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The bridge to possible

mVPN Profile 14: This is the Way

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BRKENT-2004

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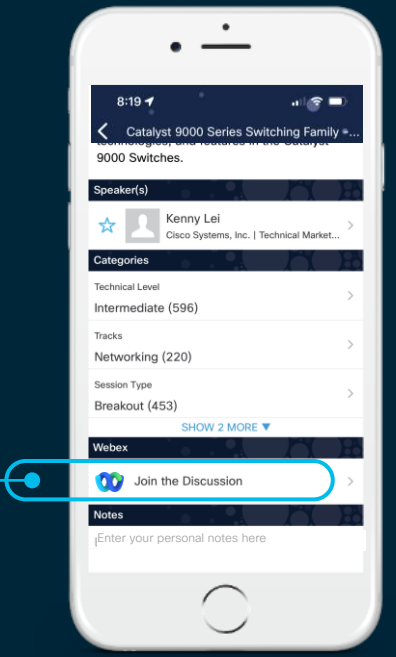

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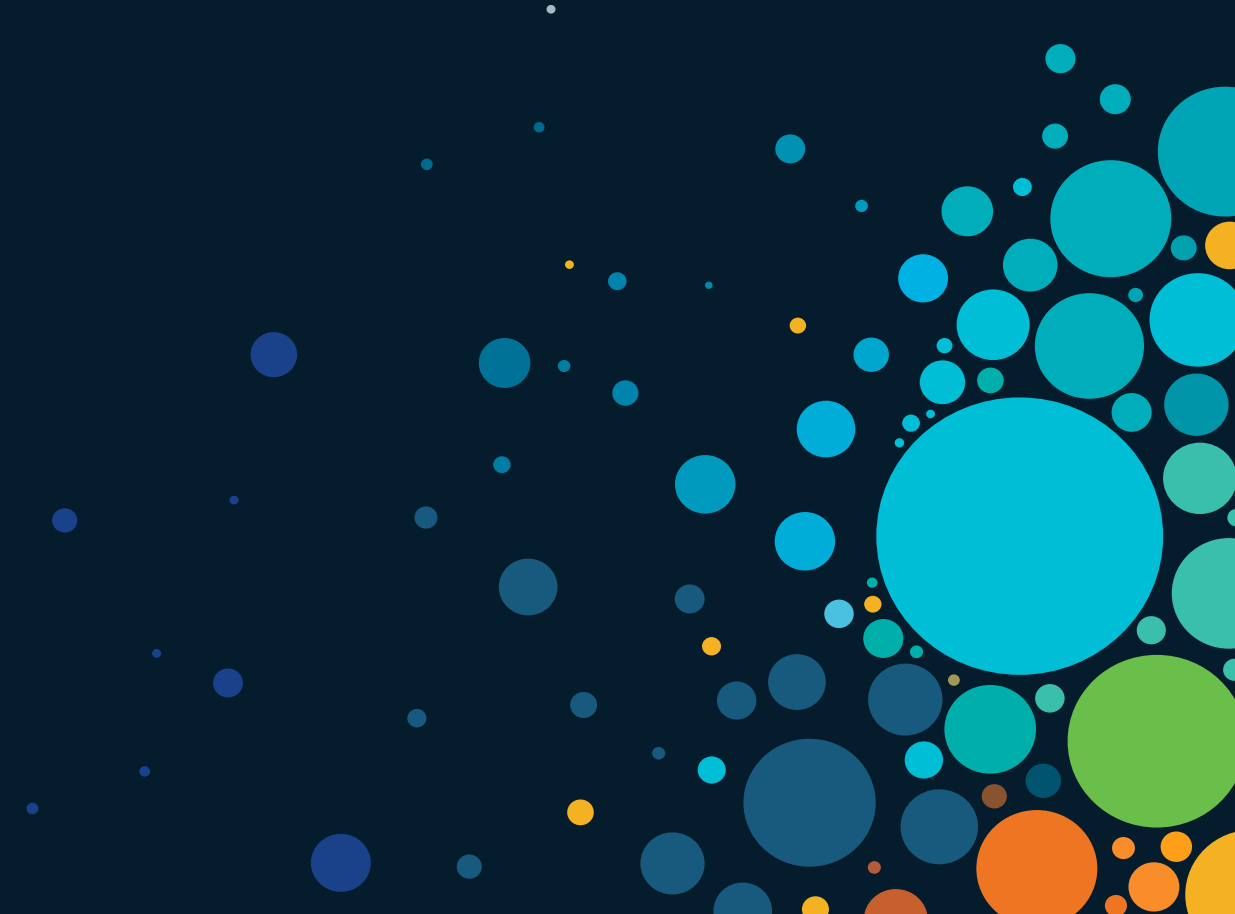
Agenda

