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★18/20 APRIL

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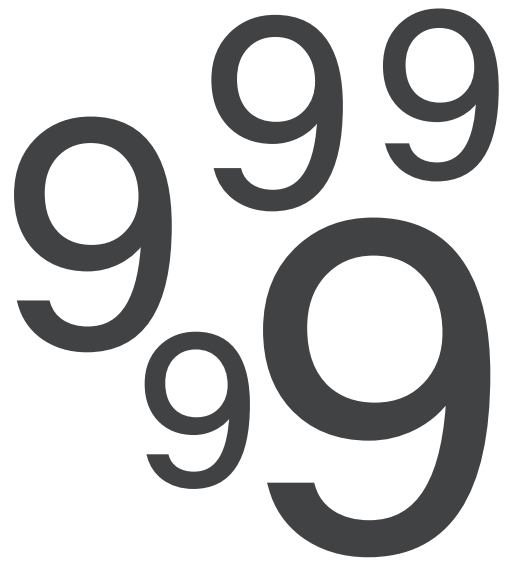
# Wavelength Services delivered over IP/MPLS ... Why Now?

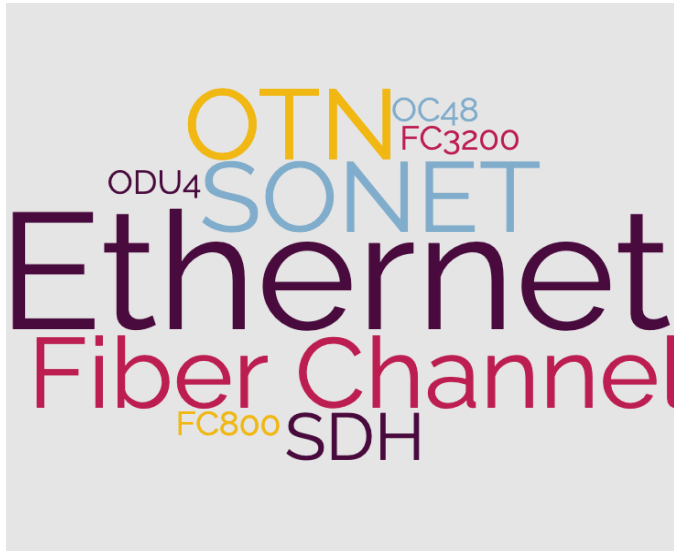
Christian Schmutzer, Distinguished Engineer

