

The background is a vibrant, abstract graphic. It features a series of overlapping, wavy bands of color in a rainbow spectrum, transitioning from red and orange on the left to yellow, green, and blue on the right. A bright, white, starburst-like light source is positioned on the right side, with rays of light emanating from it, creating a sense of energy and movement. The overall effect is dynamic and celebratory.

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The bridge to possible

# Circuit-Style Segment Routing & Service Emulation

## TDM & Private Line Emulation

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@ThomasPeiyao  
BRKMPL-2133



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# Introduction

- About speaker

- Thomas Wang, Technical Marketing Engineer, [pewang@cisco.com](mailto:pewang@cisco.com)
- Available at “Meet the Engineer” for 1:1 discussions
- Interests: SR-MPLS, SRv6, SP platforms & technologies

- Speaker Bio

**Expertise:** Large enterprise, public sector, and financial high-performance network architecture designs, and platform system support.

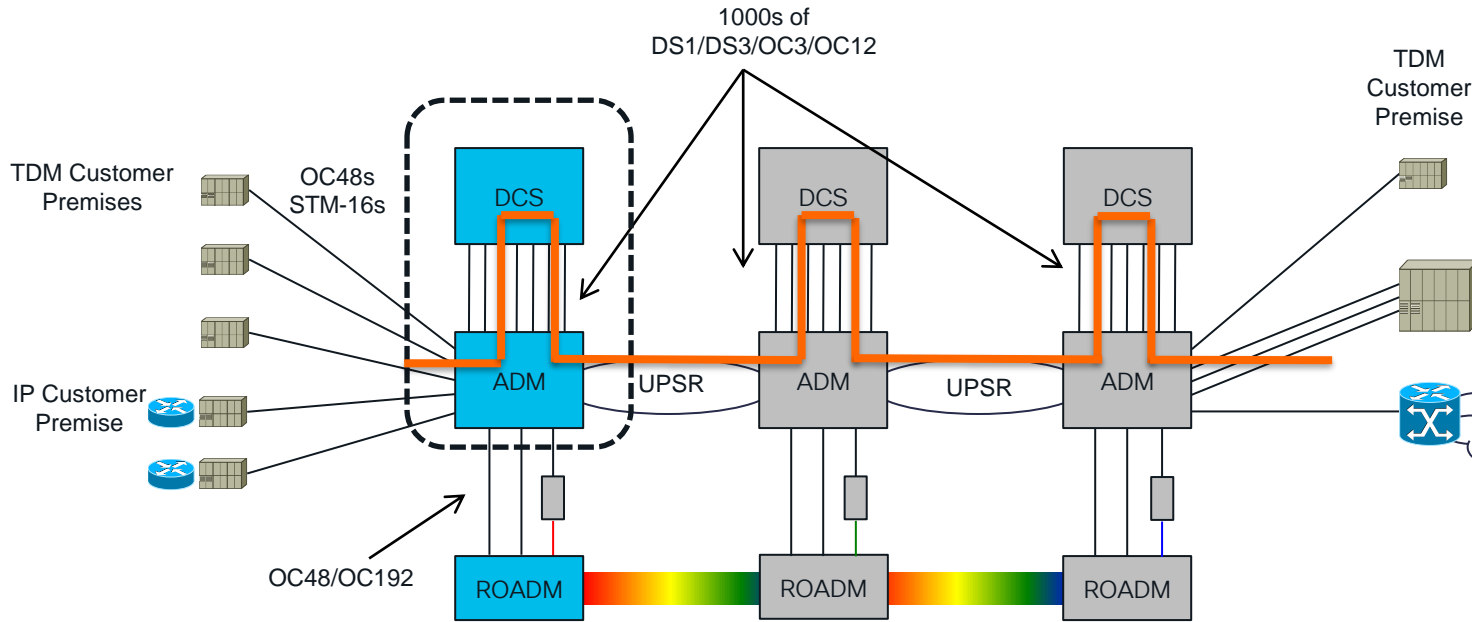
**Industry:** 18 years of Cisco engineering R&D background, strong working experience in MPLS-TE, SR-MPLS, SR-PCE, SRv6, VPN, EVPN etc



# Agenda

- Introduction
- Service Emulation Motivations
- Circuit Style Segment Routing
- TDM & Private Line Emulation
- CS-SR & Service Emulation Demystified
- CS-SR & Service Emulation Case Study

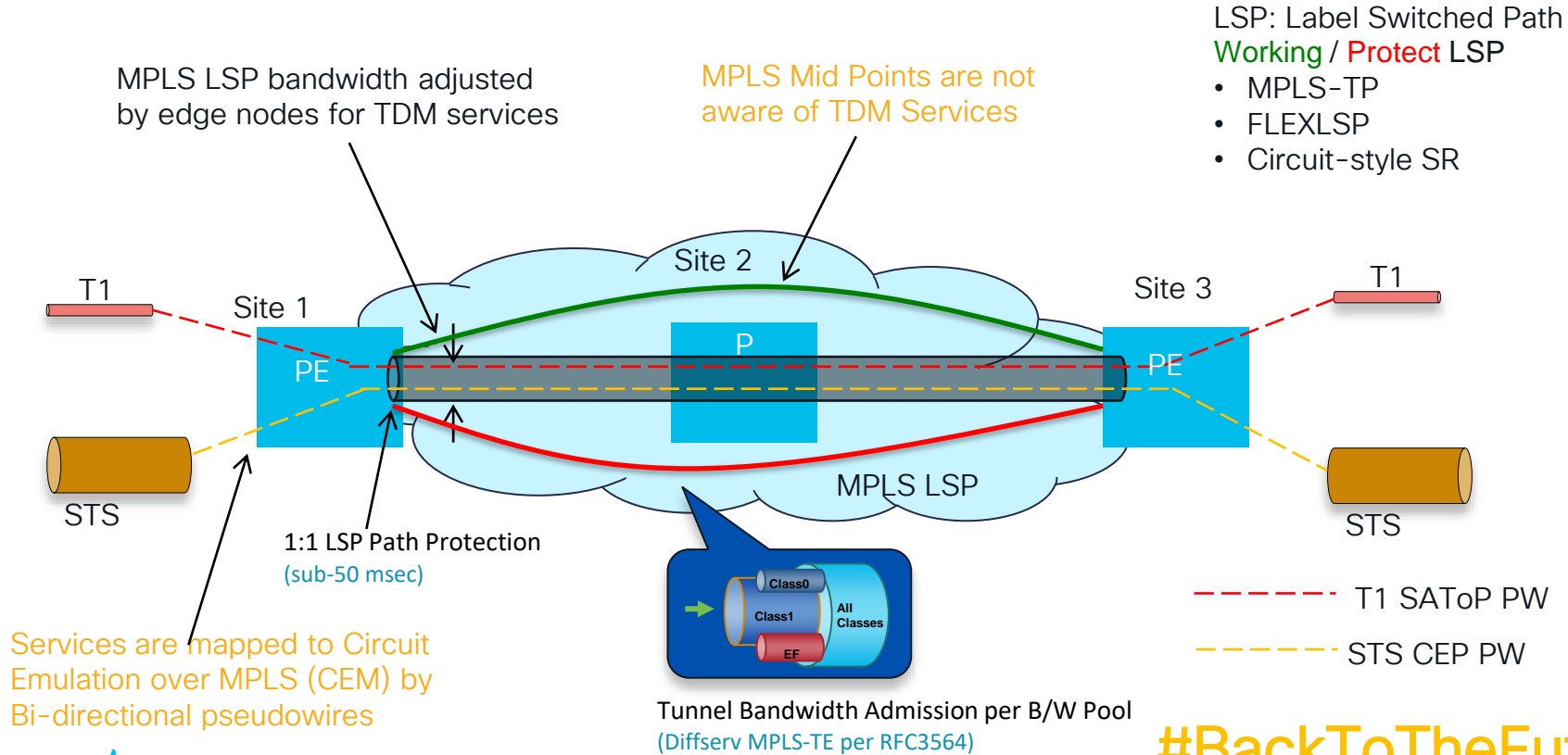
# TDM Services across the “legacy” Metro



DCS Digital Cross-connect System  
ADM Add-Drop Multiplexer  
ROADM Reconfigurable Optical Add-Drop Multiplexer



# TDM/Circuit Over MPLS Evolutions...

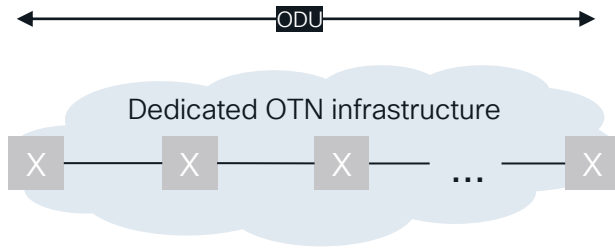


# Service Emulation Motivations



# Where the big Savings come from !

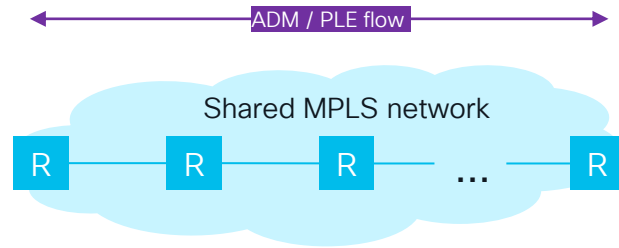
Present mode of operation (OTN)



- Legacy (expensive) OTN switches
- Complexity of B2B muxponders
- Dedicated OTN only wavelengths



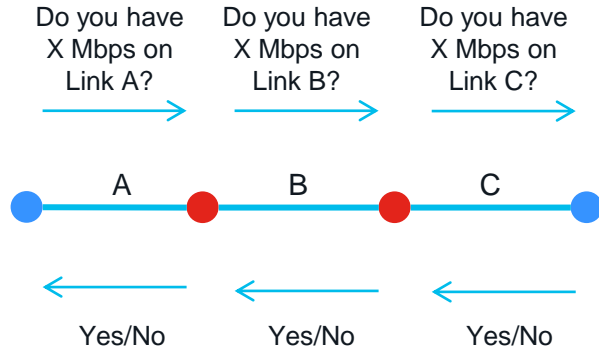
Service Emulation



- Pay as you grow (per service NID)
- Lowest cost per bit transport
- Significant power savings
- Shared wavelengths, cost reduction

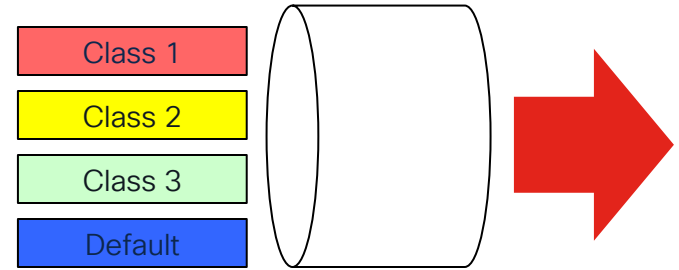
# Two independent Functions in Transport!