- Introduction
- mLDP for underlay
- BGP for overlay
- mVPN
- Profile 14 with eVPN
- Key Take Aways

Introduction

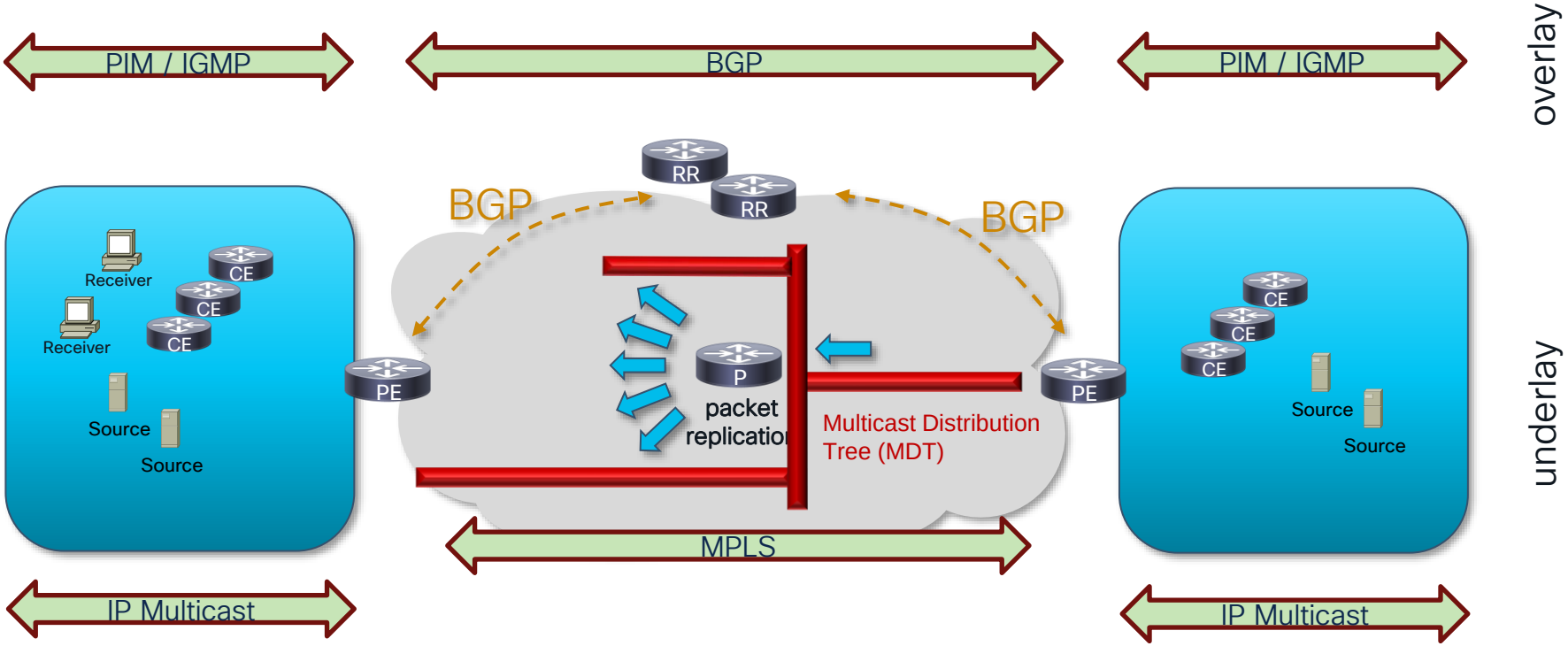


Introduction

- There are 27 mVPN profiles + 3 new for Tree-SID
  - PIM/Multicast, mLDP, P2MP Traffic Engineering, Controller, BGP, …
- Some are popular, some are not
- Profile 0: multicast/PIM in under- and overlay is still there
- Some profiles have TE (if you want bandwidth control)
- Some are rare
- Profile 14 (P-14) is now the new way to go

What Do We Want?

reliability, scalability, redundancy, fast convergence, protection, future prove



Why mVPN Profile 14?

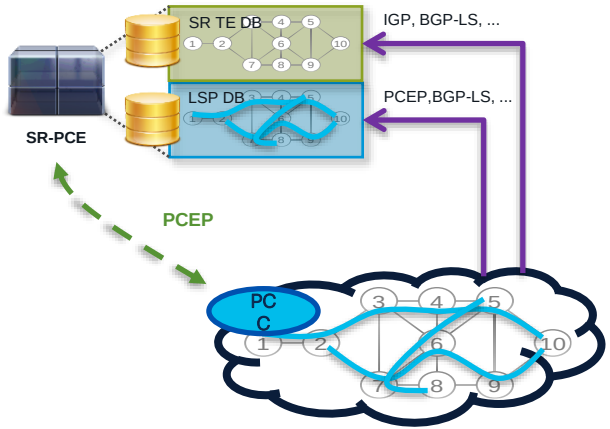
- Omni present
- MPLS forwarding (with replication on core routers)
- The best scalability
  - mLDP
    - Steady state (on top of TCP), reliable
    - Protection in core of multicast traffic
    - Simpler than PIM
  - BGP
    - Scalable, but different than PIM