# Wavelengths (Private Lines) are Premium Services


High bandwidth

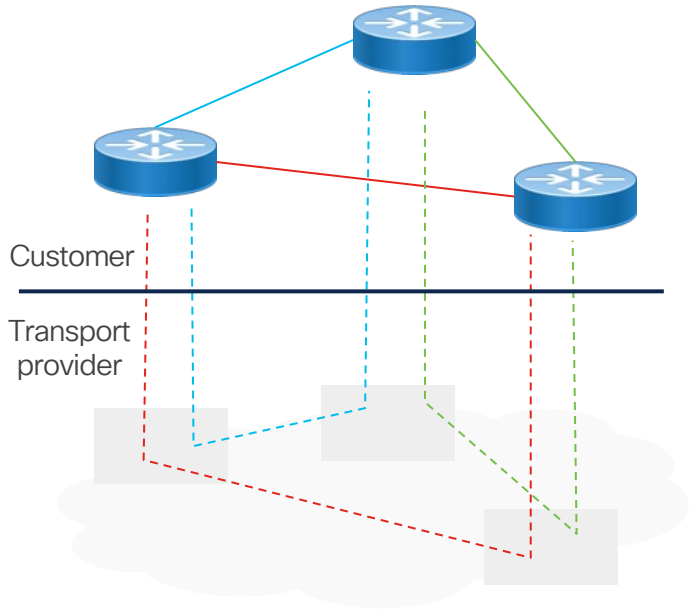



High availability

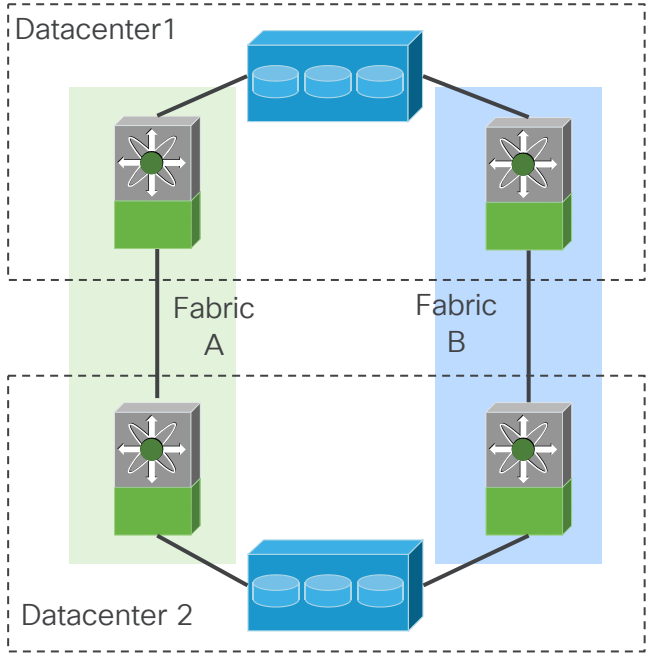



Diverse payloads

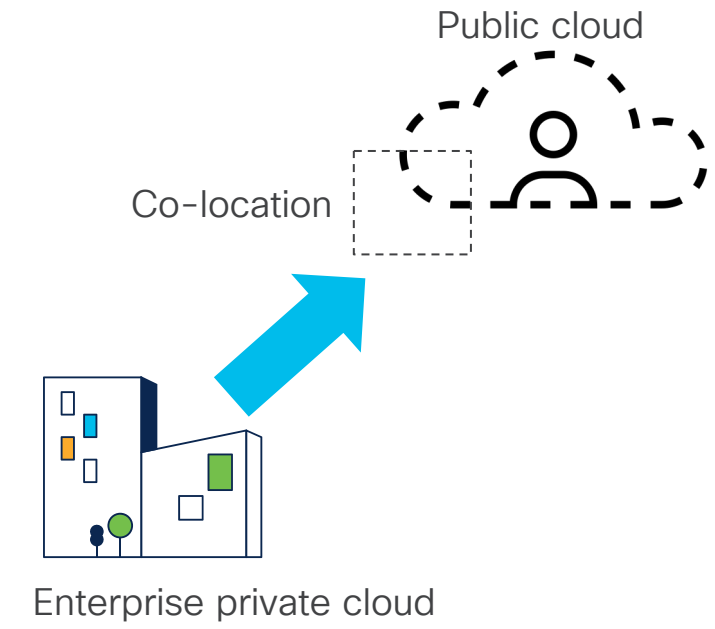
# When Only the Very Best will Do…




Dedicated WAN pipes for your topology

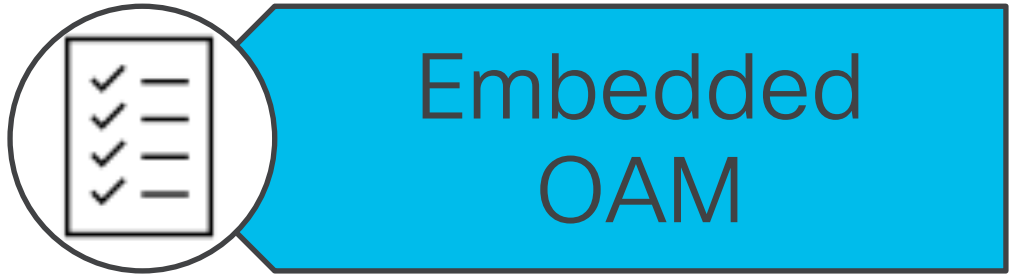


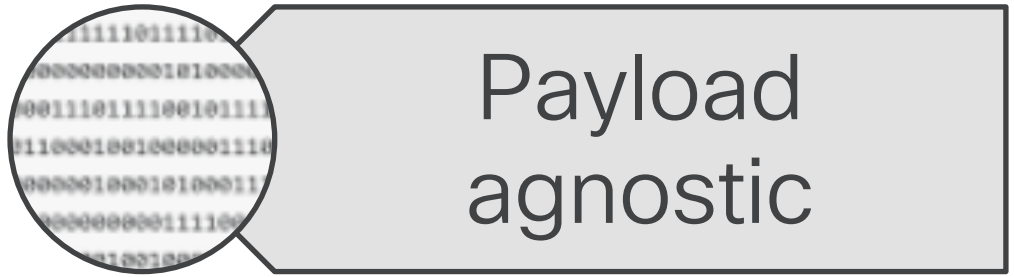

Fibre Channel to build your fault tolerant SAN



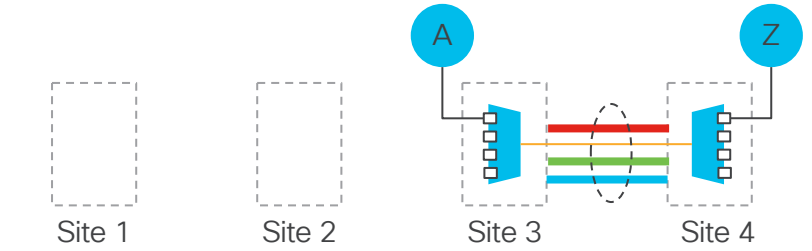

Cloud connect

# Wavelengths, TDM have been the Gold Standard

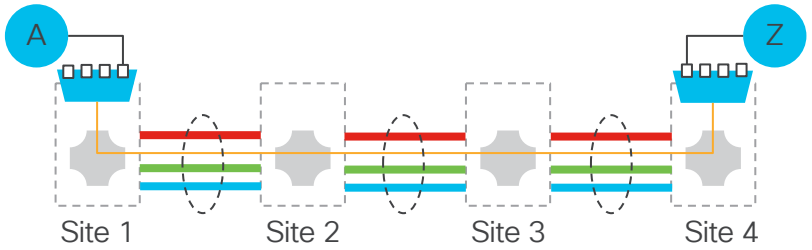



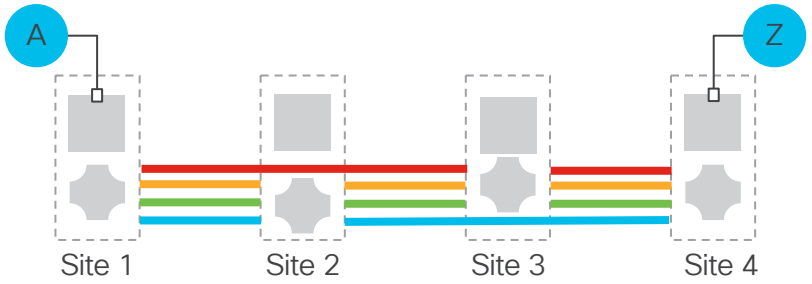

Point to point




ROADM




OTN

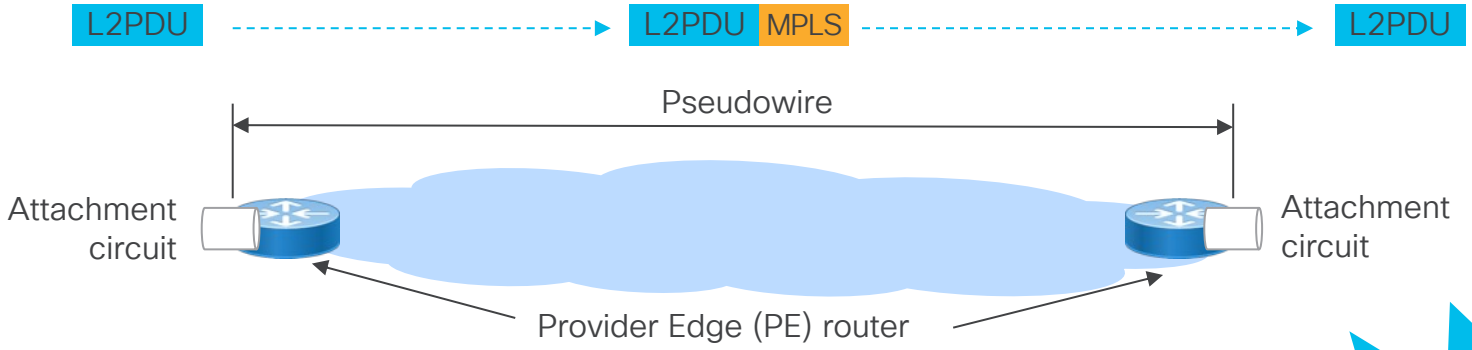