## 1. Bandwidth guaranteed LSP Setup



- Global View/Function
- Make sure that PW Bandwidth is available in the Network
- Steer Traffic (LSPs) to/away from certain Links
- Design “controlled” Oversubscription

## 2. Packet Scheduling

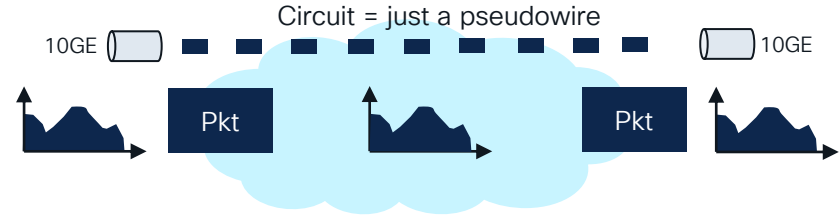


- Local Function
- Ensure Service/Packet Priority at Interface/Link Level
- Manage Bandwidth Sharing among Traffic Classes

# Circuit Emulation with Bandwidth Guaranteed

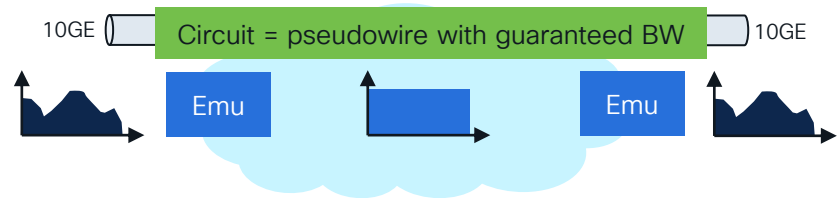
## Native packet transport

- Bandwidth only consumed when customer is sending data
- Allows for multiple traffic classes and forwarding behaviors



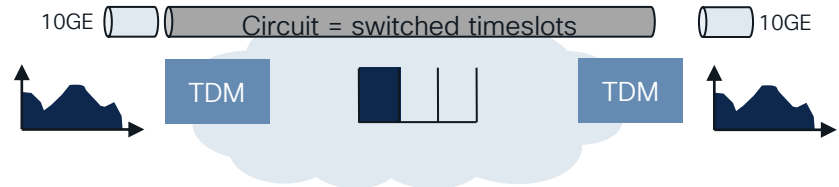
## Service Emulation

- Bit transparency
- Constant network load

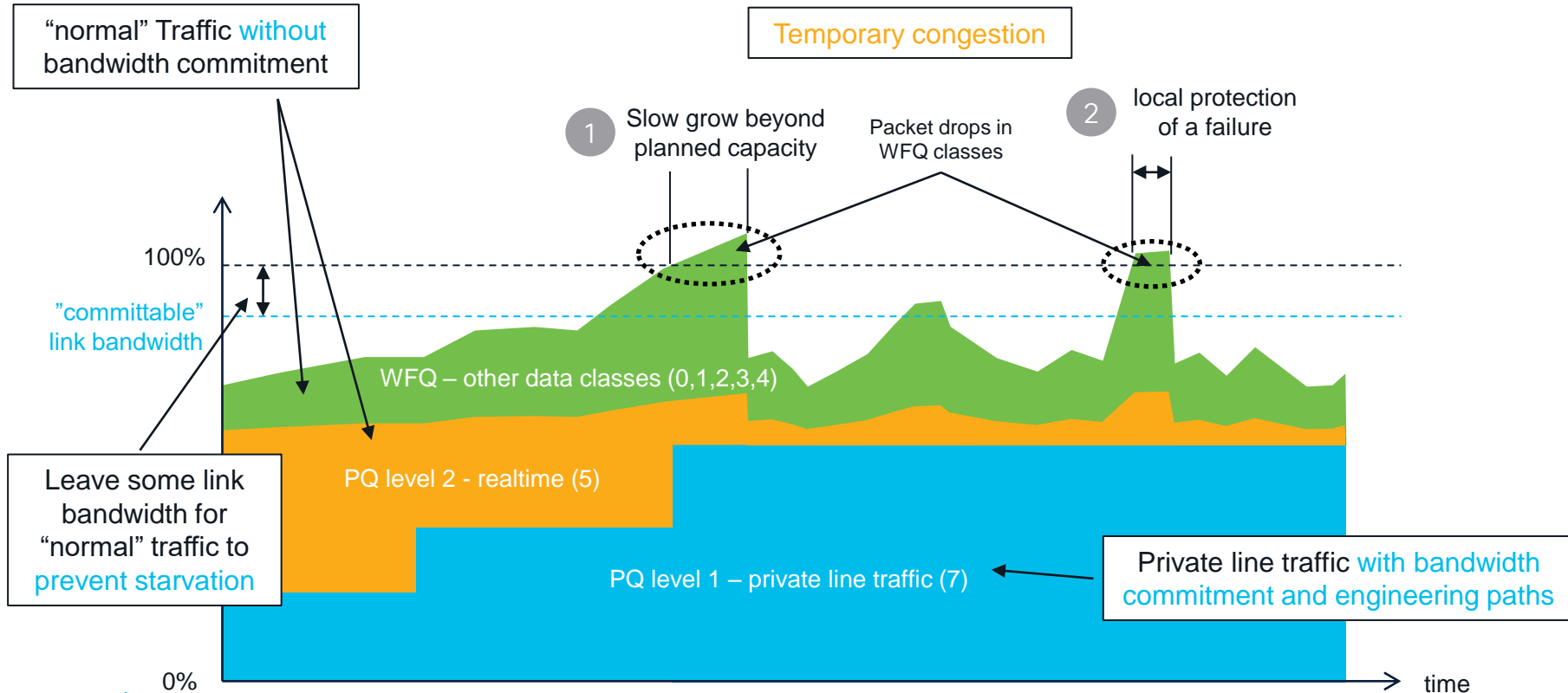


## TDM transport

- Static timeslot allocation

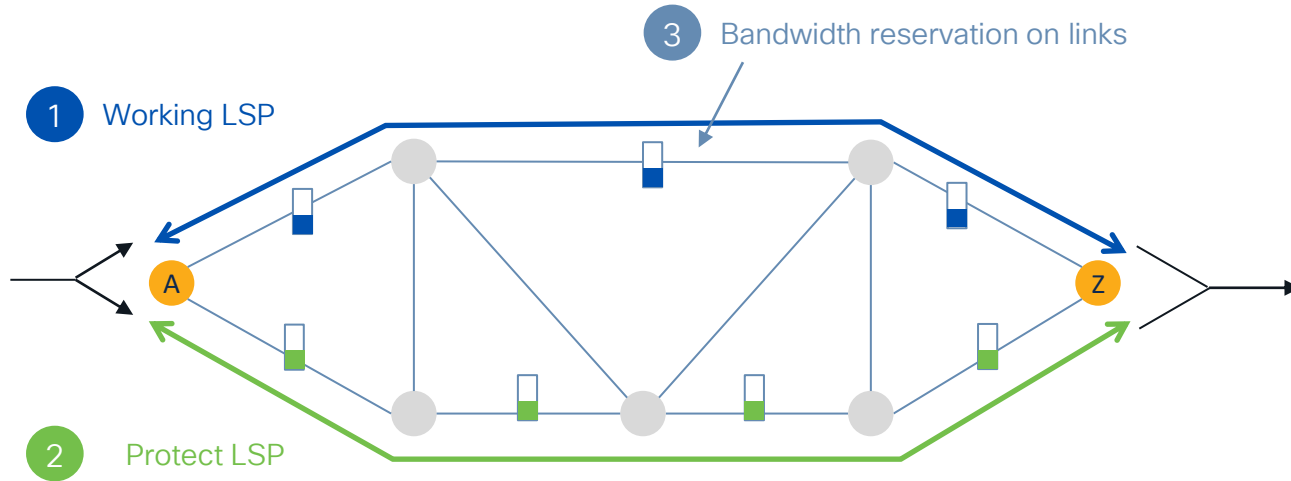


# Assuring Bandwidth Commitments with QoS



# Path-protection, Co-routed, Bi-directional LSP

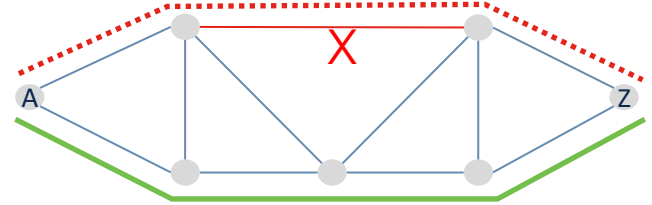
## TDM/Circuit Emulation over MPLS



# Why Path-protection Schemes matter?

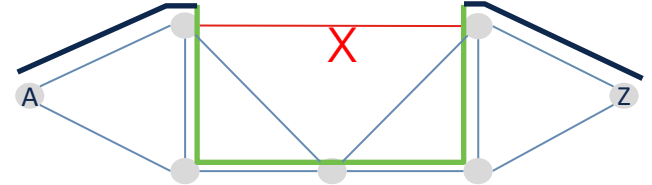
## Path Protection

pre-allocated bandwidth end2end



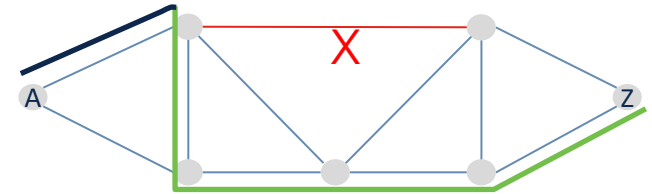
## MPLS-TE FRR

Local bypass protection, without bandwidth allocated



## Loop Free Alternate (LFA)

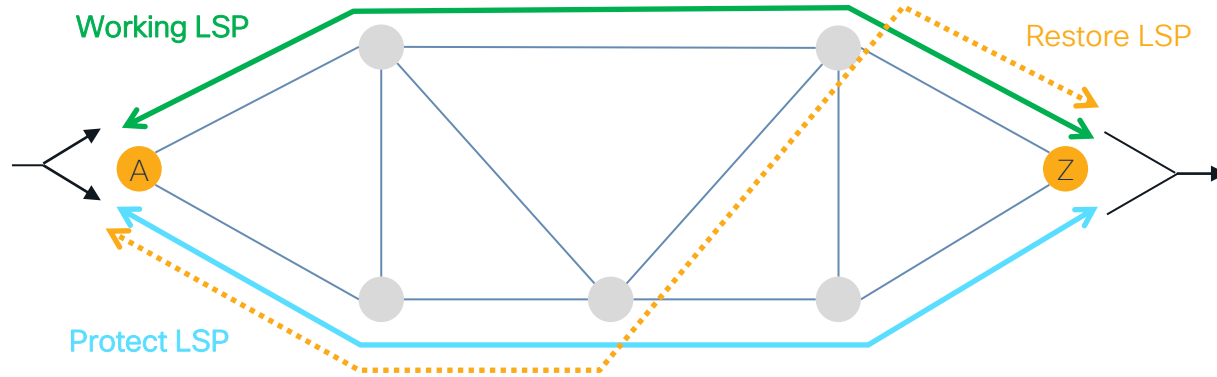
Post convergence path, without bandwidth allocated



Each scheme does require different capacity planning strategy !