- New possibilities, while maintaining the old
  - Still Data MDTs
  - Less state in the core = no Default MDT
  - Trees built on demand
  - mLDP less complex that Default MDT (no Upstream, only Downstream signaling)
- Special MPLS OAM for troubleshooting

mVPN vs. Segment Routing (SR)

- mVPN can be used with SR
  - SR for unicast, mLDP for multicast only
    - LDP for unicast disabled for faster convergence (mLDP-only SAC)

- Tree-SID
  - Inherent use of SR MPLS labels
  - SR-PCE (controller) must be used
  - Static or dynamic way (mVPN overlay signaling by BGP)



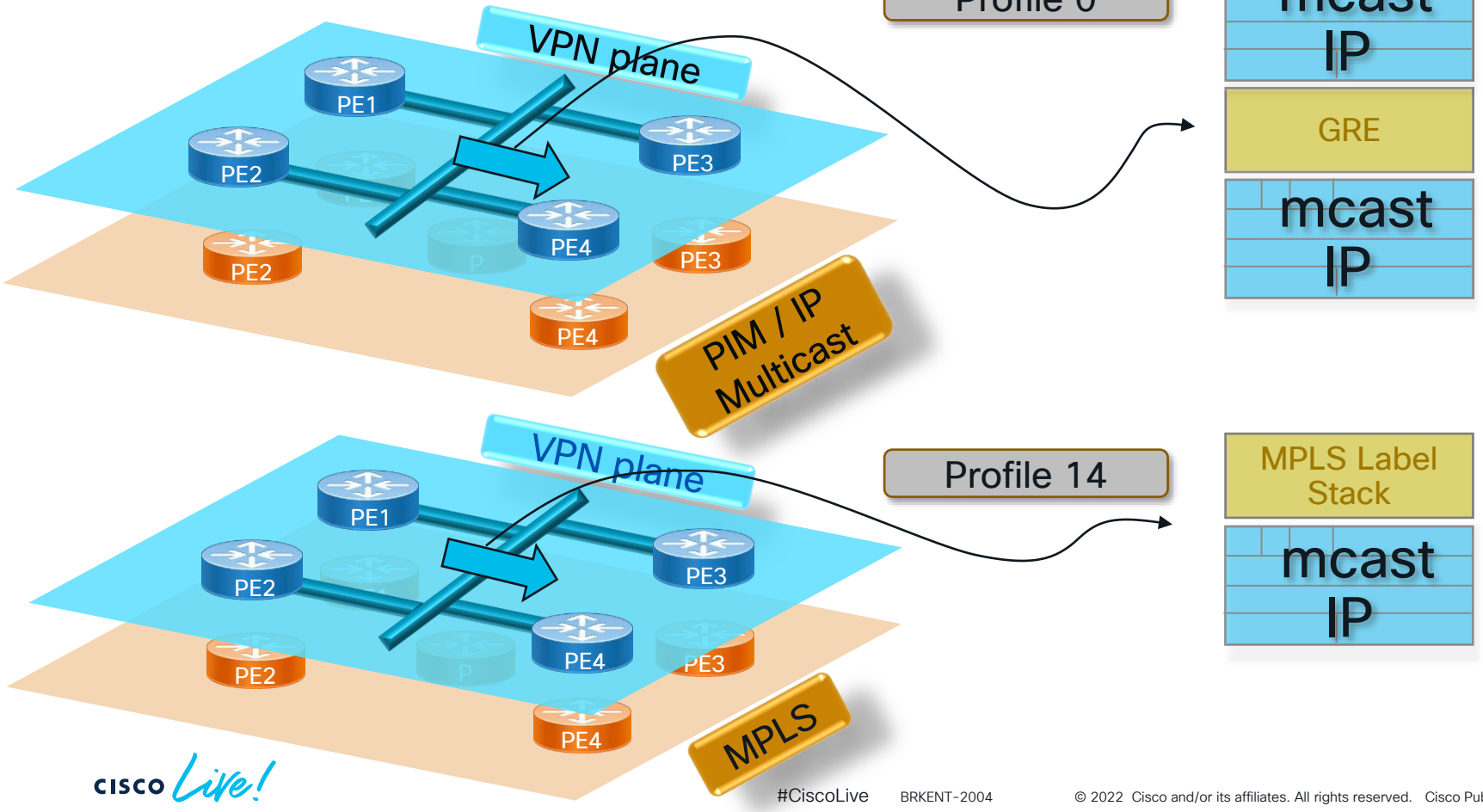
mLDP-only SAC

- RFC 7473: State Advertisement Control for Non-negotiated LDP apps
- Have an LDP peer negotiate to advertise label bindings for certain MPLS apps or not by means of capability exchange at LDP session establishment
- Configure LDP to negotiate the label advertisement for IPv4, IPv6, FEC128, FEC129, and mLDP
- Request: run (m)LDP for advertisement of mLDP label bindings, but not for unicast label bindings
  - Use-case: Segment Routing network (no LDP for unicast is needed)

```
RP/0/0/CPU0:PE(config-ldp)#capabilities sac ?