Trans- or muxponder ROADM OTN switch

# Meanwhile the Reality in Packet Networks

Brilliant Idea back in 2001 (RFC3985 and RFC3915) ➡ Transport L2 payload over packet networks using a “pseudo” wire service




## PROs

- One network for L2 and L3 services
- Efficient use of network bandwidth
- Simple and scalable

## CONs & CONCERNS

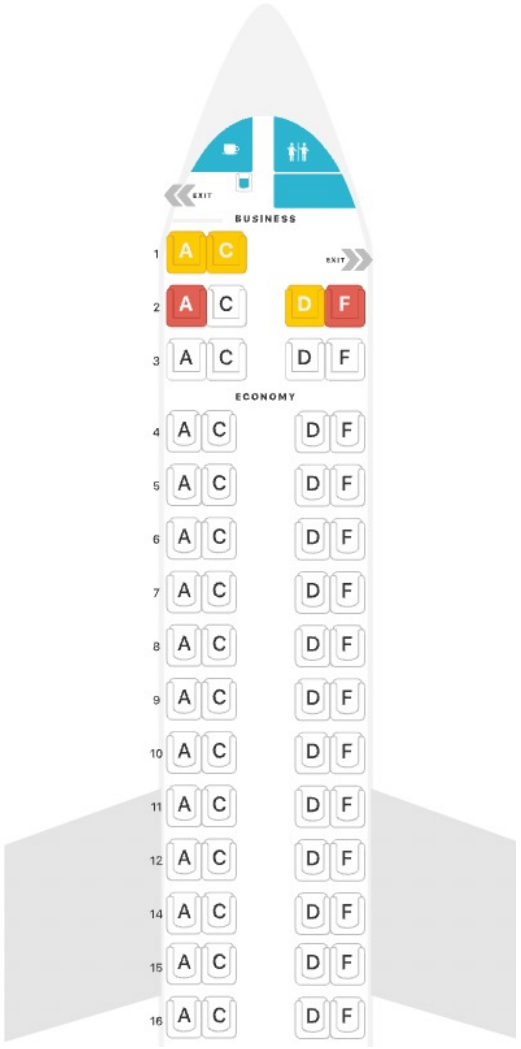
- Ethernet payloads only
- OAM
- Bandwidth commitment
- Load-balancing

Conclusion:

Good for many services but NOT for premium private line use cases

# Wavelength is a Private Jet

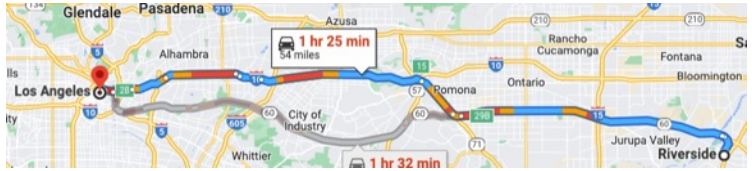
- Always reserved for your team
- Runs on a schedule
- Put whoever you want in those seats