# Circuit Style Segment Routing (CS-SR)

# CS-SR: Disjoint Path + Guaranteed Bandwidth



Guaranteed Bandwidth Services

TDM

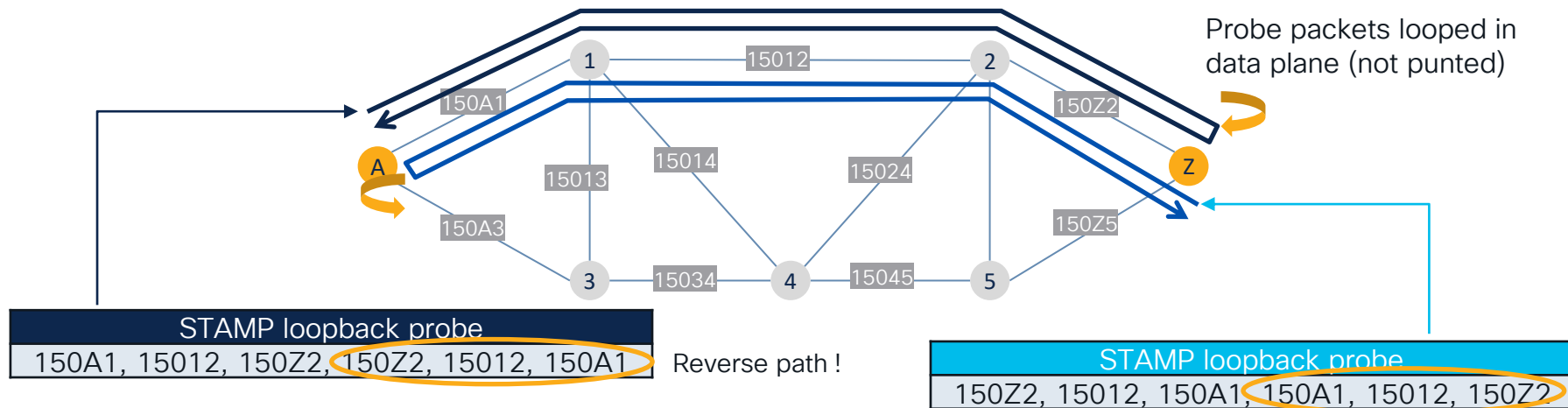
Private Line Emulation

## Circuit-style SR (CS-SR)

- Guaranteed bandwidth
- Persistent, Co-routed, Bi-directional paths
- 1:1 End-to-end path protection and restoration

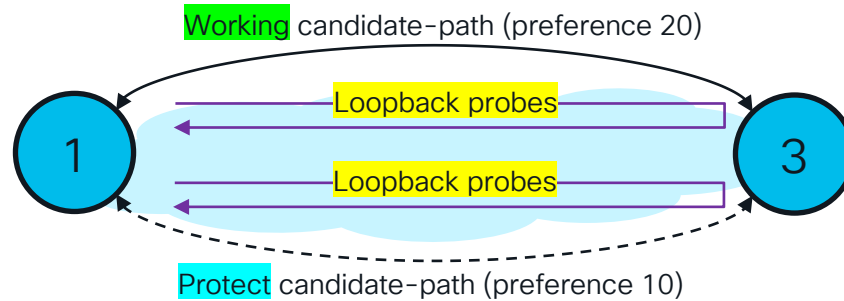


# Candidate Path Connectivity Verification (Liveness)



- Simple **TWAMP enabling liveness and performance measurement** (loss and delay)
- Candidate path is up as soon as single probe packet was received
- Candidate path is declared down when N consecutive probe packets are lost
- Due to loopback mode, also unidirectional failures are detected by both endpoints

# 1:1 Path Protection with Liveness Detection



```
segment-routing
traffic-eng
policy to_three
  performance-measurement
    liveness-detection
      liveness-profile name LIVE-detect
    !
    color 10 end-point ipv4 3.3.3.3
    candidate-paths
      preference 20
      ...
      preference 10
      ...
```

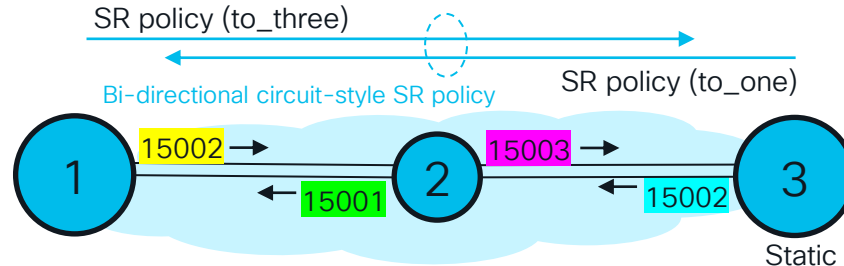
Working path

Protect path

```
performance-measurement
  liveness-profile name LIVE-detect
  liveness-detection
    logging state-change
    multiplier 3
  !
  probe
    tx-interval 3300 # means 3.3msec
  !
```

Note: only one direction shown for easier readability

# SR Policy Configuration with static CS-SR



## Static CS-SR policy configuration

```
segment-routing
 traffic-eng
  segment-list WFlist
   index 1 mpls label 15002
   index 2 mpls label 15003
 !
 segment-list WRlist
  index 1 mpls label 15002
  index 2 mpls label 15001
 !
 policy to_three
  color 10 end-point ipv4 3.3.3.3
  candidate-paths
   preference 20
   explicit segment-list WFlist
   reverse-path segment-list WRlist
```

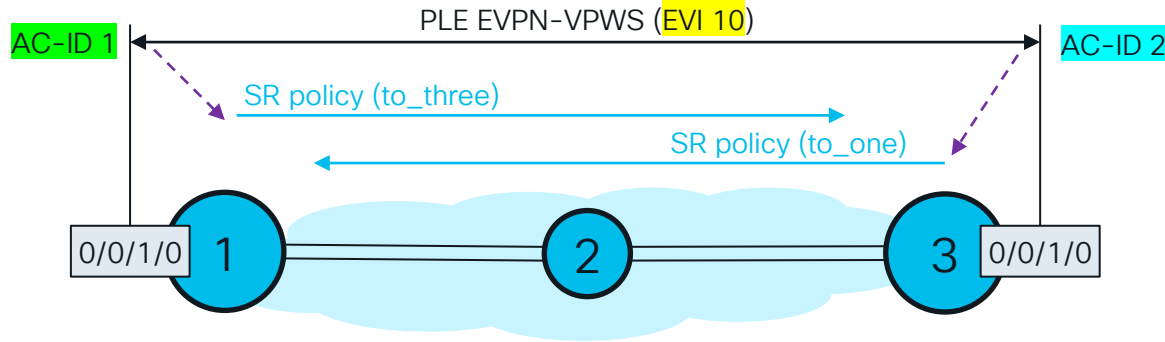
## Manual (persistent) & unprotected adjacency SID configuration (SRLB)

```
router isis rtr1
 ...
 interface HundredGigE0/0/2/0
  address-family ipv4 unicast
   adjacency-sid absolute 15002
```

## Static CS-SR policy configuration

```
segment-routing
 traffic-eng
  segment-list WFlist
   index 1 mpls label 15002
   index 2 mpls label 15001
 !
 segment-list WRlist
  index 1 mpls label 15002
  index 2 mpls label 15003
 !
 policy to_one
  color 10 end-point ipv4 1.1.1.1
  candidate-paths
   preference 20
   explicit segment-list WFlist
   reverse-path segment-list WRlist
```

# PLE over VPWS Basic Example



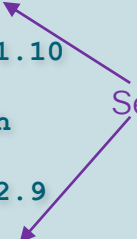
```
l2vpn
pw-class pw-cs-srte
  encapsulation mpls
  preferred-path sr-te policy to_three
!
!
xconnect group evpn_vpws
p2p p0
  interface CEM0/0/1/0
  neighbor evpn evi 10 target 2 source 1
  pw-class pw-cs-srte
```

```
l2vpn
pw-class pw-cs-srte
  encapsulation mpls
  preferred-path sr-te policy to_one
!
!
xconnect group evpn_vpws
p2p p0
  interface CEM0/0/1/0
  neighbor evpn evi 10 target 1 source 2
  pw-class pw-cs-srte
```

# CS-SR Configuration

```
segment-routing
global-block 16000 23999
local-block 15000 15999
traffic-eng
segment-list working-forward-path
  index 10 mpls label 15004
  index 20 mpls adjacency 10.109.1.10
!
segment-list working-reverse-path
  index 10 mpls label 15005
  index 20 mpls adjacency 10.109.2.9
!
segment-list protect-forward-path
  index 10 mpls label 15005
  index 20 mpls adjacency 10.109.2.10
!
segment-list protect-reverse-path
  index 10 mpls label 15004
  index 20 mpls adjacency 10.109.1.9
!
```

Segment-list



```
policy PE9toPE10
color 1001 end-point ipv4 10.10.10.10
path-protection
candidate-paths
  preference 10
    explicit segment-list protect-forward-path
      reverse-path segment-list protect-reverse-path
    !
  !
  preference 20
    explicit segment-list working-forward-path
      reverse-path segment-list working-reverse-path
    !
  !
performance-measurement
  liveness-detection
    liveness-profile name liveness-check
  !
  !
```

# CS-SR Configuration (Cont)

```
router isis 100
address-family ipv4 unicast
  metric-style wide
  microloop avoidance segment-routing
  mpls traffic-eng level-2-only
  mpls traffic-eng router-id Loopback0
  router-id Loopback0
!
interface Loopback0
  passive
  address-family ipv4 unicast
  prefix-sid index 9
interface HundredGigE0/0/0/4
  point-to-point
  address-family ipv4 unicast
  fast-reroute per-prefix
  fast-reroute per-prefix ti-lfa
  adjacency-sid absolute 15004
!
interface HundredGigE0/0/0/5
  point-to-point
  address-family ipv4 unicast
  fast-reroute per-prefix
  fast-reroute per-prefix ti-lfa
  adjacency-sid absolute 15005
```

```
performance-measurement
interface HundredGigE0/0/0/4
  delay-measurement
interface HundredGigE0/0/0/5
  delay-measurement
  liveness-profile name liveness-check
  liveness-detection
    multiplier 3
  probe
    tx-interval 3300
```

Liveness detection



```
RP/0/0/CPU0:PE1# show performance-measurement sessions
Transport type           : SR Policy
Measurement type         : Liveness Detection
Policy name              :
srte_c_1001_ep_10.10.10.10
Color                   : 1001
Endpoint                 : 10.10.10.10
preference               : 20
Segment-list             : working-forward-path
Atomic path:
  Hops                   : 10.10.10.10
  Session ID             : 4100
  Liveness Detection: Enabled
  Session State: Up
```

# CS-SR Policy Example

```
RP/0/0/CPU0:PE1# show segment traffic-eng policy color 1001
SR-TE policy database
-----
```

```
Color: 1001, End-point: 10.10.10.10
Name: srte_c_1001_ep_10.10.10.10
Status: Admin: up Operational: up for 01:39:15
Candidate-paths:
  Preference: 20 (configuration) (active)
    Name: PE9toPE10
    Requested BSID: dynamic
    PCC info:
      Symbolic name: cfg_PE9toPE10_discr_100
      PLSP-ID: 7
    Constraints:
      Protection Type: protected-preferred
      Maximum SID Depth: 10
    Performance-measurement:
      Reverse-path Label: Not Configured
      Delay-measurement: Disabled
      Liveness-detection: Enabled
        Profile: liveness-check
        Invalidation Action: down
        Logging:
          Session State Change: No
      Statistics:...
```

```
Explicit: segment-list working-forward-path (valid)
  Reverse: segment-list working-reverse-path
  Weight: 1, Metric Type: TE
  15004 [Adjacency-SID, 10.109.1.9 - 10.109.1.10]
Protection Information:
  Role: WORKING
  Path Lock: Timed
  Lock Duration: 300(s)
Preference: 10 (configuration) (protect)
  Name: PE9toPE10
  Requested BSID: dynamic
  PCC info:
    Symbolic name: cfg_PE9toPE10_discr_50 PLSP-ID: 6
  Constraints:
    Protection Type: protected-preferred
    Maximum SID Depth: 10
  Performance-measurement:
    Reverse-path Label: Not Configured
    Delay-measurement: Disabled
    Liveness-detection: Enabled
      Profile: liveness-check
      Invalidation Action: down
      Logging:
        Session State Change: No
    Statistics:...
```