  fec128-disable  Disable exchanging PW FEC128 label bindings
  fec129-disable  Disable exchanging PW FEC129 label bindings
  ipv4-disable    Disable exchanging IPv4 prefix label bindings
  ipv6-disable    Disable exchanging IPv6 prefix label bindings
  mldp-only       Only exchange mLDP label bindings
  <cr>
```

Underlay

Encapsulation



Replication in Core

- Core (P) routers signal mLDP

Control plane

mLDP

Modified LDP
1 additional FEC for LDP Label Mapping Message

- Replicate MPLS Multicast packets

Data plane

MPLS

MPLS as we know it

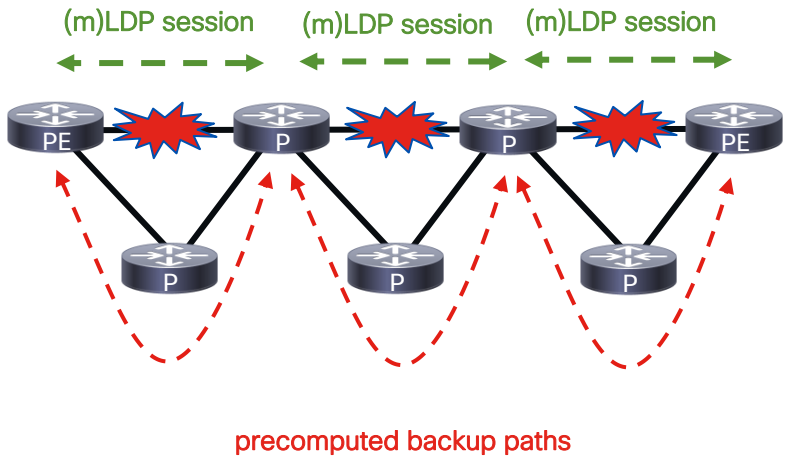
No implicit-null
QOS propagation (EXP)
TTL behavior
Label stacking when needed
Regular forwarding = 1 label
Protection = 2 labels

replication

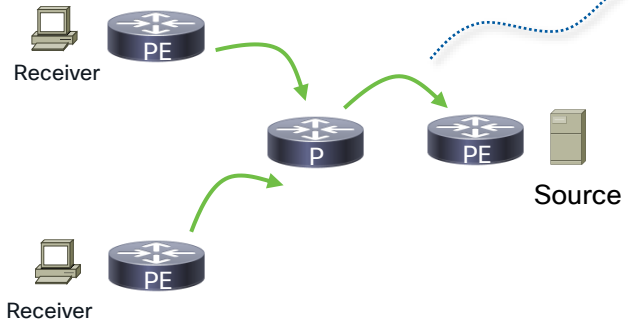
```
RP/0/0/CPU0:P#show mpls forwarding p2mp
Local    Outgoing    Prefix             Outgoing     Next Hop
Label    Label       or ID              Interface
------   ----------- ------------------ ------------ --------
24006    24004       mLDP/IR: 0x00001   Gi0/0/0/0    10.1.4.1
         24009       mLDP/IR: 0x00001   Gi0/0/0/2    10.3.4.3
```