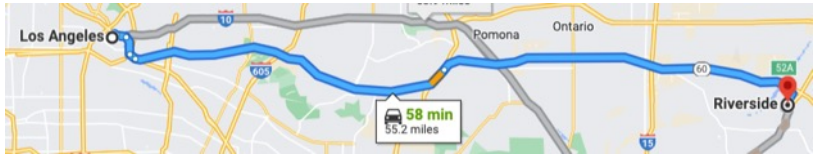

Source: Seatguru

# Packet is Like Driving in LA

Shared Bandwidth (rush hour)



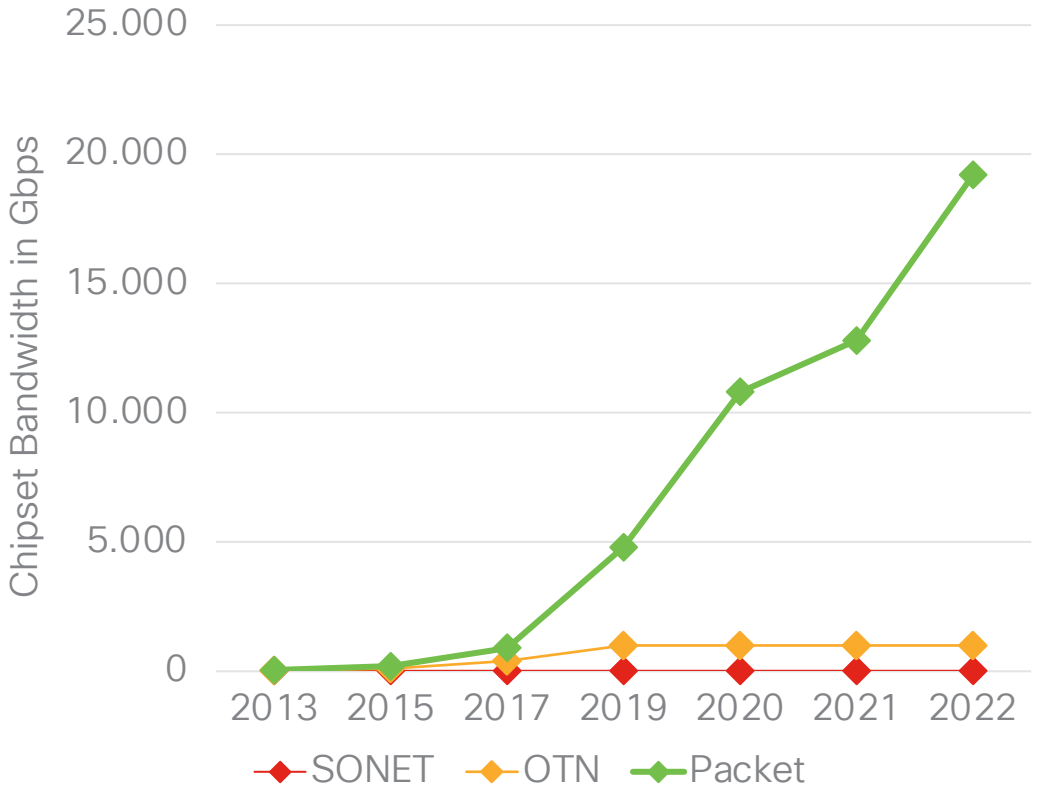

Asymmetric routes & latency




Source: google maps

# Massive Shifts in Economics of Routing

## Advances in silicon




## Coherent transceivers eliminate the need for DWDM transponders

No density penalty

interoperable

OpenZR+ MULTI-SOURCE AGREEMENT

OIF 400ZR

# Private Line Emulation (PLE)

## … addressing Multi-Protocol support and Transparency

# Innovations on Ingress: Bits to Packets & OAM

- Encapsulation of bit-stream into packets
  - Extend idea from RFC 4553 (SATOP) beyond T1/E1 to Ethernet, Fibre Channel, OCn/STMn, …
  - Carry RTP timestamps for clock recovery
- Embedded OAM via PW control word
  - Client faults → L bit set
  - Rx pseudowire network fault → R bit set

