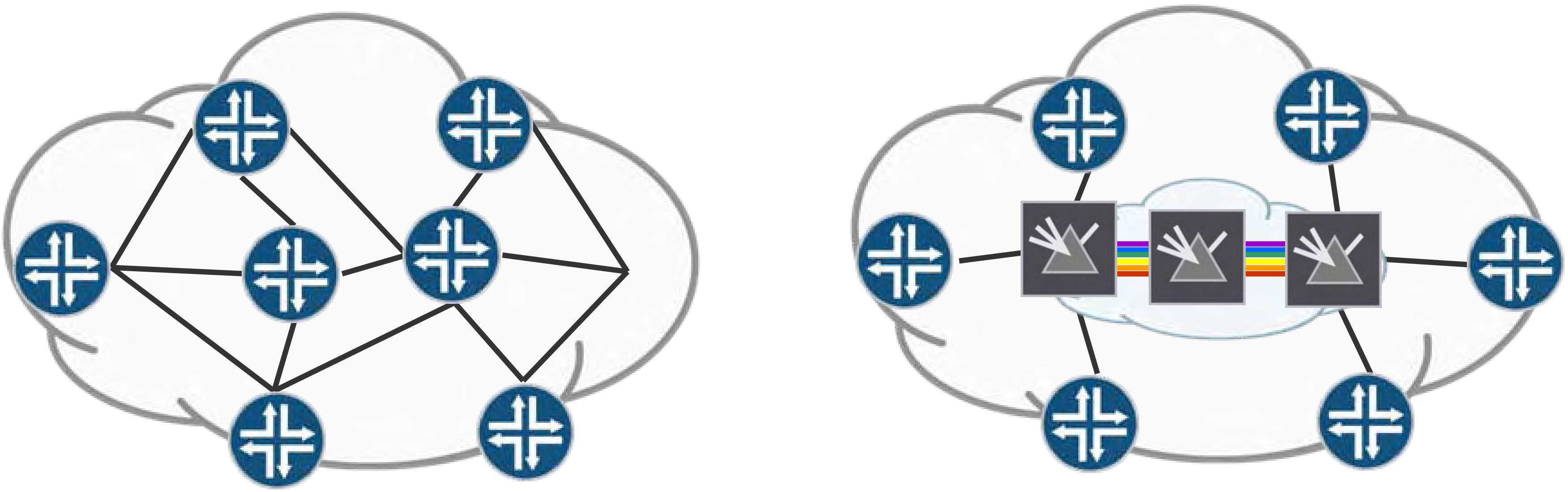
Express Connection

Add/Drop Capable
Stat Mux Capable



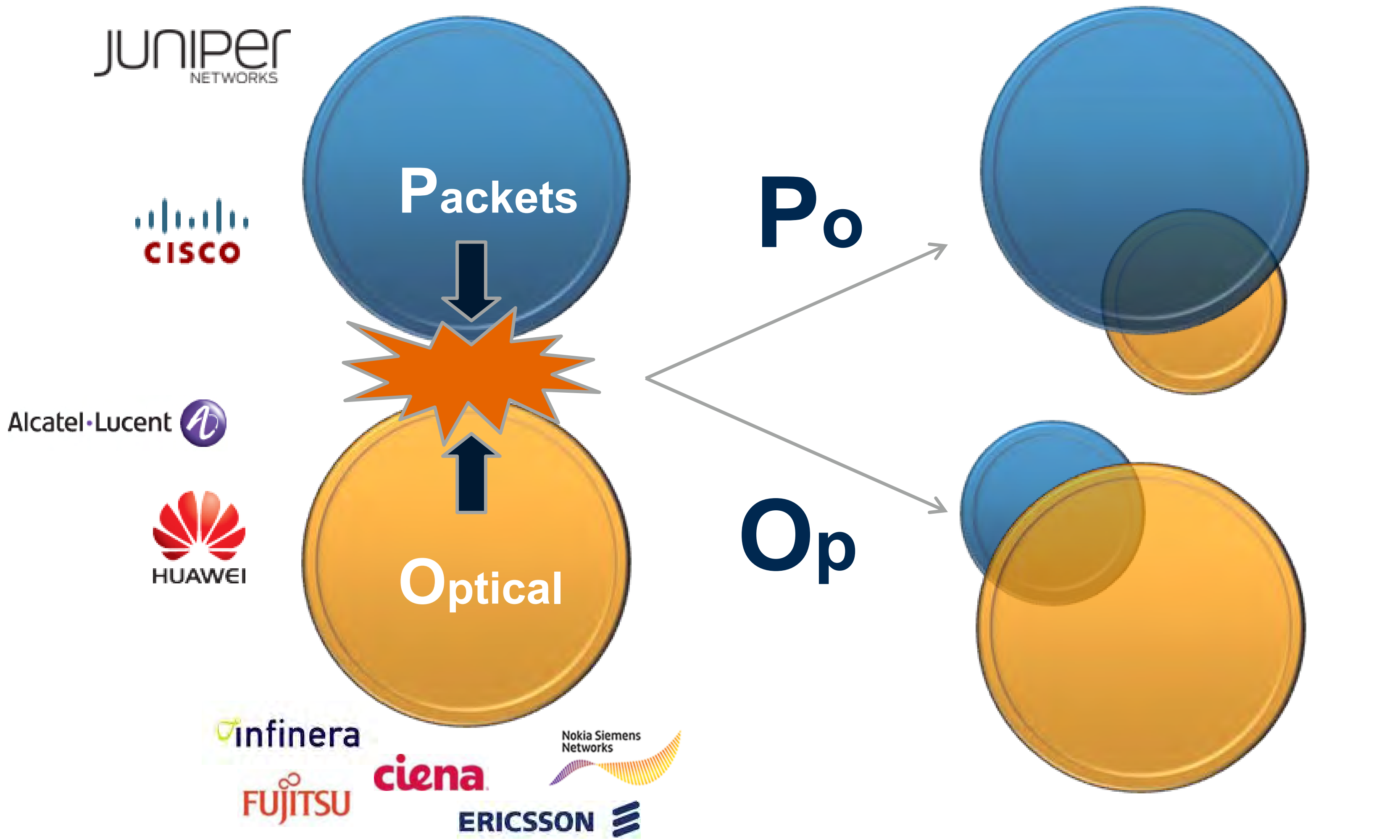
LOOKING AT THE ALTERNATIVES

- **When does it make sense to create expressways with optical layer gear in the core?**



IP/MPLS network → **Optical Transparency**

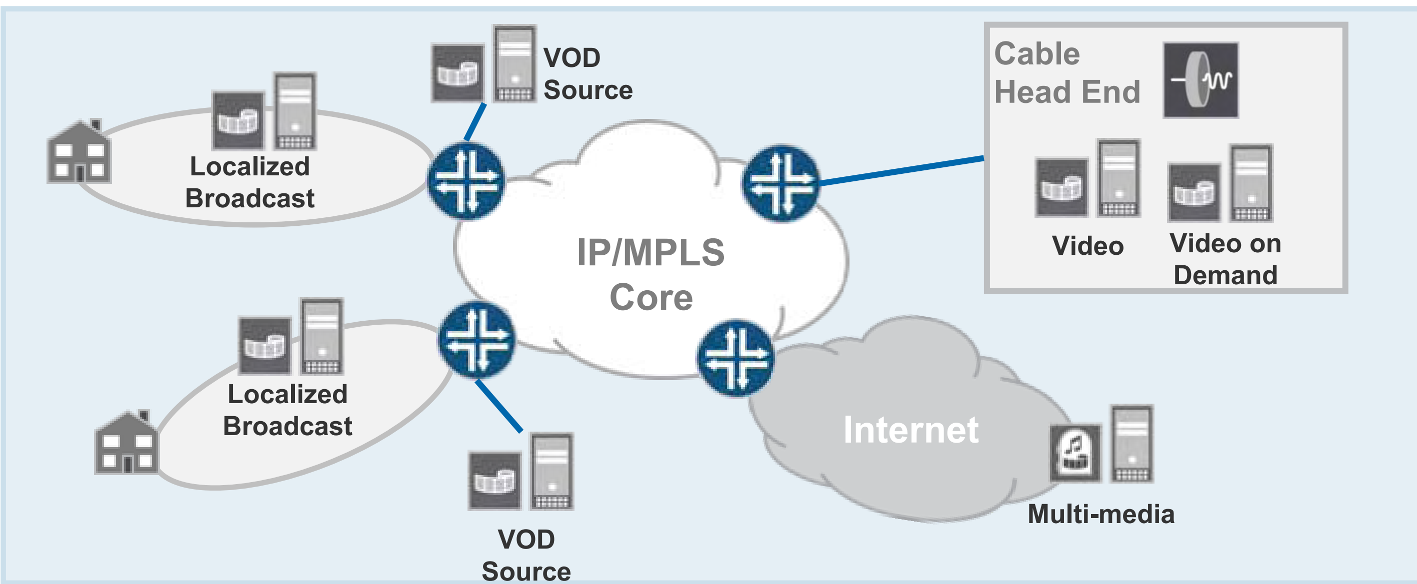
INDUSTRY AT A CROSSROADS
NETWORK AND PRODUCT ARCHITECTURE MIGRATION



WHERE IS THE TRAFFIC COMING FROM: SERVICES

Core routers serve as decision makers for many types of traffic

- **Internet traffic:** from data centers hosted in large cities (core router locations)
- **Internet traffic:** also traverses peering points (core router nodes)
- **IPTV and VOD content:** from video head end to residence across local and aggregation networks
- **Business VPNs:** travels from branch offices to HQs in major metros (core router locations)