mLDP Protection in Underlay

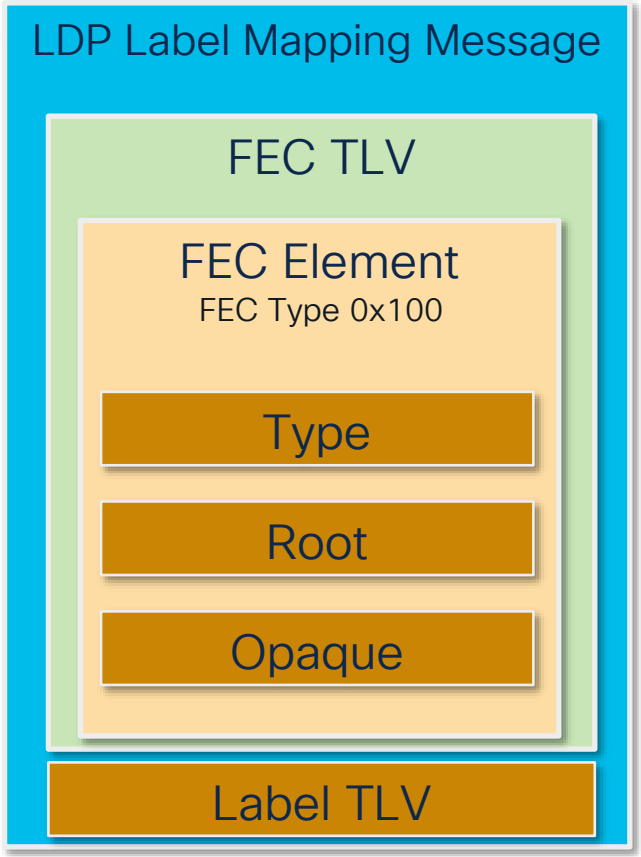
- Backup path is precomputed
- Two possibilities
  - LFA and Ti-LFA (aka FRR)
    - Loop Free Alternate
    - Per-prefix FRR
    - No signalling involved
    - Link protection only (no node protection)
  - Unicast TE LSPs
    - Requires to have MPLS Traffic Engineering
    - Backup auto-tunnels can be used to protect primary one hop tunnels protecting all links



LDP Label Mapping Message: 4 Important Fields



these 3 items uniquely identify the mLDP tree



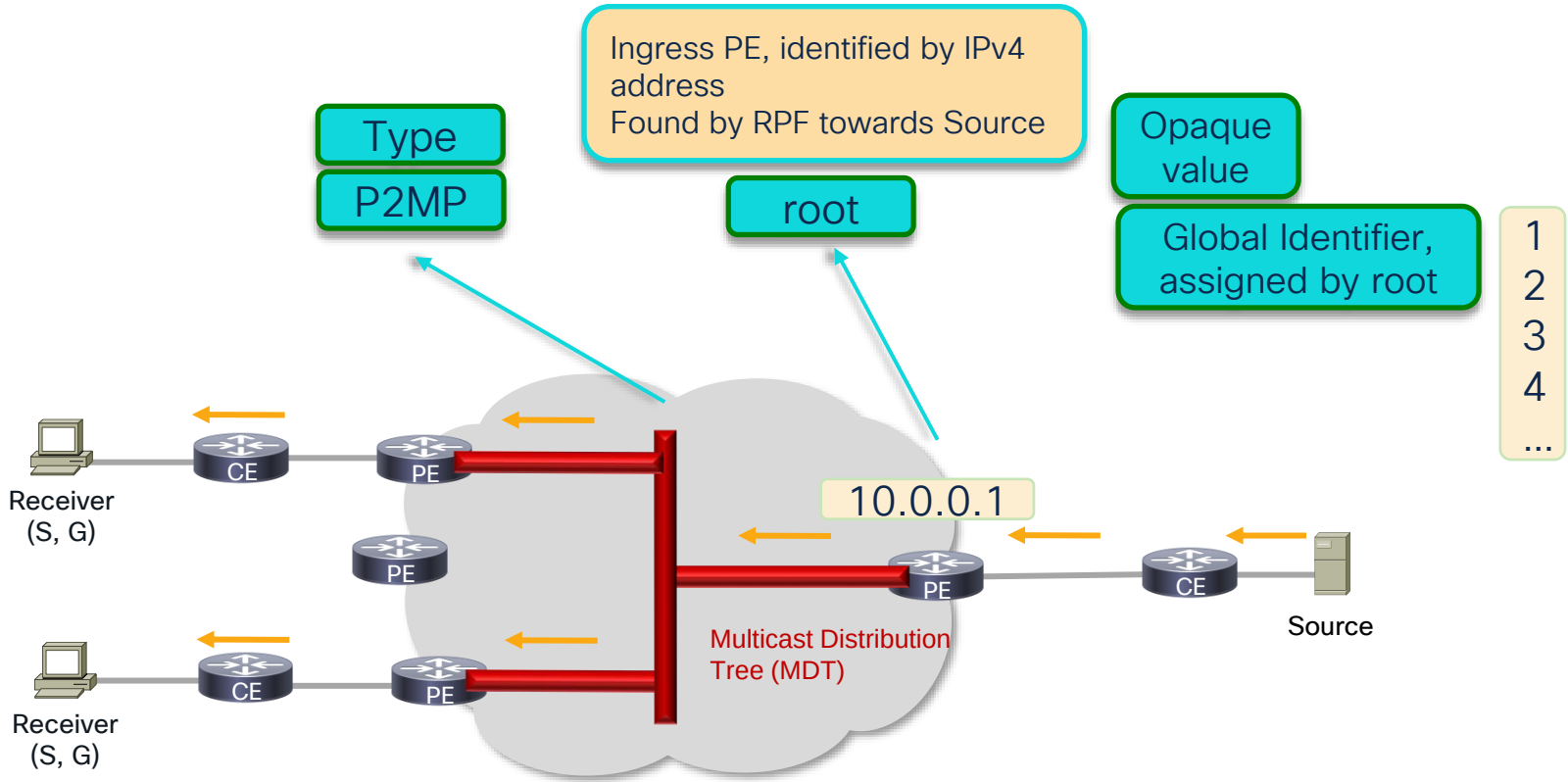
P2MP

Ingress PE

Global Identifier
P routers do not interpret this value

MPLS label!