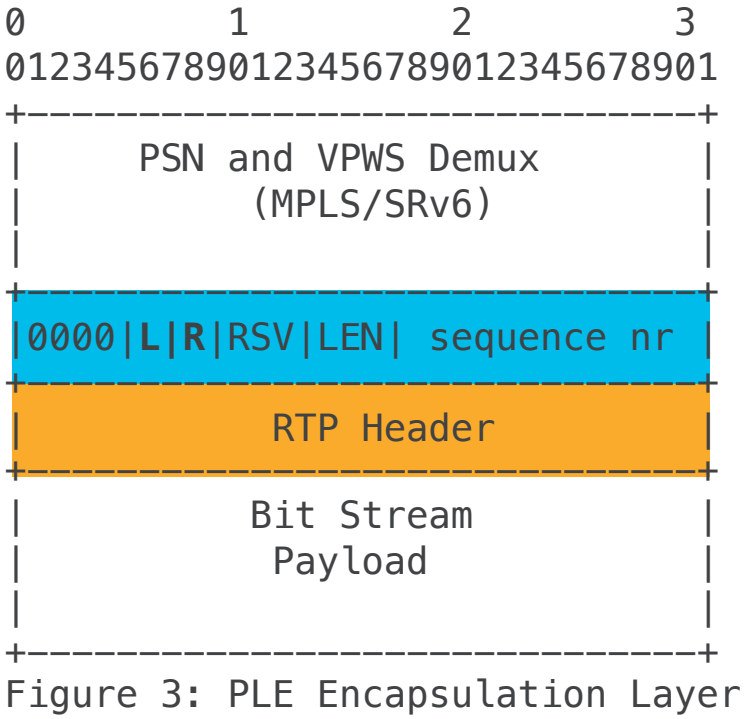


Figure 3: PLE Encapsulation Layer

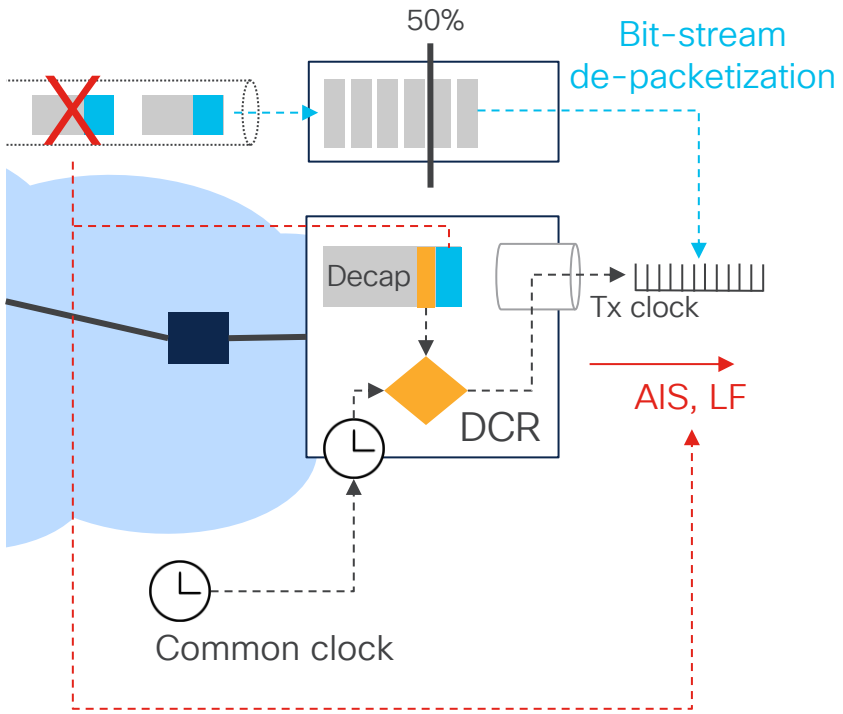
Source: draft-schmutzer-pals-ple



PSN … Packet Switched Network

# Tougher Problems to Solve on Egress

- De-jitter buffer
  - Packet Delay Variation (PDV)
  - Re-sequencing
- Differential clock recovery (DCR)
  - Compare common clock and RTP timestamps to recover client clock
- Client fault indication
  - Too many packets lost
  - If L bit is set