DESIGN CONSIDERATIONS

Differences between OTN and Stat Mux for Core Traffic Handling

- **Flexibility** to moderate bandwidth variations between PE–PE meshes
- **Efficiency** port usage (high port demand on PE routers)
- **Signalling** (no dynamic re-signalling for hitless switchovers)
- **Granularity** circuit granularity (1.25G, 2.5G) versus "LSP" granularity
- **HA:** Strict protection with no SLA levels

The potential costs of transparency

- Cost and complexity move to the edge
- Higher traffic volumes in the core

The most cost-effective backbone-network designs are:

Packet services over MPLS, circuits over OTN switching

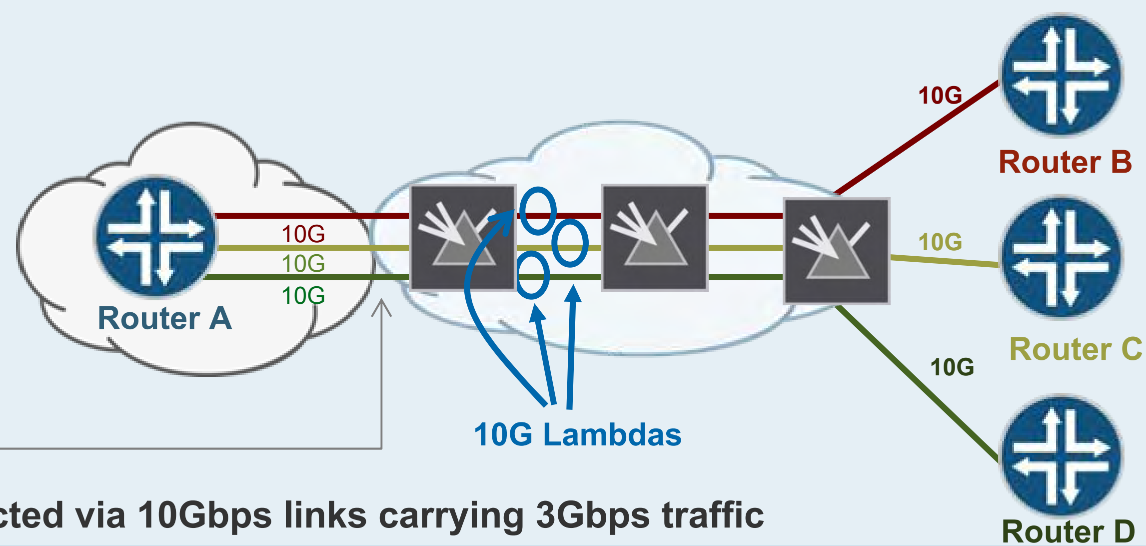
NEW WHITEPAPER
Building Flexible and Intelligent Core Networks

OPTICAL LAYER SCENARIO

Optical overlays imply fixed bandwidth lambda “circuits” or OTN circuits

These are typically provisioned for each individual service

Requires as many links as there are remote routers due to lack of granularity at optical layer