Root, P2MP Type, Opaque Value



mLDP -> LFIB

mLDP Signaling

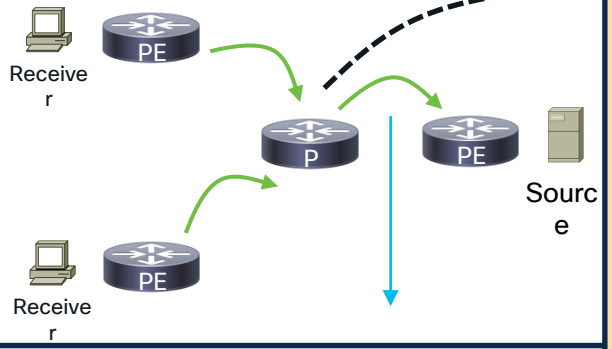
- mLDP signaling hop-per-hop
- Label binding, FEC 0x100
- Egress PE towards ingress PE (root)

mLDP DB

- 1 mLDP DB entry per tree

LFIB

- 1 LFIB entry per tree



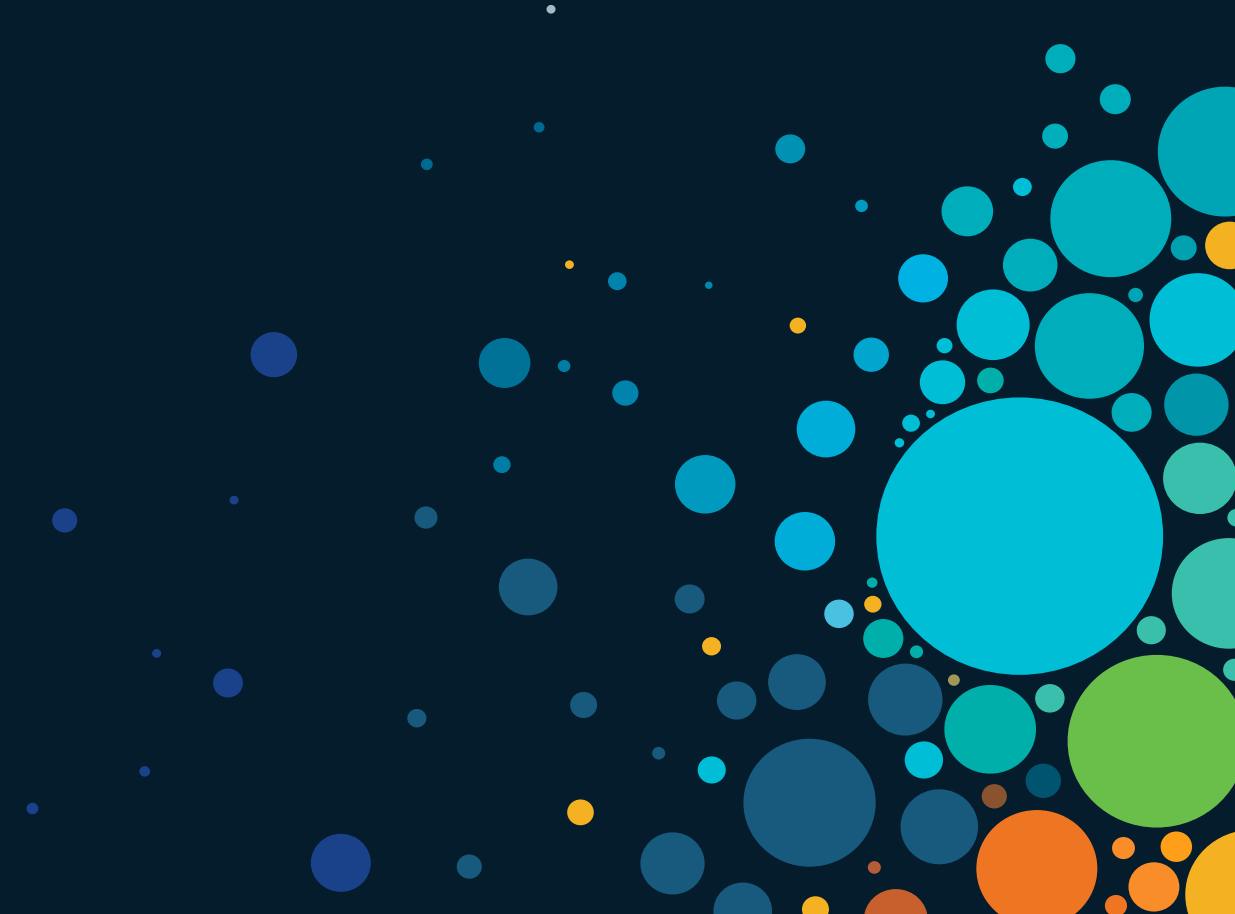

```
RP/0/0/CPU0:P#show mpls mldp bindings
mLDP MPLS Bindings database

LSP-ID: 0x00001 Paths: 3 Flags:
 0x00001 P2MP   10.0.0.2 [global-id 1]
   Local Label: 24006 Active
   Remote Label: 24004 NH: 10.1.4.1 Inft: GigabitEthernet0/0/0/0
   Remote Label: 24009 NH: 10.3.4.3 Inft: GigabitEthernet0/0/0/2
```

```
mLDP database
LSM-ID: 0x00001  Type: P2MP
  FEC Root           : 10.0.0.2
  Opaque decoded     : [global-id 1]
  Upstream neighbor(s) :
  Is CSI accepting    : N
    10.0.0.2:0 [Active] Uptime: 00:28:37
      Local Label (D) : 24006
  Downstream client(s):
    LDP 10.0.0.1:0
      Next Hop        : 10.1.4.1
      Interface       : GigabitEthernet0/0/0/0
       Remote label (D) : 24004
    LDP 10.0.0.3:0     Uptime: 00:20:31
      Next Hop        : 10.3.4.3
      Interface       : GigabitEthernet0/0/0/2
       Remote label (D) : 24009
```

```
RP/0/0/CPU0:P#show mpls forwarding p2mp
Local  Outgoing    Prefix            Outgoing     Next Hop
Label  Label       or ID             Interface
------ ----------- ----------------- ------------ --------
24006  24004       mLDP/IR: 0x00001  Gi0/0/0/0    10.1.4.1
       24009       mLDP/IR: 0x00001  Gi0/0/0/2    10.3.4.3
```