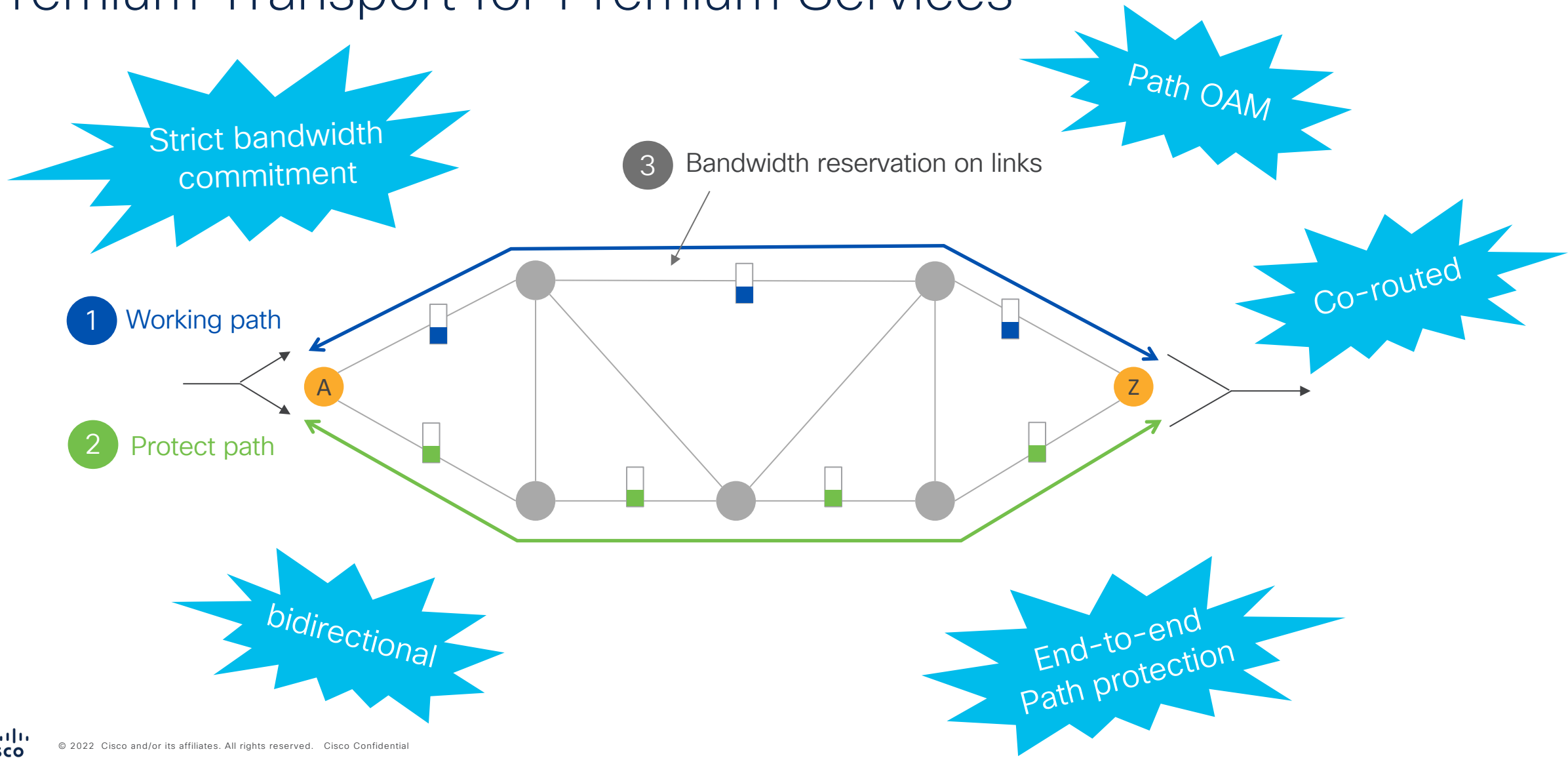



AIS ... Alarm Indication Signal
LF ... Local Fault

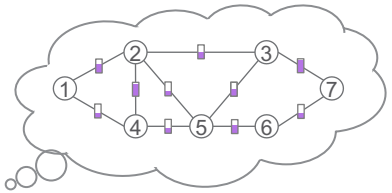
# Circuit-style Segment Routing (CS-SR)

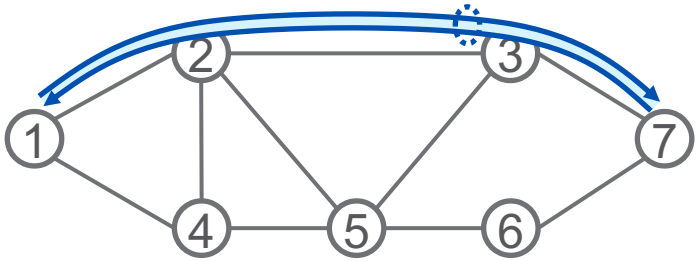
## … Solving the LA Rush Hour Problem

# Premium Transport for Premium Services



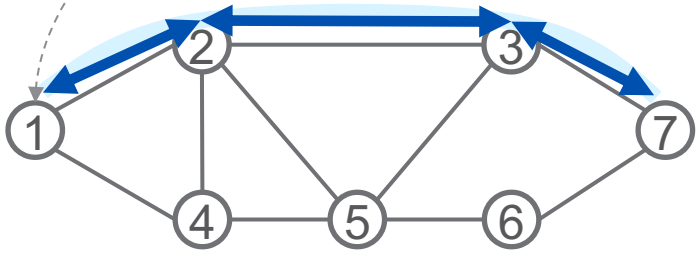
# CS-SR provides the Solution



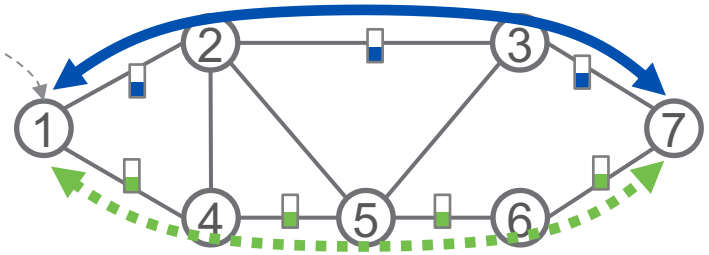




3. Forward and retourn SR policies are routed co-routed

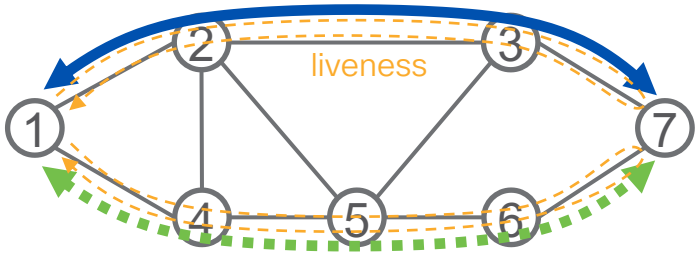
Central controller (PCE)