# CS-SR Policy Example (Cont)

```
Explicit: segment-list protect-forward-path (valid)
Reverse: segment-list protect-reverse-path
Weight: 1, Metric Type: TE
15005 [Adjacency-SID, 10.109.2.9 - 10.109.2.10]
```

## Protection Information:

```
Role: PROTECT
Path Lock: Timed
Lock Duration: 300(s)
```

## LSPs:

### LSP[0]:

```
LSP-ID: 5 policy ID: 4 (active)
Local label: 24028
State: Programmed
Binding SID: 24026
Performance-measurement:
  Reverse-path Label: Not Configured
  Delay-measurement: Disabled
  Liveness-detection: Enabled
  Profile: liveness-check
  Invalidation Action: down
  Logging:
    Session State Change: No
    Session State: up, for 01:17:27
```

## Working & Protected Path



### LSP[1]:

```
LSP-ID: 6 policy ID: 4 (standby)
Local label: 24024
State: Standby programmed state
Performance-measurement:
  Reverse-path Label: Not Configured
  Delay-measurement: Disabled
  Liveness-detection: Enabled
  Profile: liveness-check
  Invalidation Action: down
  Logging:
    Session State Change: No
    Session State: up, for 01:17:27
```

### Attributes:

```
Binding SID: 24026
Forward Class: Not Configured
Steering labeled-services disabled: no
Steering BGP disabled: no
IPv6 caps enable: yes
```



# CS-SR Policy Example Forwarding Check

```
RP/0/0/CPU0:PE1# show segment-rou traffic-eng forwarding policy color 1001
SR-TE Policy Forwarding database
-----
Color: 1001, End-point: 10.10.10.10
Name: srte_c_1001_ep_10.10.10.10
Binding SID: 24026
Active LSP:
Candidate path:
  Preference: 20 (configuration)   Name: PE9toPE10
  Protection Role: WORKING
Local label: 24028
Segment lists:
  SL[0]:
    Name: working-forward-path
    Switched Packets/Bytes: 0/0
    Paths:
      Path[0]:
        Outgoing Label: Pop
        Outgoing Interfaces: HundredGigE0/0/0/4
        Next Hop: 10.109.1.10
        Switched Packets/Bytes: 0/0
        FRR Pure Backup: No
        ECMP/LFA Backup: No
        Internal Recursive Label: Unlabelled (recursive)
        Label Stack (Top -> Bottom): { Pop }
      Path[1]:
        Outgoing Label: Pop
        Outgoing Interfaces: HundredGigE0/0/0/5
        Next Hop: 10.109.2.10
        Switched Packets/Bytes: 0/0
        FRR Pure Backup: Yes
        ECMP/LFA Backup: No
```

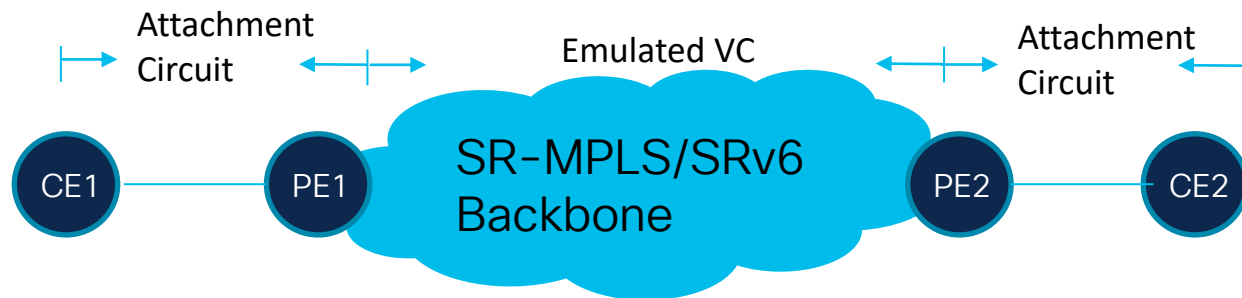
...

```
Internal Recursive Label: Unlabelled (recursive)
Label Stack (Top -> Bottom): { Pop }
Standby LSP(s):
LSP[0]:
Candidate path:
  Preference: 10 (configuration)   Name: PE9toPE10
  Protection Role: PROTECT
Local label: 24024
Segment lists:
  SL[0]:
    Name: protect-forward-path
    Paths:
      Path[0]:
        Outgoing Label: Pop
        Outgoing Interfaces: HundredGigE0/0/0/5
        Next Hop: 10.109.2.10
        FRR Pure Backup: No
        ECMP/LFA Backup: No
        Internal Recursive Label: Unlabelled (recursive)
        Label Stack (Top -> Bottom): { Pop }

Policy Packets/Bytes Switched: 0/0
```

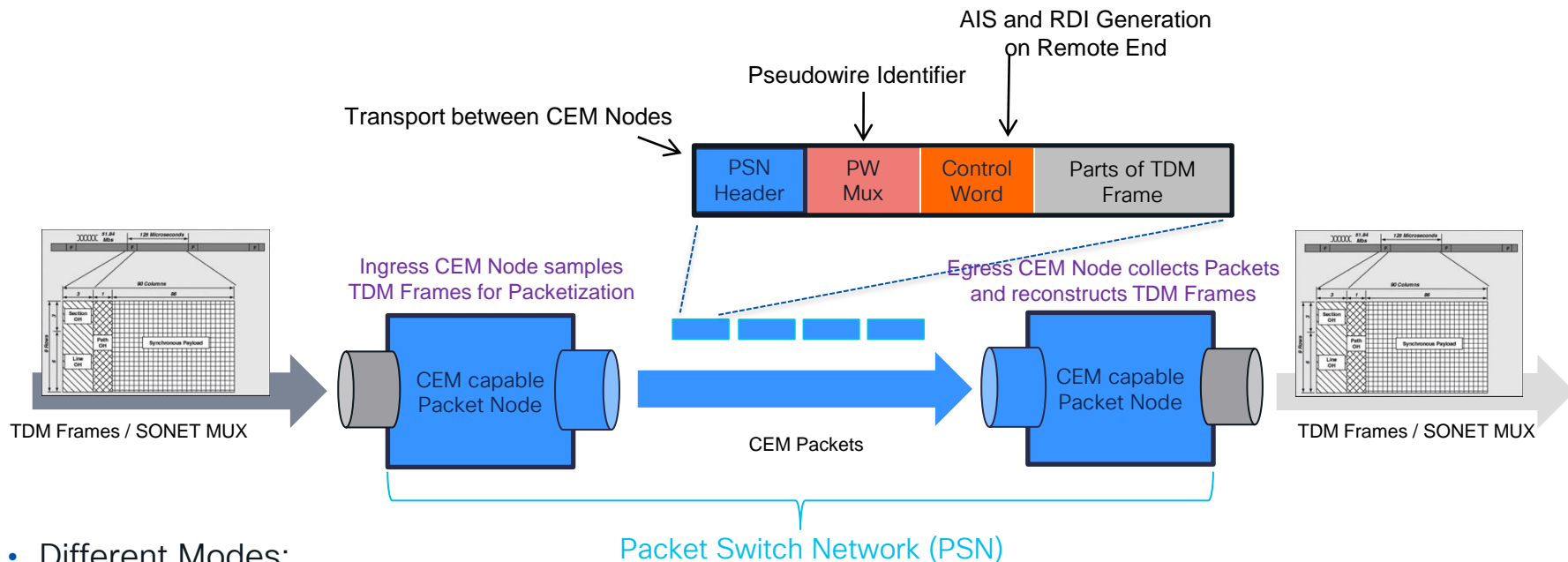
# TDM and Private Line Emulation (PLE)

# Circuit Emulation over MPLS (CEM) Interworking



- **Attachment Circuit:** It is a physical or virtual circuit (VC) that attaches a CE to a PE. An AC can be, a VC, an Ethernet port, a VLAN, an HDLC link, or a PPP connection.
- **Packet switched network (PSN):** Uses IP or MPLS as the mechanism for packet forwarding. The endpoints of a pseudo wire are two PE routers connected to ACs of the same type.
- **Emulated VC:** Used to provide a Layer 2 connection between the two CE devices.

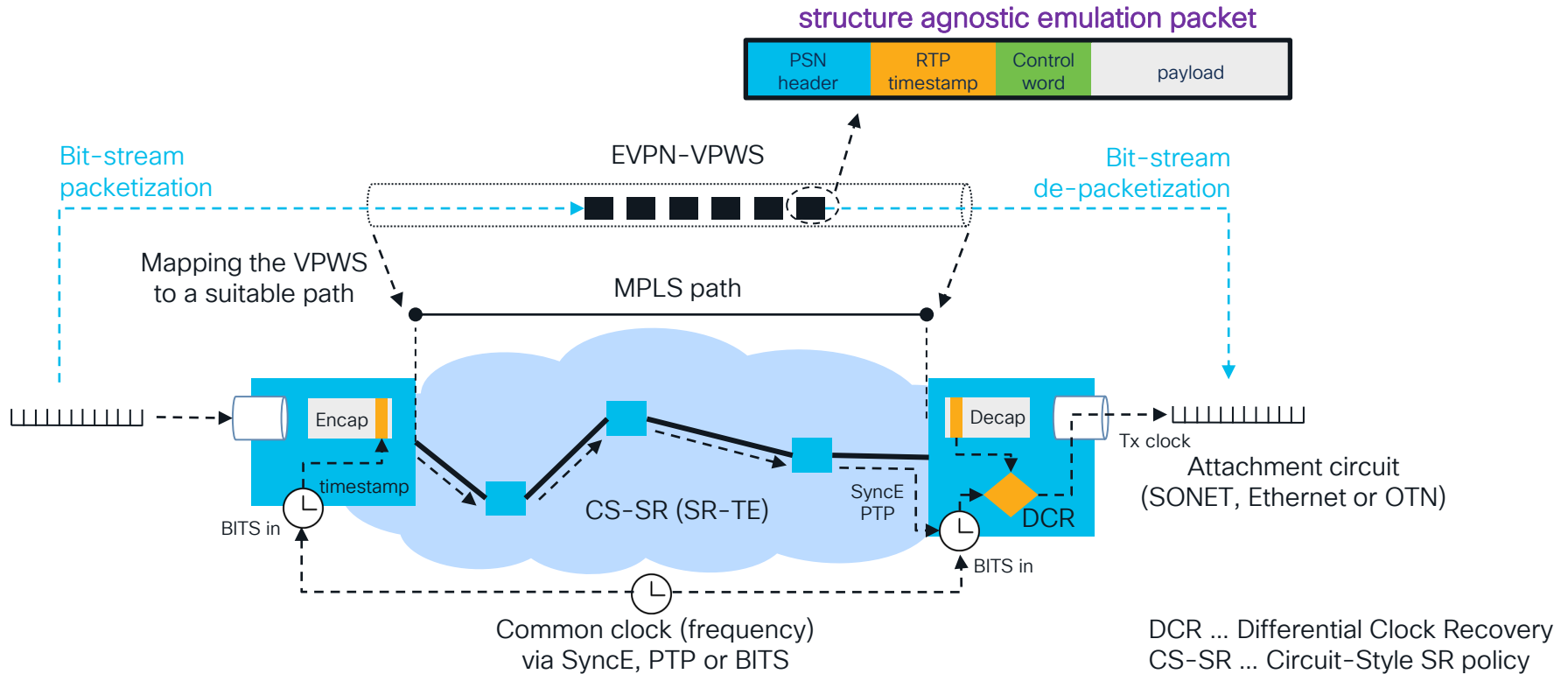
# Circuit Emulation (CEM) Standards



- Different Modes:

1. SAToP = Structure Agnostic TDM over Packet, such as T1/E1/T3 /E3 (RFC4553)
2. CESoPSN = Structure Aware Circuit Emulation Service over PSN, such as NxDS0 PDH (RFC5086)
3. CEP = SONET/SDH Circuit Emulation over Packet, such as Container (SPE/VC-n, VT/VC-n) (RFC4842)

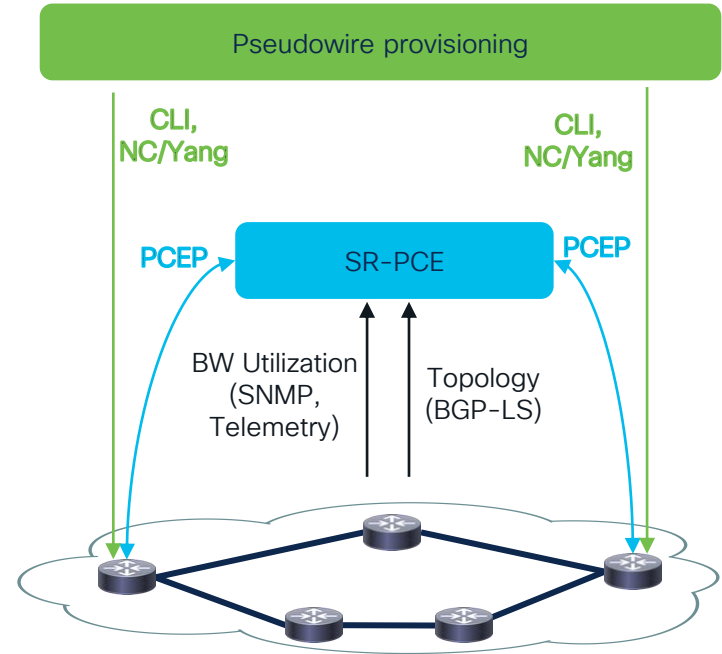
# Private Line Emulation (aka PLE)



# CS-SR and Service Emulation Demystified

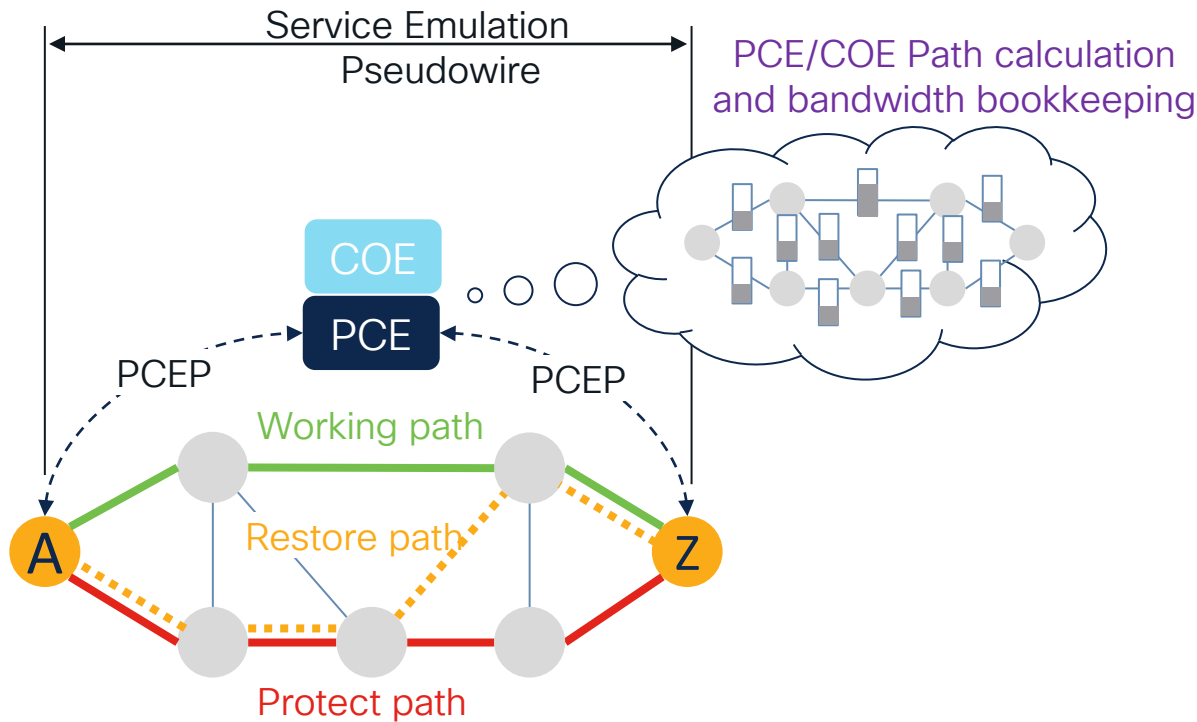
# Service Emulation over CS-SR Demystified

- Service emulation pseudowire has a distinct bandwidth requirement assigned
- Pseudowire is mapped to a CS-SR policy
- The path is encoded via a list of adjacency SIDs in the packet header
- Headend router requests a **CS-SR policy path via PCEP from a central PCE**
  - **Bandwidth**
  - Path **disjoint constraints**
- The central PCE maintains a real time view of
  - the network topology (BGP-LS)
  - All path/bandwidth requests (PCEP)



# CS-SR: Co-routed, Bidirectional Packet Transport

## Guaranteed Bandwidth with PCE/COE





# PCC Initiate CS-SR Policy & Bandwidth OnDemand

1. Operator configures SR-TE policy with bandwidth constraint
2. PCC sends PCReq to SR-PCE controller
3. SR-PCE requests BW-path from Crosswork Optimization
4. Crosswork Optimization returns BW-path (or no-path) to SR-PCE
5. SR-PCE sends BW-path (or no-path) to PCC

segment-routing  
traffic-eng  
policy to\_three

bandwidth 888

path-protection

color 100 end-point ipv4 3.3.3.3

candidate-paths

preference 100

dynamic pcep

constraints

segments protection unprotected-only

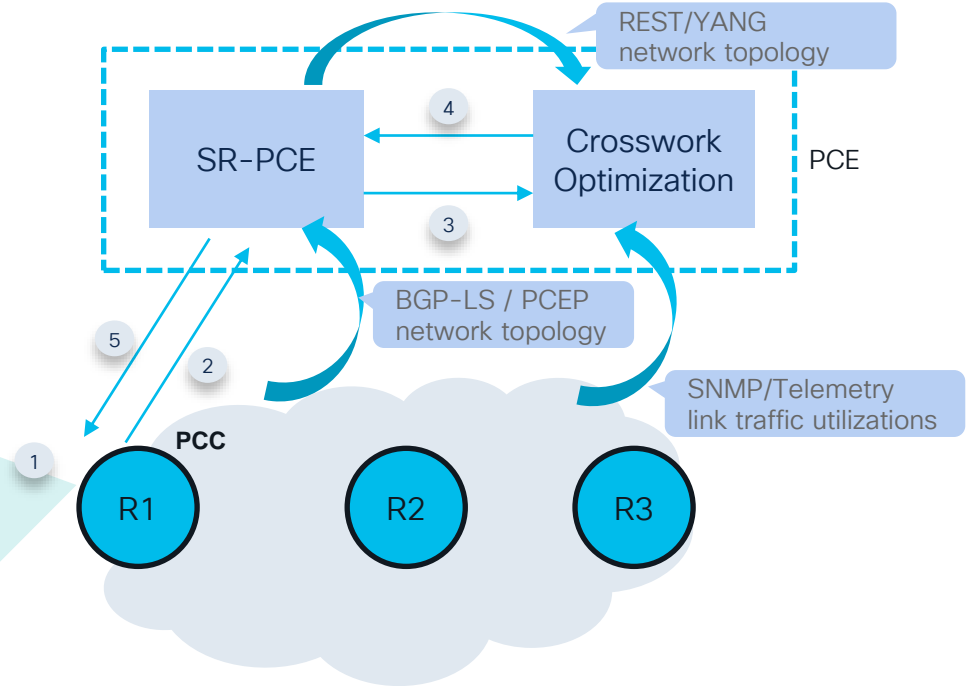
disjoint-path group-id 100 type link

bidirectional co-routed association-id 100

preference 50

dynamic pcep

CS-SR policy disjoint  
path calculated by PCE



# COE Initiate/Provisioning CS-SR Policy

## CS-SR Policy Details

Circuit-Style Policy {CS-SR-node-5-node-4-201}

**name \***  
CS-SR-node-5-node-4-201 ?

**color-choice**  
**auto-color** **color** ?

**color**  
201 ?

**bandwidth**  
250 ?

☒ **path-protection** ?