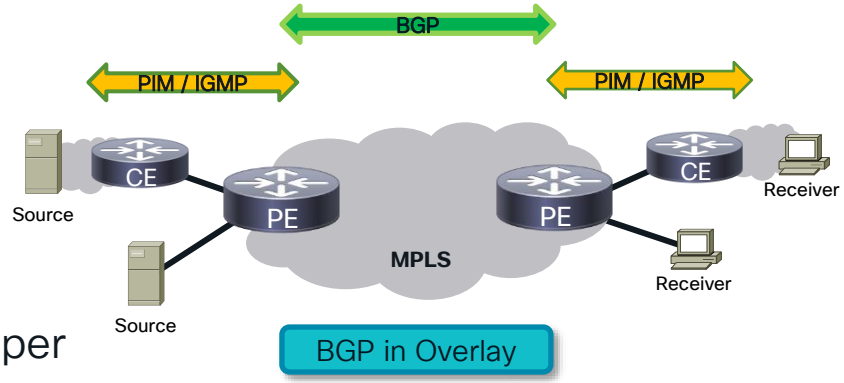
Packet replication

Overlay



BGP in Overlay

- PE-CE is PIM signaling
- PE-PE is BGP signaling



- BGP scales well
- BGP is not a multicast signaling protocol per design
  - Receiver to Source signaling …
  - PIM Sparse Mode works differently in BGP → new procedures
- New address family “IPv4 mVPN”
  1. Signal Auto-Discovery (AD)
  2. Signal multicast information
     - (*,G) or (S,G)
     - Which tunnel to use (core tree protocol and tunnel type: mLDP and Partitioned MDT)

A New-Found Role for BGP

Auto-Discovery

Discovering PE endpoints automatically
- Replacing some PIM signalling, signalling Data MDT

Customer Multicast Signalling

Control plane replacing PIM
- Shared tree (*,G)
- Source tree (S,G)

replacing PIM Joins, Prunes, Hellos

- New BGP address family: IPv4 mVPN
- PMSI Tunnel Attribute (PTA) information
  - Describes the core tree (PIM, mLDP, MPLS TE, IR)
- Prefix (NLRI)
  - Describes multicast state
  - Source, Group, Originator, Route Distinguisher

* PMSI = Provider Multicast Service Instance

BGP Address Family IPv4 mVPN

Signal multicast information

(*,G) (S,G)

Tunnel information

mcast vpn NLRI

PMSI* Tunnel Attribute (PTA)