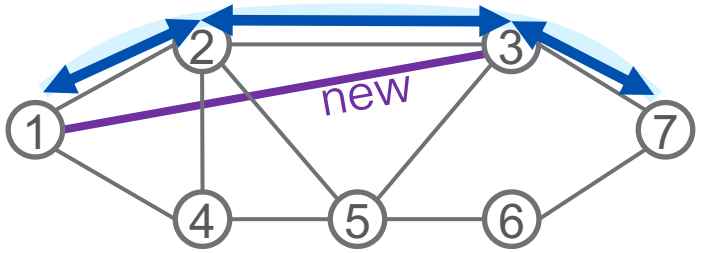

1. Adj-SIDs provide a non-ECMP path with guaranteed latency




5. Guaranteed bandwidth by central reservation bookkeeping




4. Path protection with disjoint protect path

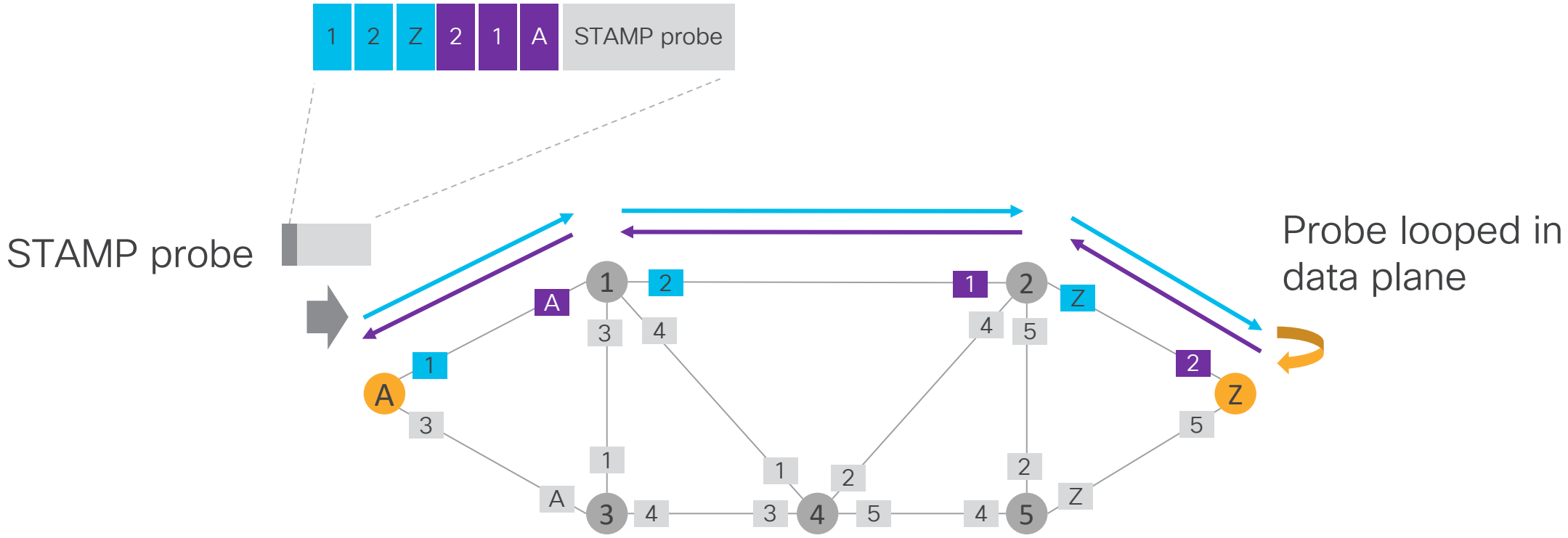



2. The persistent path is independent from network events and control-plane status



Source: BRKRST-3122, Cisco Live EMEA 2020

# CS-SR with STAMP adds OAM to Transport

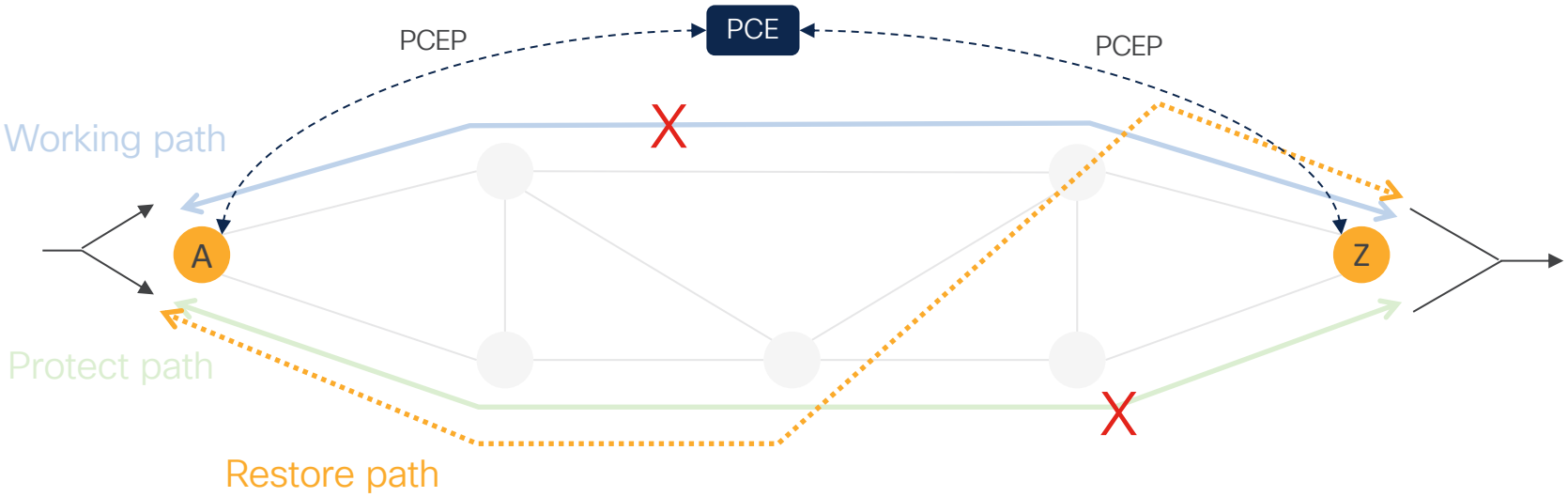


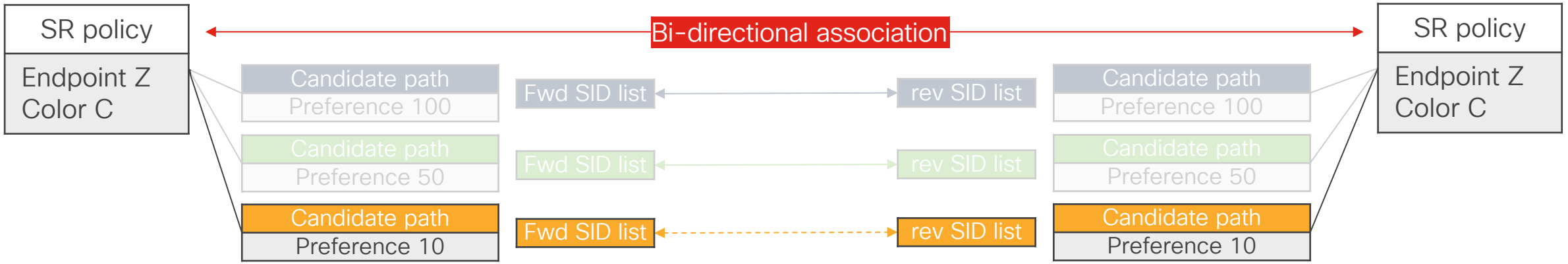

- Bidirectional Liveness and performance measurement via a single protocol (STAMP)