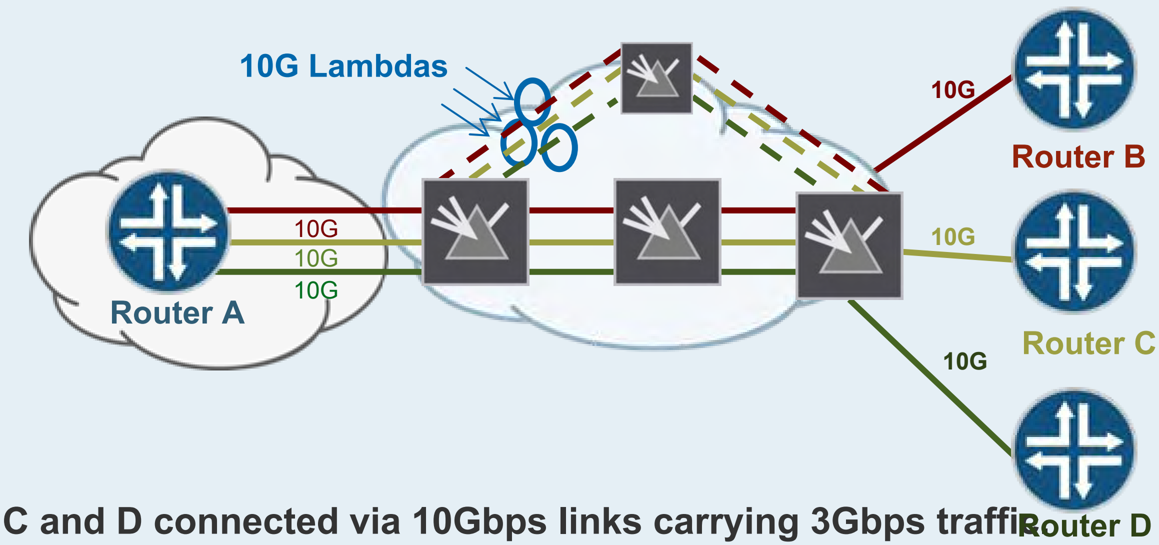
Routers B, C and D connected via 10Gbps links carrying 3Gbps traffic

REDUNDANCY SCENARIO AT LAYER 1

With 1+1, redundant paths for each of these services would double the number of lambdas

Over-provisioning is an essential component

Σ (peaks) as against Σ (average flows) plus one peak



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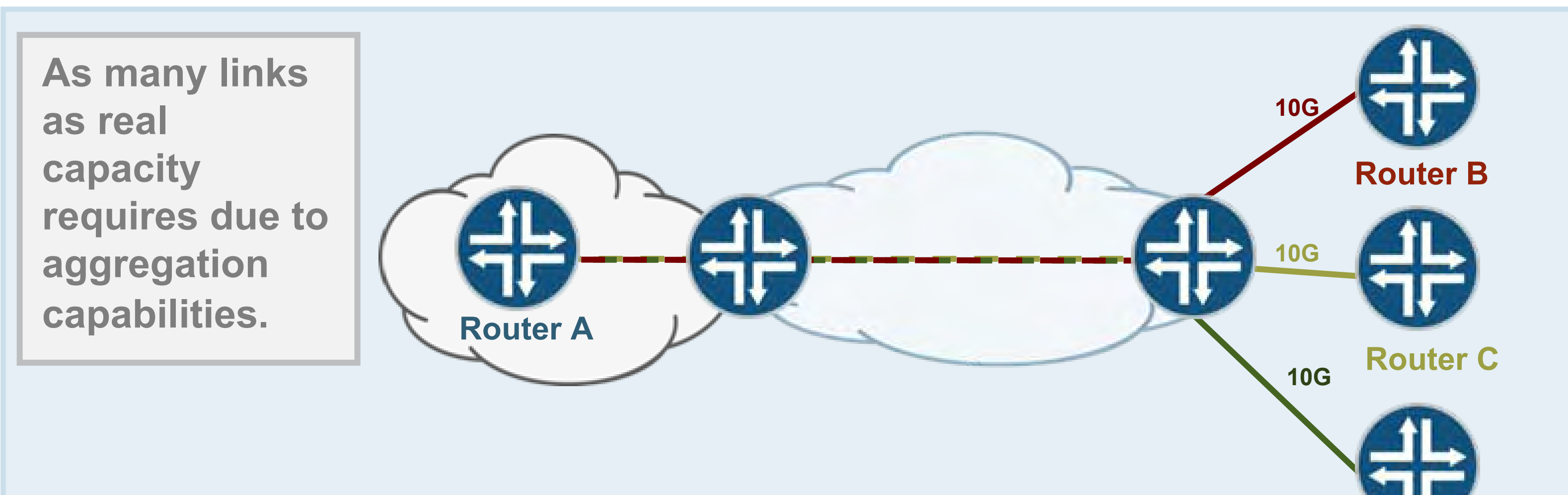
IP/MPLS BANDWIDTH UTILIZATION

IP/MPLS networks flexibly aggregate/groom traffic to ensure efficient utilization

- Reduces number of links that must be managed
- Enables faster turn up of new services
- Provides more flexibility for unpredictable traffic/service patterns

Protection can be provided via MPLS FRR or other IP layer mechanism



Routers B, C and D connected via 10Gbps links carrying 3Gbps traffic.