**head-end**

**device \***  
Node-5 x ?

**ip-address \***  
198.19.1.5 ?

**tail-end**

**device \***  
Node-4 x ?

**ip-address \***  
198.19.1.4 ?

## Forward/Reverse Path

**disjoint-path**  
Enable disjoint-path ☐ ?

**forward-path**  
Enable forward-path ☐ ?

**type \***  
node

**group-id-type**  
**group-id** **auto-group-id**

**auto-group-id** ?  
☒

**reverse-path**  
Enable reverse-path ☐ ?

**type \***  
node

**group-id-type**  
**group-id** **auto-group-id**

**auto-group-id** ?  
☒

## Working Path

**working-path**  
**sr-te-path-choice \***  
**explicit-path** **dynamic-path**

**dynamic**  
Enable dynamic ☐ ?  
☒ **pce** ?

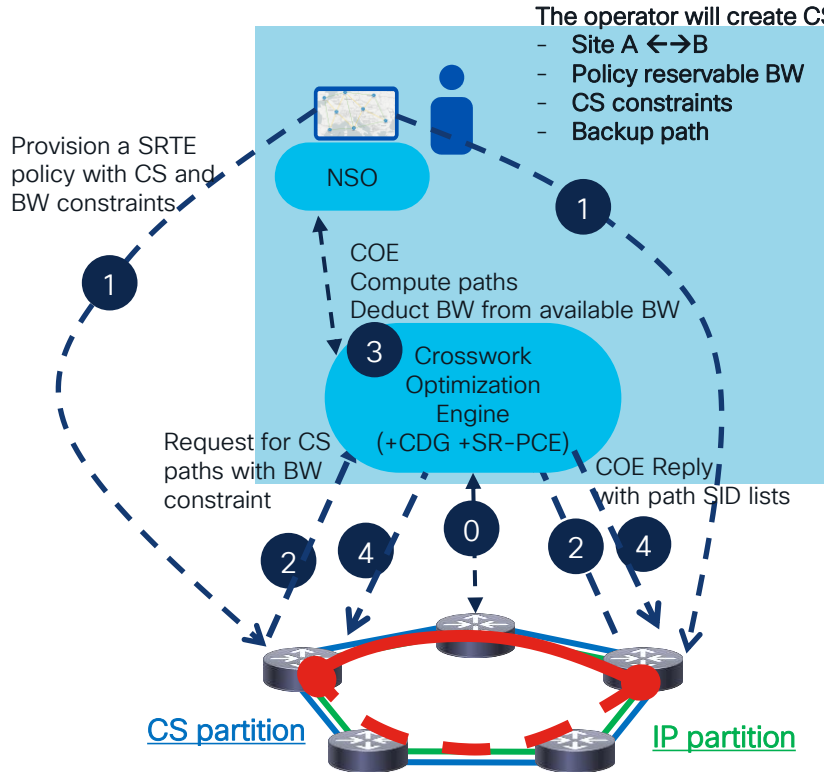
**metric-type**  
latency

**constraints**

**affinity**  
Enable affinity ☐ ?

**segments**  
Enable segments ☐ ?  
**protection**  
unprotected-only

# COE Provisioning a Circuit-style SR Policy



0. PCE/COE Collect network topology

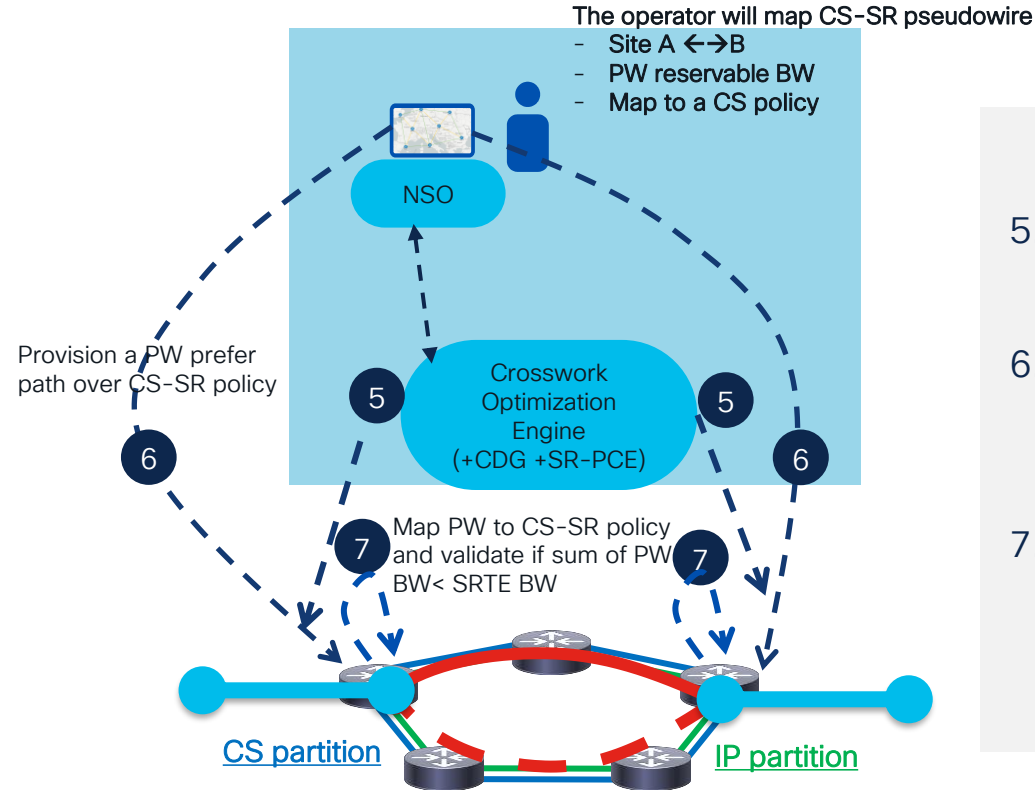
1. When creating CS-SR policy, the SP will specify the BW to reserve and make CS computation as a constraint.

2. PCC will request to compute paths with BW and CS constraints (both candidate paths in single PCEP request message).

3. COE/PCE will compute both paths and reserved BW from available BW pool

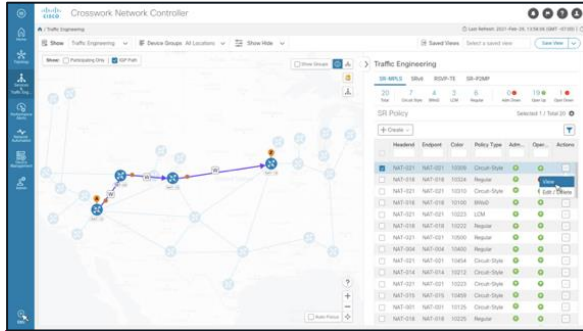
4. COE will reply to the PCC with the path lists (2 path lists – primary & backup).

# Provisioning a Pseudowire over CS-SR Transport

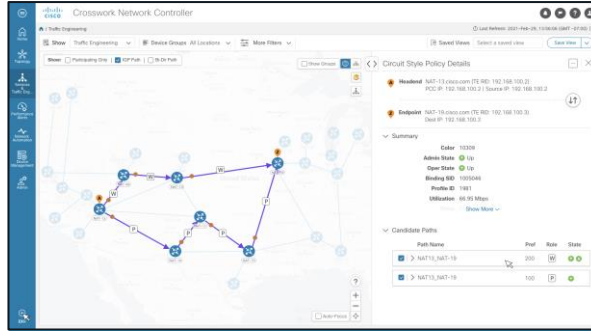


5. Primary and backup paths are signalled at same time.
6. Provisioning the PW, SP will specify the PW ingress limiter, the PW prefer path over CS-SR policy
7. The PCC will validate the sum of PW BW don't exceed CS-SR BW and bind the PW AC with associated CS-SR policy.

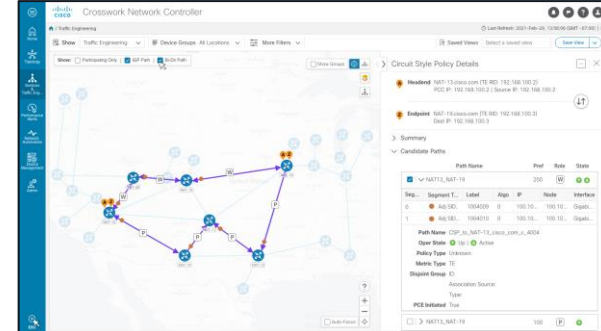
# Circuit-Style SR Policy Overlay in COE



CS SR-TE Policy Listing




CS policy details  
Path Protection



CS Policy details  
co-routed bidirectional

- Modern look and feel
- Seamless and consistent experience across various Crosswork application workflows
- Detailed information about CS SR Policies, Path Protection, Co-routed Bidirectional

# Why Circuit-Style Segment Routing?



Leverage Segment Routing to embrace SDN disjoint path for efficient network utilization, strengths to carry any kind of services: IP, TDM, Optical

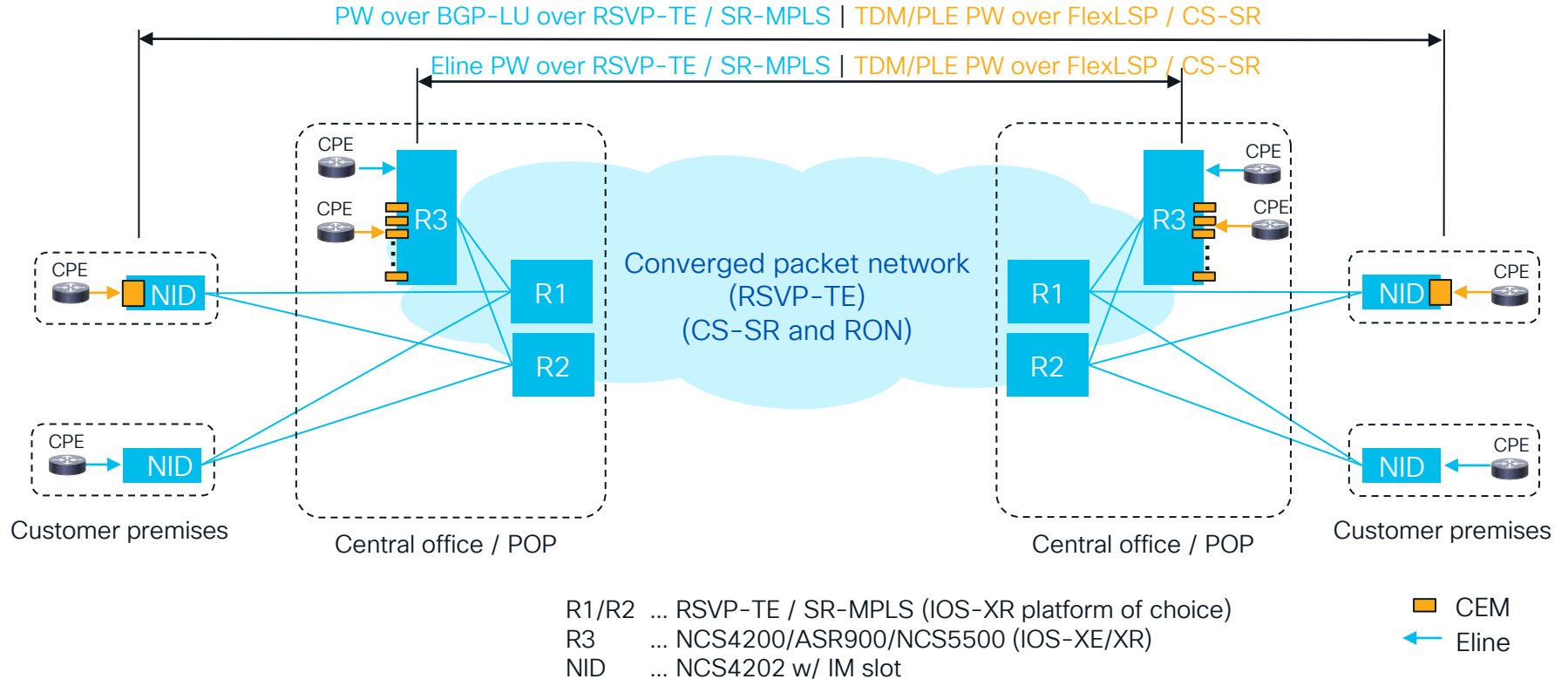
Provide SR policies that are bi-directional, fast-reroute protection (<50msec) and guaranteed bandwidth

To support different types of services with Guaranteed Bandwidth: TDM2IP circuits, Private Line Emulation (PLE)  
Local congestion mitigation approaches (Cisco COE LCM)

Integrated in our customers SDN/PCE strategy: “low available bandwidth” threshold, SRLG & Affinity path disjointness