- Loopback probes with exact reverse path encoded



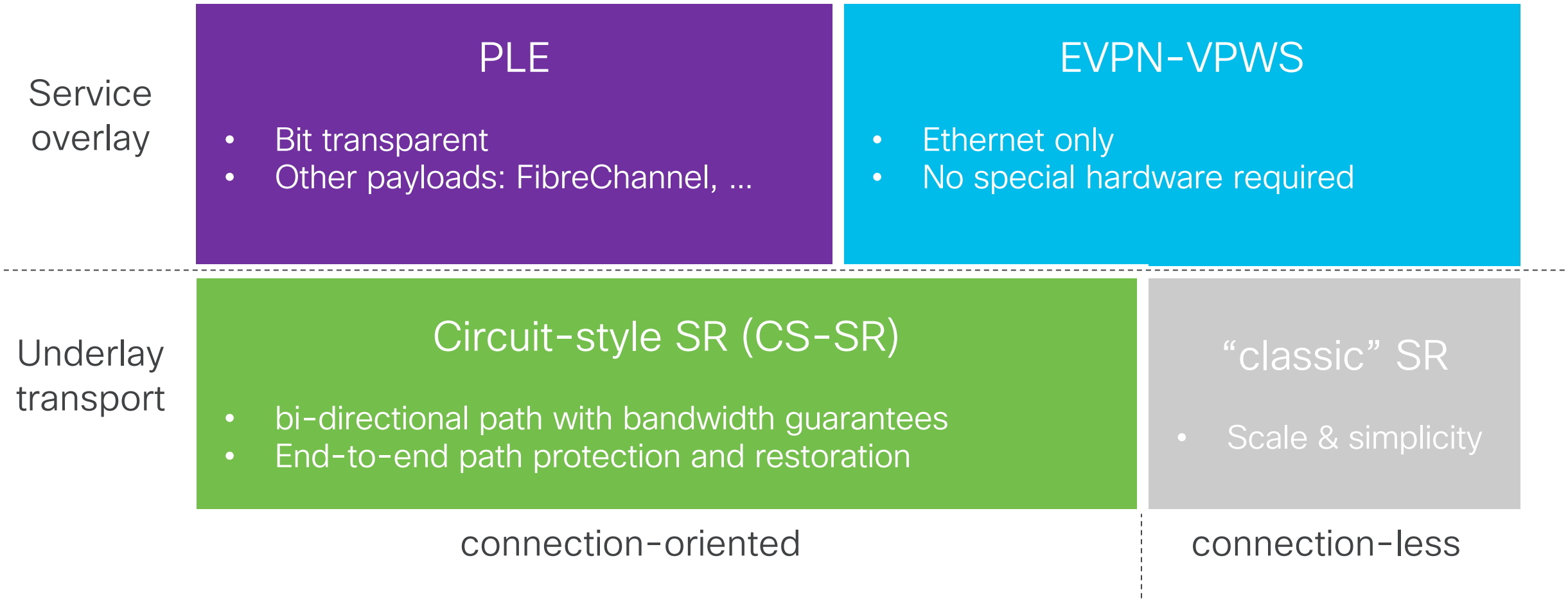
For more see draft-ietf-spring-stamp-srpm

# With CS-SR, Dynamic Recovery from Double Failures



# Make the Network Suit your Needs



# From Closed Optical to Open Packet Private Lines

Big Routers with standard interfaces

OpenZR+ MULTI-SOURCE AGREEMENT

OIF 400ZR

+

IETF®

draft-schmutzer-pals-ple
draft-schmutzer-spring-cs-sr-policy
draft-sidor-pce-circuit-style-pcep-extensions

=

Cost-efficient, standards-based solution

upperside conferences

*Since 1994*