EFFICIENCY GAINS INCREASE AT 100G

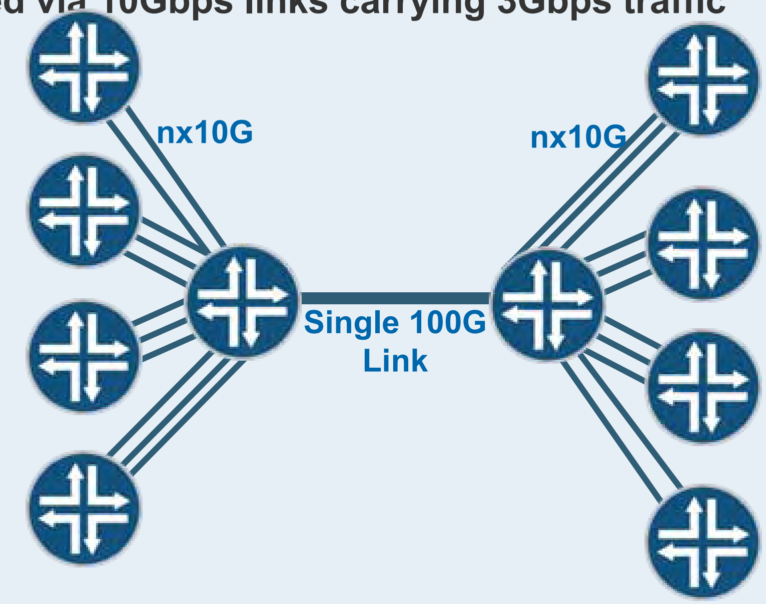
Higher link speed, higher benefits of stat mux gain

Lower load and limited lambda also points to need for gains

100 GE on Layer 3 adds to this

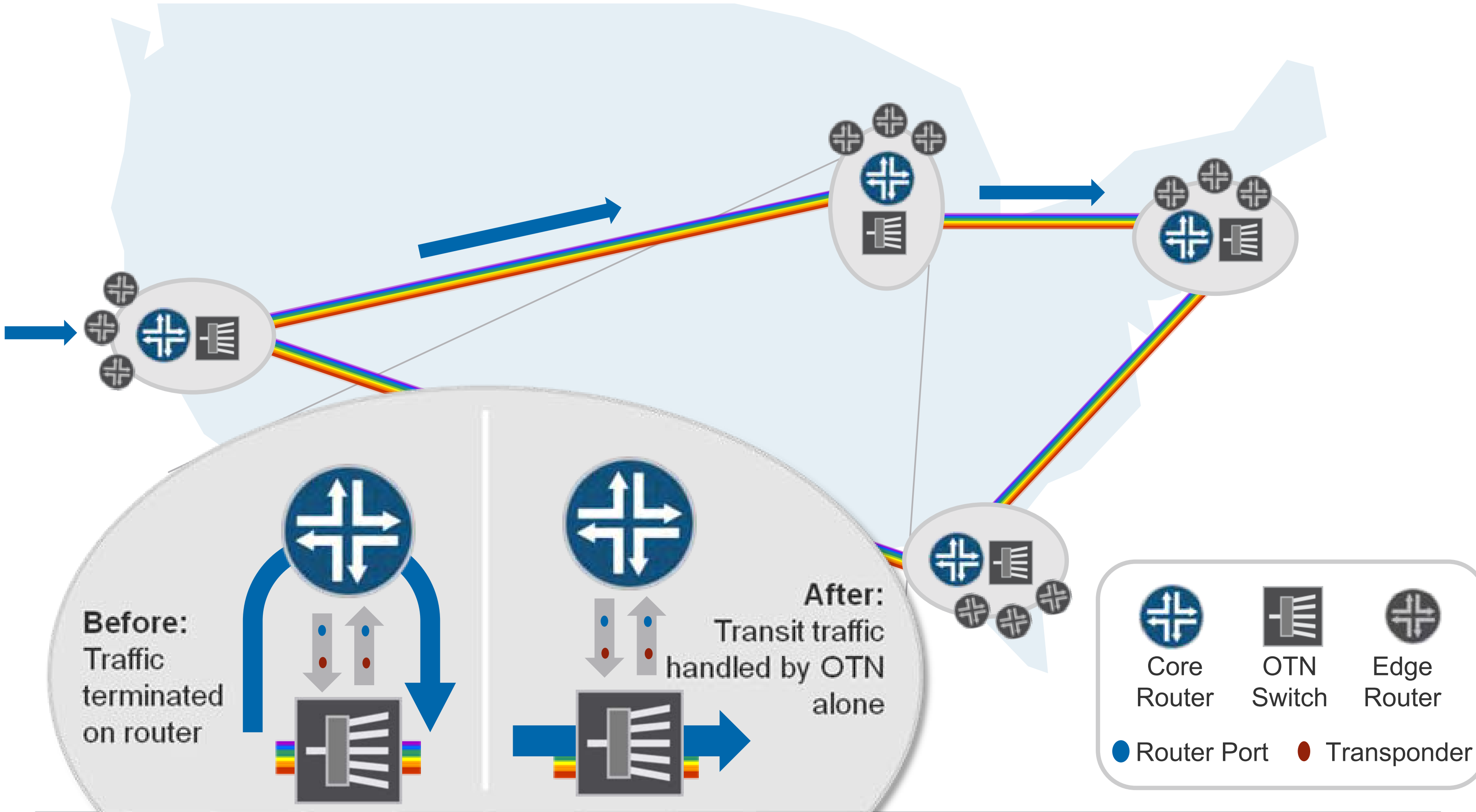
Routers B, C and D connected via 10Gbps links carrying 3Gbps traffic