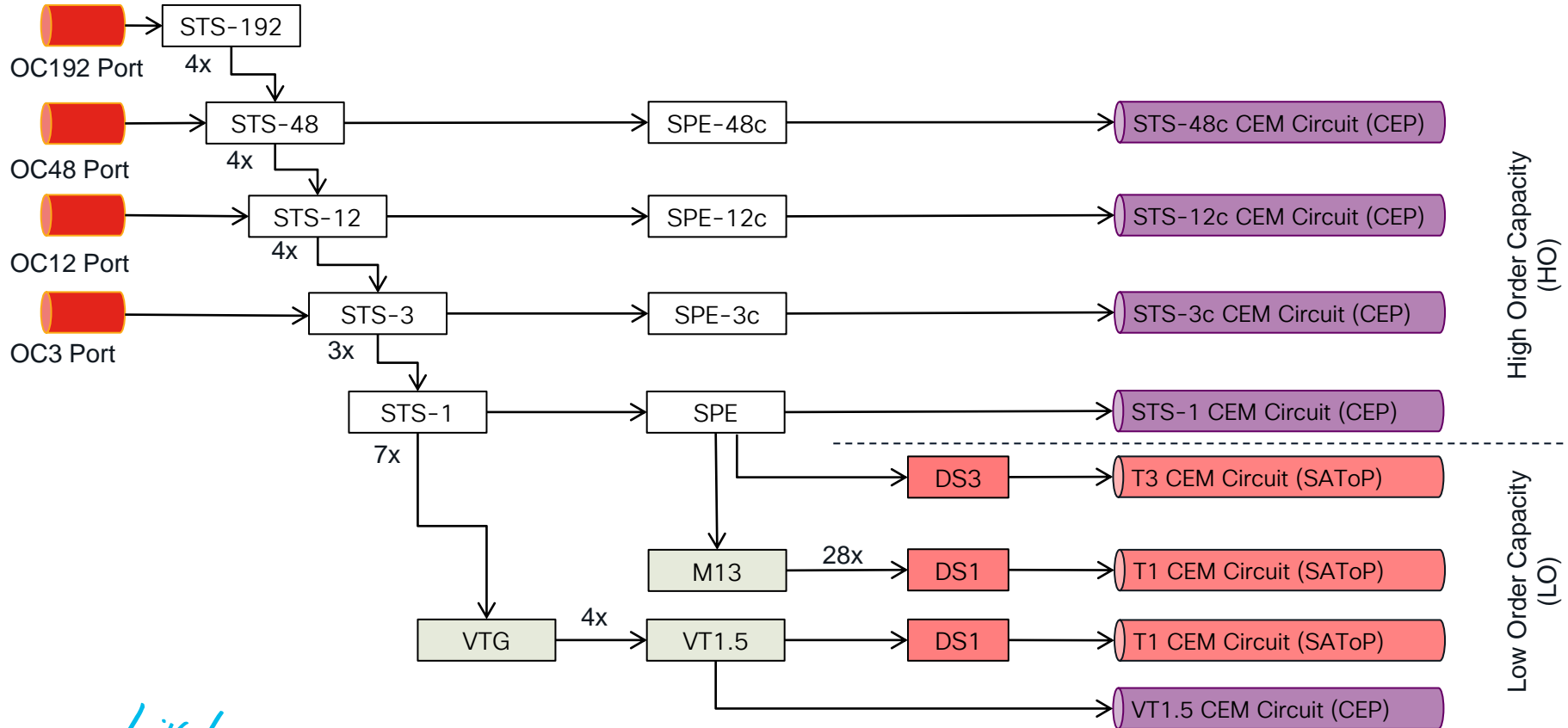
# CS-SR and Service Emulation Case Study

# ...That's what we ended up for TDM / PLE

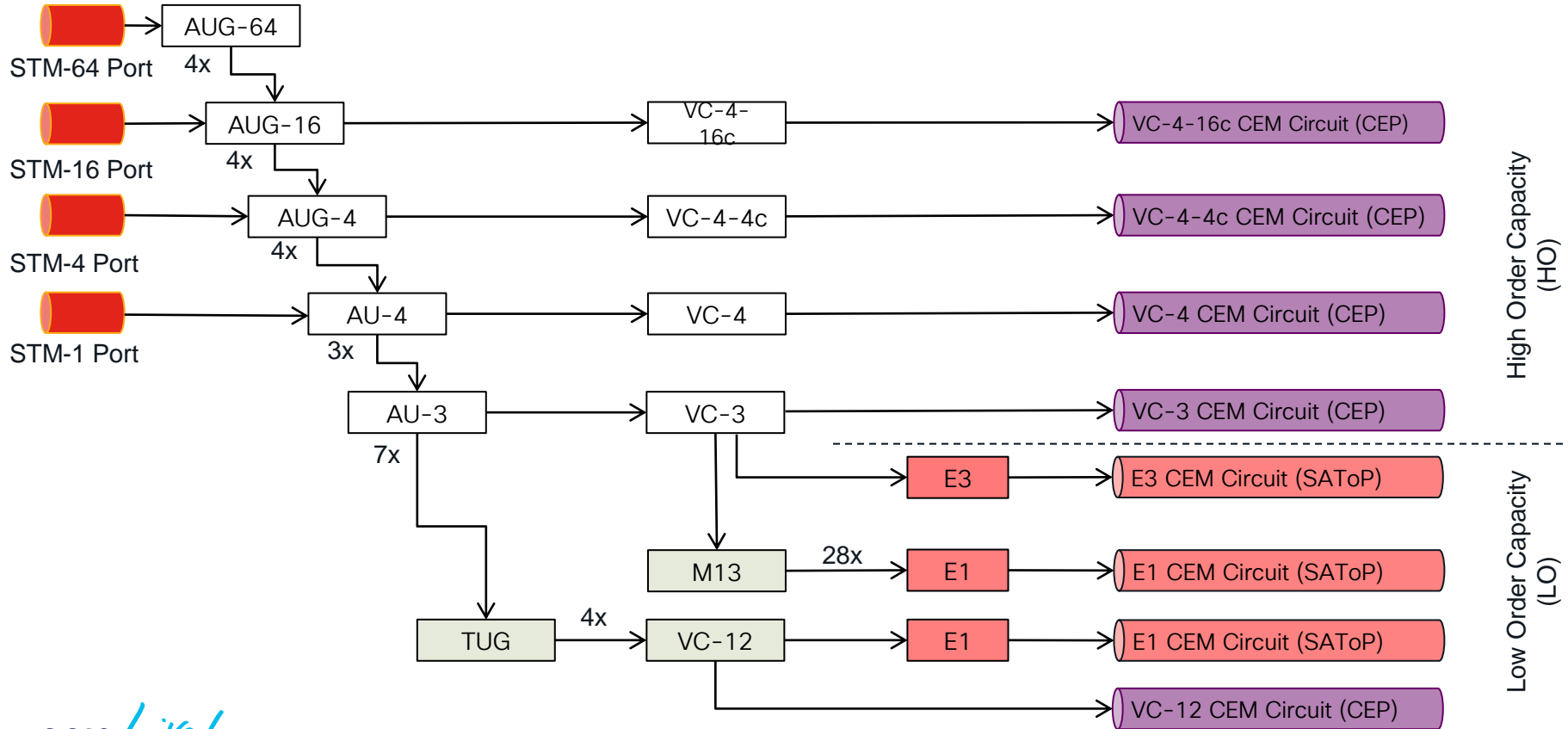




# Supported CEM Types for OC-n



# Supported CEM Types for STM-n



# Cisco Solution for Smart Grid Power Utilities



## Business Challenge

- Introduce new smart grid capabilities for improved grid reliability and automated metering infrastructure to give customer greater control over energy usage and costs
- Need of robust WAN infrastructure
- **Eliminating separate SONET/SDH networks which could result in inefficiencies**
- Strategic Investment plan for Overall cost reduction in deploying modernized network

## Cisco Solution and Benefits

- Decrease in complexity of smart grid networks
- Optimization of capital and operating expense
- Cost, power, floor space, cooling savings
- Alignment with proven trends in operational efficiency

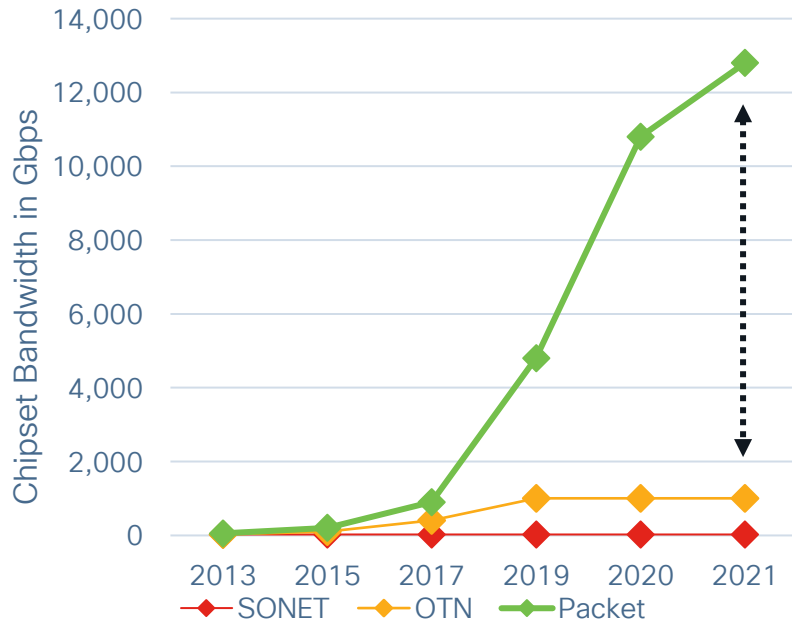
***“Our Partnership with Cisco enabled development of a modular approach and convergence of services onto a common IP infrastructure, which helps us optimize OPEX and meet new business challenges.”*** – Director Electric Utility Company

**CISCO** *Live!*



# Routers Are No Longer Slow Nor Expensive!

## Silicon Evolution



### Cisco ASR 900

- 200Gbps
- Mix of 10,25,40,50,100GE



### Cisco NCS 5500

- 57.6Tbps
- Mix of 10,25,40,100 and 400GE



### Cisco NCS 5700

- 153.6Tbps
- Mix of 10,40,100 and 400GE



# NCS5500 Series PLE Hardware Support

NCS-57C3-MOD



8x PLE MPA



NCS-55A2-MOD



Client optics

Ethernet	SFP-10G-SR/LR/ER, GLC-LH/EX/ZX-SMD, 1G/10G CWDM*
OTU2e	SFP-10G-LR-X, SFP-10G-ER-I, SFP-10G-ZR
SONET/SDH	ONS-SC+-10G-LR/ER/SR (OC-192/STM-64), ONS-SI-2G-L1/L2/S1 (OC-48/STM-16)
Fiber Channel	DS-SFP-FCGE, DS-SFP-FC8G, DS-SFP-FC16G, DS-SFP-32G, 1/2/4/8G FC CWDM



# ASR 900 Series PLE/TDM Hardware Support



ASR-914  
14RU F2B  
16 Slots, ISSU  
400G



ASR-907  
7RU  
16 Slots, ISSU  
400G



ASR-903  
3RU, 6 Slots, ISSU  
400G



ASR-920 12SZ  
1RU, 1 card slot, 64G



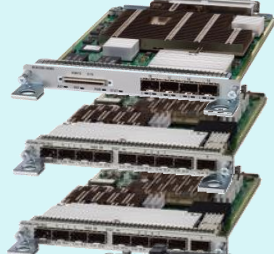
ASR-920 24Z  
1RU, 64G

**CISCO** *Live!*

TDM



8 x DS1\E1 CEM  
48 x DS1\E1 CEM  
48 x DS3\E3 CEM



3G CEM / iMSG (12 x DS1/E1 + 4 x DS3/E3 +  
4 x OC-3/12/48 or STM-1/-4/-16)  
10G CEM (1xSFP+, 8xSFP)  
(OC-3/12/48/192 or STM-1/-4/-16/-64)  
10G CEM /iMSG (1xSFP+, 8xSFP)  
(OC-3/12/48/192 or STM-1/-4/-16/-64)

PACKET



Combo 8x GE/FE, 1 x 10GE SFP/SFP+  
16 x 1GE + 1 x 10GE / 18 x GE CSFP/SFP+  
8 x 10GE Ethernet SFP+  
2 x 40GE Ethernet QSFP  
1 x 100GE Ethernet CPAK  
2 x 100GE Ethernet QSFP28