100 GE provides further statistical gains.
Routers can aggregate multiple 10G links into a single, efficient link.

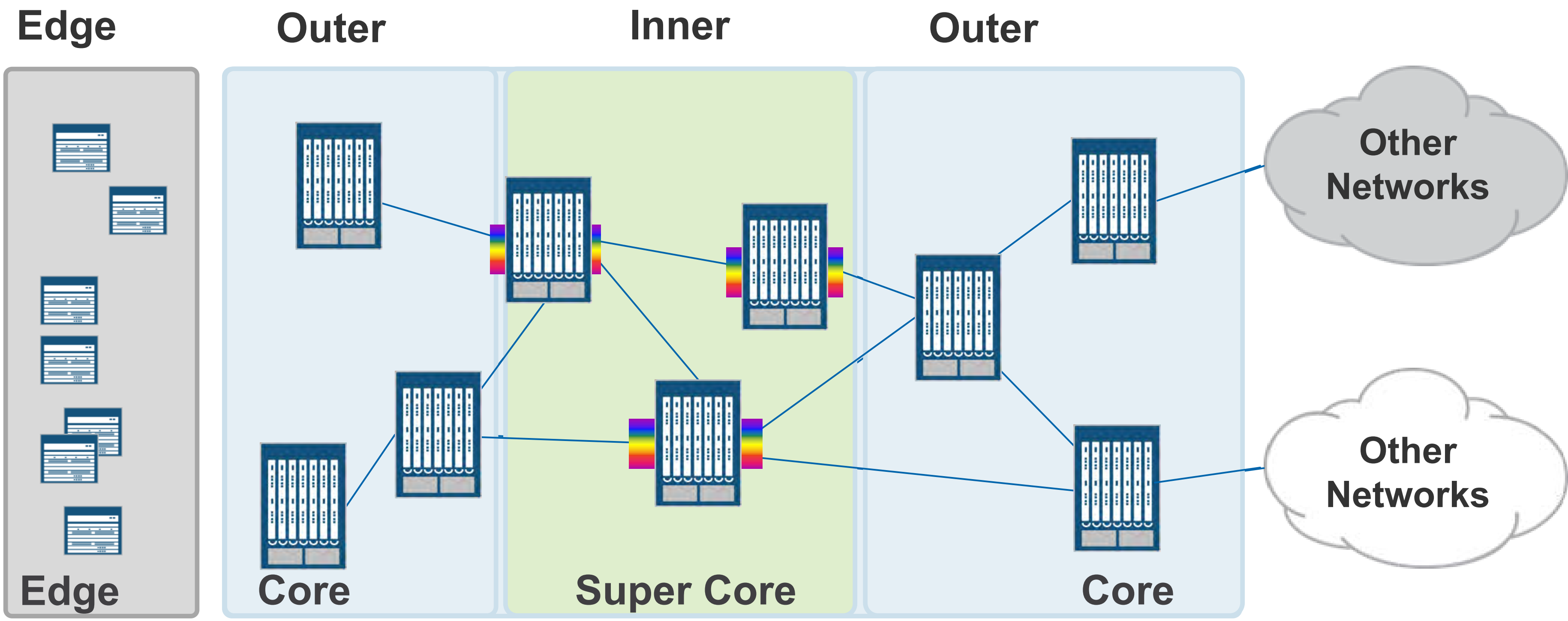


100 GE Interface for T1600

CURRENT INDUSTRY THOUGHTS ON OPTIMIZATION



CORE NETWORK EVOLUTION



Super-core based on a set of cost optimized MPLS/Ethernet point-to-point connections between IP/MPLS devices