# NCS 4200 Series PLE/TDM Hardware Support



NCS4216-F2B  
14RU, 16 Slots, ISSU  
400G



NCS4216  
7RU, 16 Slots, 400G  
ISSU



NCS4206  
3RU, 6 Slots, 400G  
ISSU

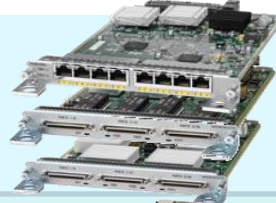


NCS4202  
1RU, 1 card slot, 64G

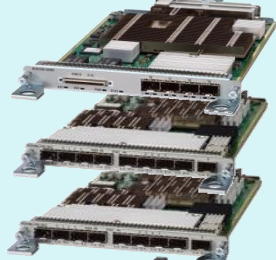


NCS4201  
1RU, 64G

TDM



8 x DS1\E1 CEM  
48 x DS1\E1 CEM  
48 x DS3\E3 CEM



3G CEM / iMSG (12 x DS1/E1 + 4 x DS3/E3  
+ 4 x OC-3/12/48 or STM-1/-4/-16  
10G CEM (1xSFP+, 8xSFP)  
(OC-3/12/48/192 or STM-1/-4/-16/-64)  
10G CEM /iMSG (1xSFP+, 8xSFP)  
(OC-3/12/48/192 or STM-1/-4/-16/-64)

PACKET



Combo 8x GE/FE, 1 x 10GE SFP/SFP+  
16 x 1GE + 1 x 10GE / 18 x GE CSFP/SFP+  
8 x 10GE Ethernet SFP+  
2 x 40GE Ethernet QSFP  
1 x 100GE Ethernet CPAK  
2 x 100GE Ethernet QSFP28



# Unique Advantages for Cisco CEM Solution

## Service emulation technology readiness

Circuit emulation (CEM) technology, which provides boundless scale with high-density TDM services over a protected MPLS FlexLSP, or SR-MPLS CS-SR



## Manage all customers on the same platform

Modernization for legacy TDM DCS replacement and SONET/SDH ADM ring overlay/migration facilitating transition to packet-based networks



## Cisco CEM Solution

- BIDIR, symmetrical
- Guaranteed BW
- Disjoint Path Protection

## Optimization of CapEX & OpEX expense

Carrier-class design requiring much smaller central office footprint and higher capacity than legacy DCS/ADM metro network equipment)



## Increase agility and operation efficiency

Evolved Programmable Network Manager (EPN-M) and SDN support for automating device operations, provisioning, and proactive assurance



# Fill out your session surveys!



Attendees who fill out a minimum of four session surveys and the overall event survey will get **Cisco Live-branded socks** (while supplies last)!

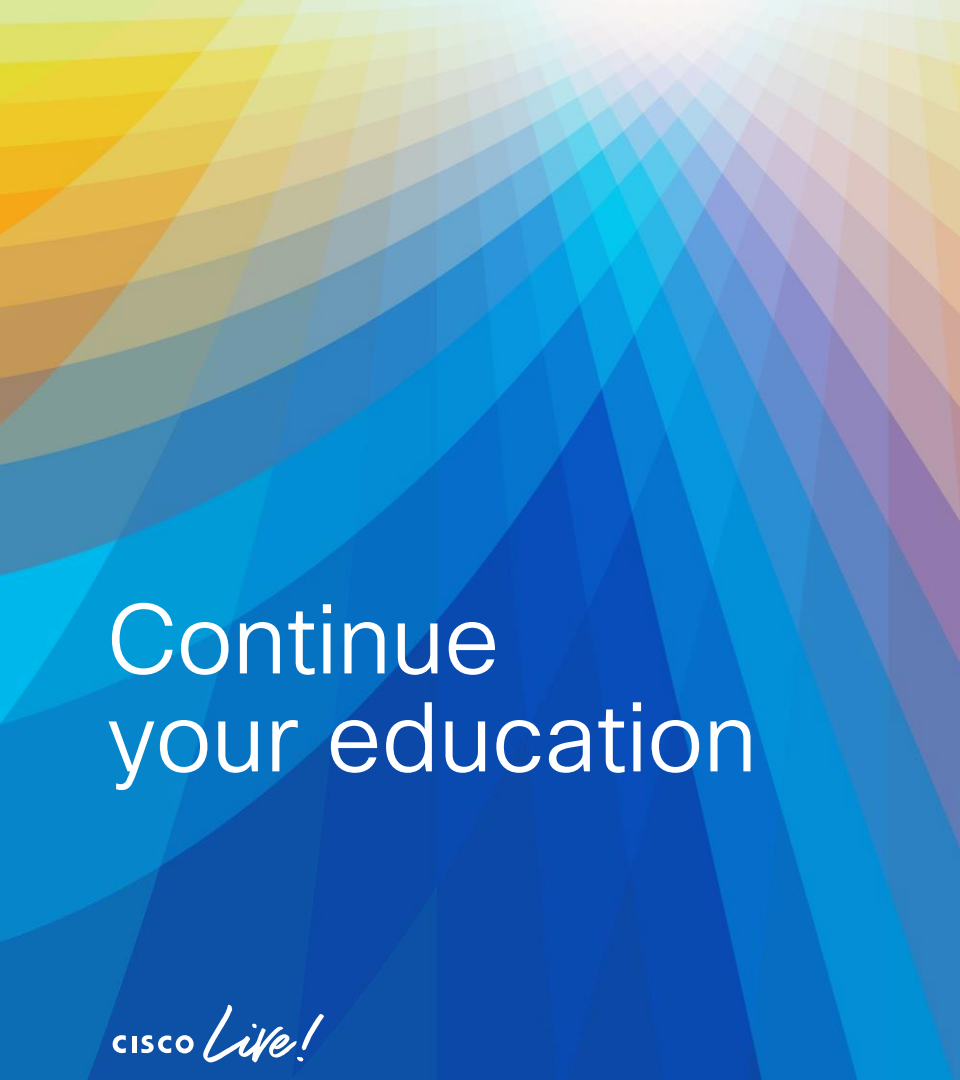
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Attendees will also earn 100 points in the **Cisco Live Challenge** for every survey completed.



**These points** help you get on the leaderboard and increase your chances of winning daily and grand prizes



# Continue your education



- Visit the Cisco Showcase for related demos
- Book your one-on-one Meet the Engineer meeting
- Attend the interactive education with DevNet, Capture the Flag, and Walk-in Labs
- Visit the On-Demand Library for more sessions at [www.CiscoLive.com/on-demand](https://www.CiscoLive.com/on-demand)

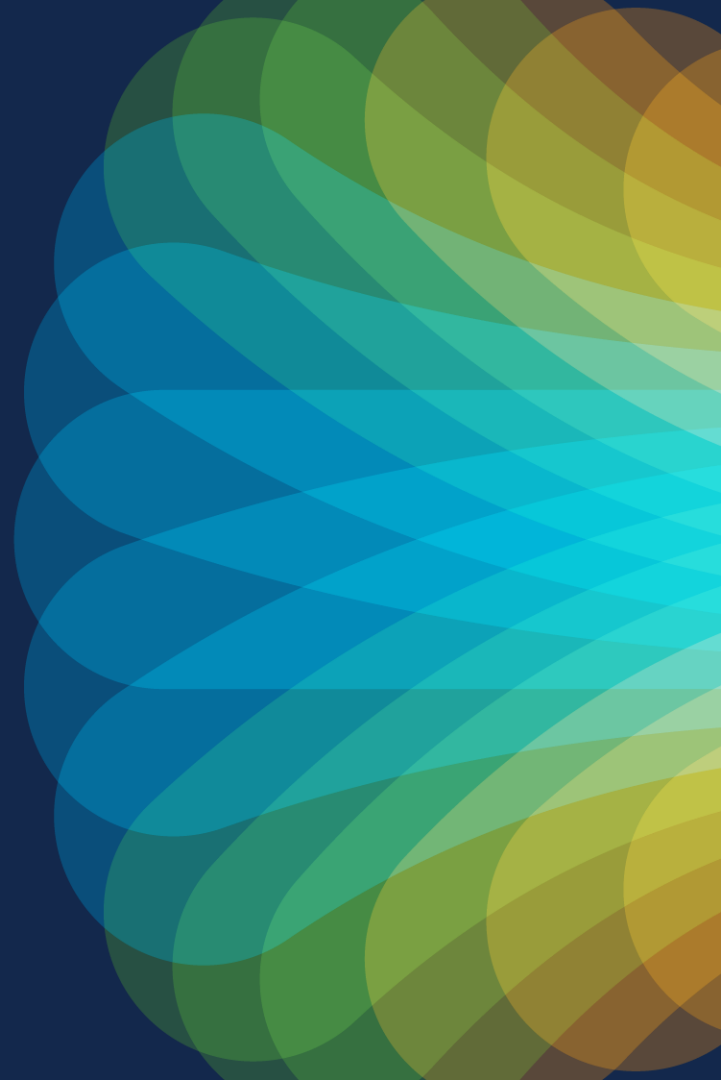


The bridge to possible

# Thank you



#CiscoLive

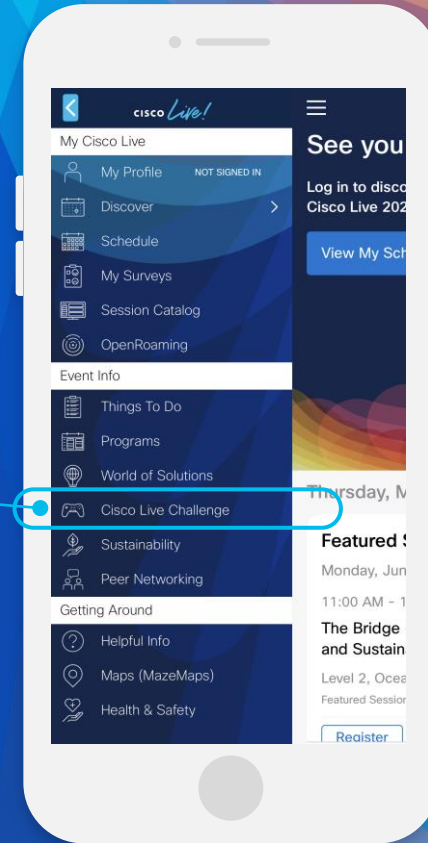
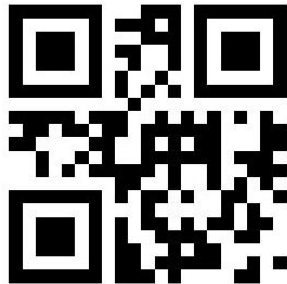


# Cisco Live Challenge

Gamify your Cisco Live experience!  
Get points for attending this session!

## How:

- 1 Open the Cisco Events App.
- 2 Click on 'Cisco Live Challenge' in the side menu.
- 3 Click on View Your Badges at the top.
- 4 Click the + at the bottom of the screen and scan the QR code:



The background is a vibrant, abstract graphic. It features a central bright white light source from which numerous colorful rays emanate, creating a sunburst or starburst effect. The rays transition through a spectrum of colors including yellow, orange, red, and various shades of blue and green. Overlaid on this are several large, semi-transparent, wavy shapes in similar color tones, giving the overall image a sense of motion and energy.

cisco *Live!*

Let's go

#CiscoLive