Integrated ultra long-haul colored optics

Inner (Super) Core needs 100 GE links

ON CIRCUIT AND PACKET SWITCHING

Circuits	Packets
Nailed-up bandwidth	Shared, distributed bandwidth
End-to-end protection required	Flexible, local protection
No Statistical gain	Statistical multiplexing for bandwidth efficiency
Coarse-grained switching	Fine grained switching
No oversubscription	Can be oversubscribed
Single class of service	Many classes of service
Lower jitter	Higher jitter
Intolerant to traffic changes	Adaptive to traffic changes
Established OAM	Emerging OAM
Established carriers of clock	Emerging standards and implementations for clock
Primarily point to point	P2P, MP2P, P2MP, MP2MP

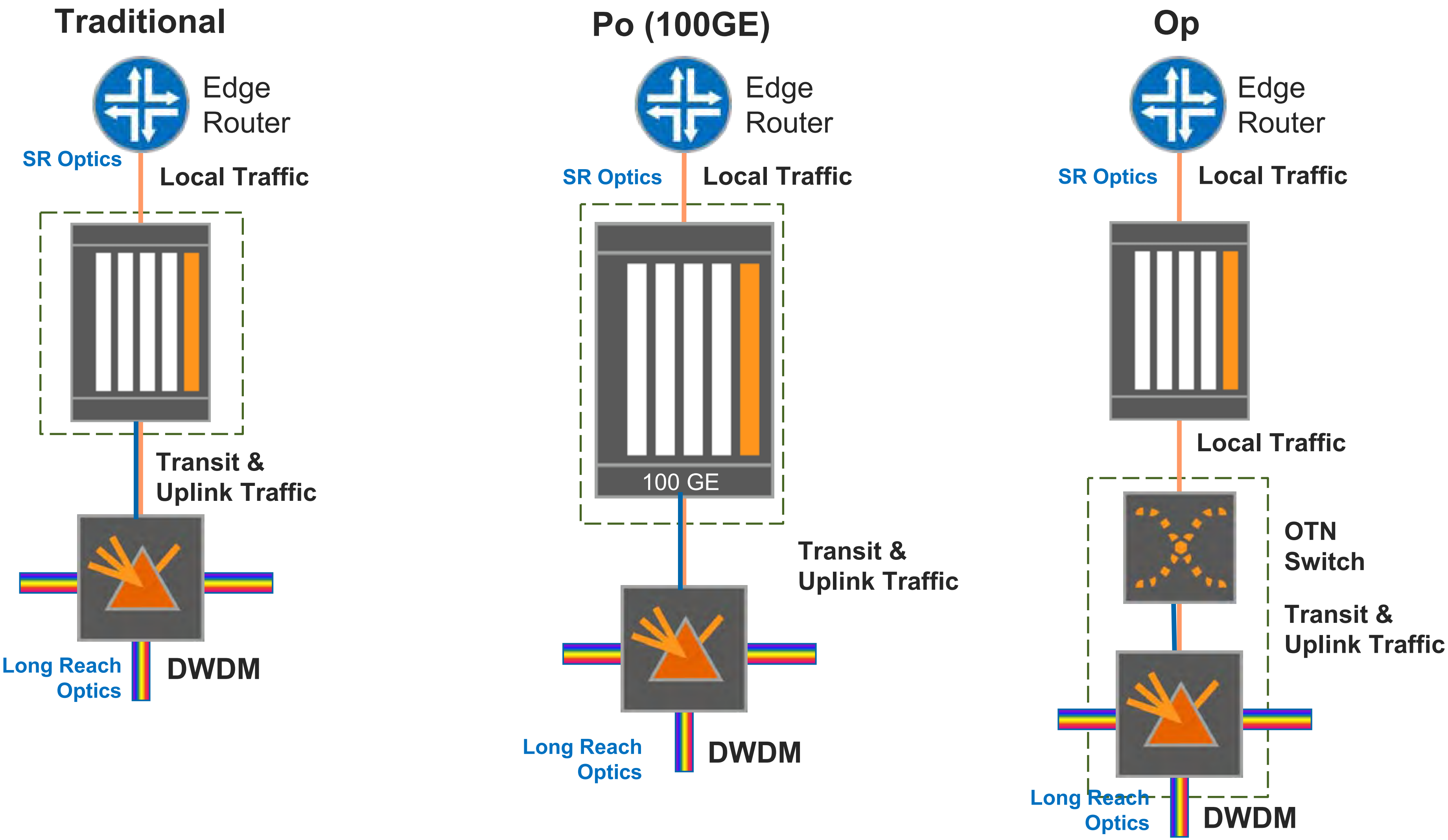
Packets ≠ Service

Infrastructure ≠ Circuits

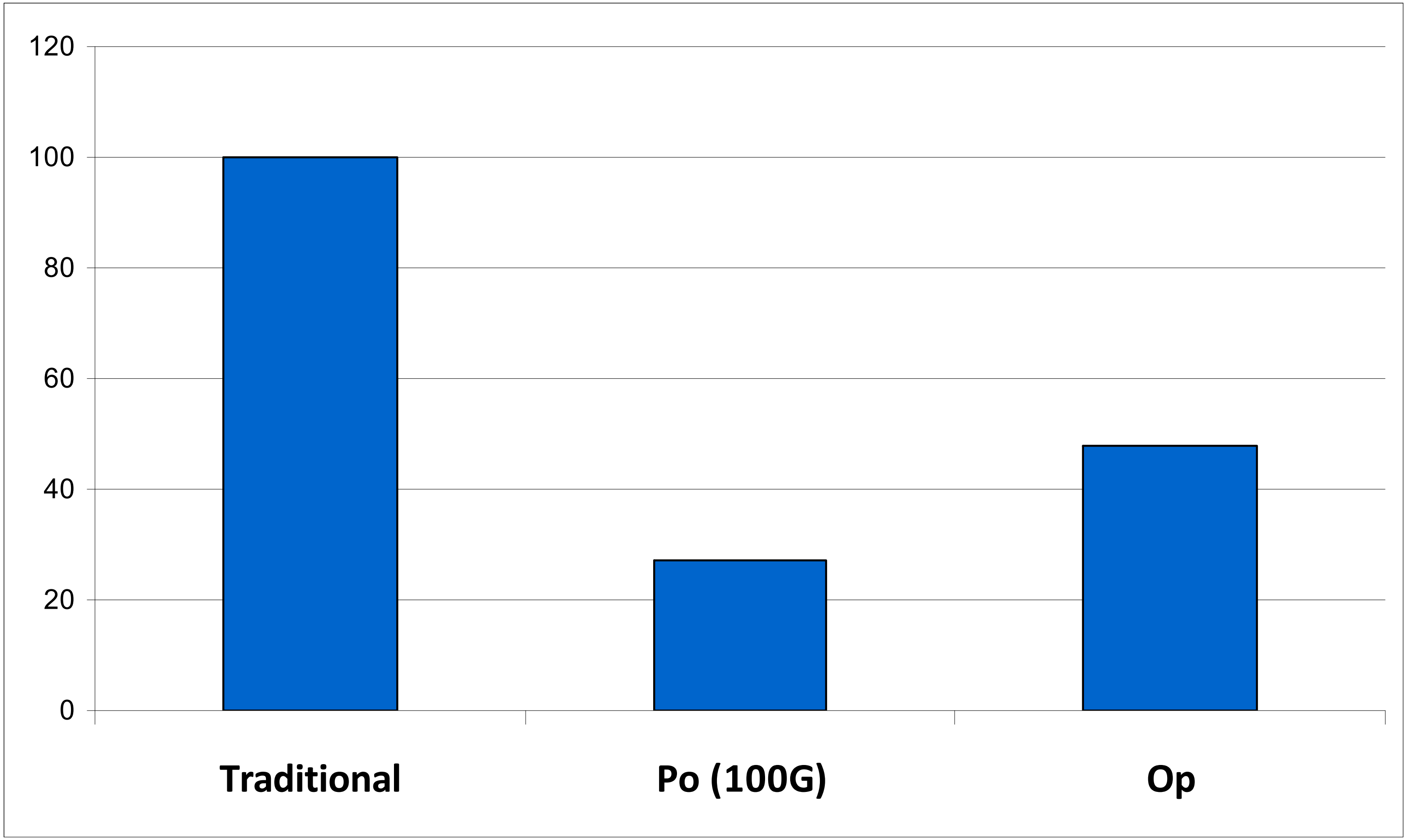
Each has its own services, and each needs its own infrastructure over which to run

JUNIPER NETWORKS

NETWORK COST ANALYSIS ARCHITECTURAL MODELS



COST MODELING SUMMARY



SUMMARY

If efficient lambda usage is needed, then stat mux becomes more important

If you have higher speed links (say > 10 Gbps in current world) then bypass is even less interesting

The effect of statistical multiplexing allows the creation of a much cheaper network

Even when the cost of MPLS nodes is very high (relative to link cost) there is a total CapEx saving to using MPLS nodes in the core

This is because the stat mux capabilities of the MPLS nodes greatly reduce the amount traffic into the transport nodes

See, for example, Pietro Beloti: *Multi-layer MPLS Network Design: the Impact of Statistical Multiplexing* at antlab.elet.polimi.it/PUB/ComNet00_network_**design**.pdf everywhere