Route Type	Meaning	Usage
1	Intra-AS I-PMSI A-D route	AD Signaling
2	Inter-AS I-PMSI A-D route	AD Signaling
3	S-PMSI A-D route	AD Signaling
4	Leaf A-D route	AD Signaling
5	Source Active A-D route	AD Signaling
6	Shared Tree Join route	C-signaling
7	Source Tree Join route	C-signaling

Encoding can be RD (8 octets) , MCAST source length (1 octet), MCAST source (variable) , MCAST group length (1 octet), MCAST group (variable), Originating router's IP address

Tunnel Type	Meaning	Info encoded
0	No tunnel info present	-
1	P2MP TE tunnel	Ext tunnel ID / Tunnel ID / P2MP ID
2	mLDP P2MP	P2MP FEC Element
3	PIM SSM	Root address / P-Group
4	PIM Sparse Mode	Sender Address / P-Group
5	PIM BiDirectional	Sender Address / P-Group
6	Ingress Replication	Unicast tunnel endpoint address
7	mLDP MP2MP	MP2MP FEC Element
8	Transport Tunnel	Source PE address / local number

* Provider Multicast Service Instance

BGP Signaling

IOS-XE Example

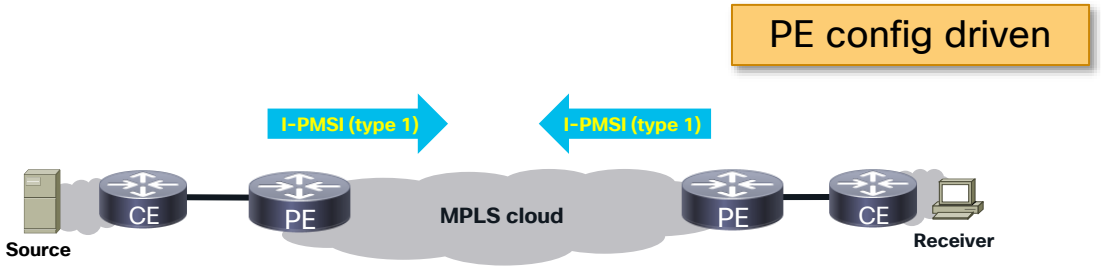
```
vrf definition one
 rd 1:1
!
address-family ipv4
  mdt auto-discovery mldp
  mdt partitioned mldp p2mp
  mdt overlay use-bgp
  route-target export 1:1
  route-target import 1:1

router bgp 1
 neighbor 10.100.1.7 remote-as 1
 neighbor 10.100.1.7 update-source Loopback0
!
 address-family ipv4 mvpn
  neighbor 10.100.1.7 activate
  neighbor 10.100.1.7 send-community extended
```

Auto-Discovery using mLDP

Multicast Signalling using BGP

New BGP address family

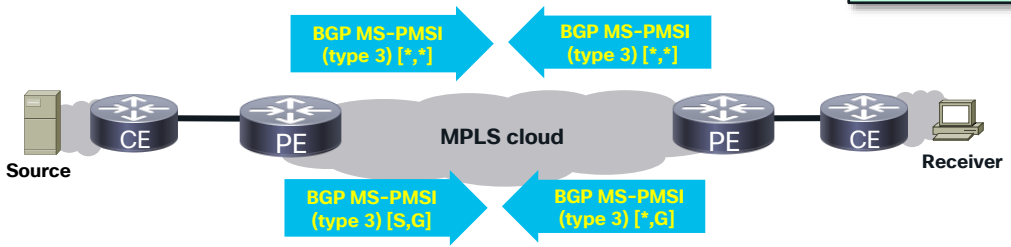
BGP Signaling: Route-Type 1



- Advertised when profile-14 is configured
- Carries PE loopback address
- 1 per PE, per VRF
- Meaning = I'm a PE willing to do mVPN for this VRF

BGP Signaling: Route Type 3

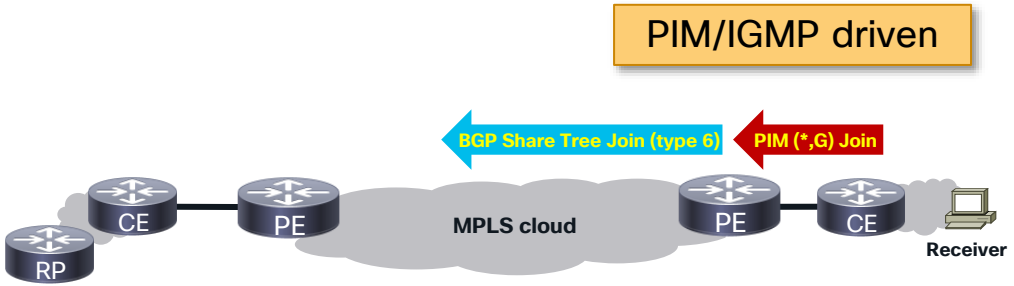
Carries PMSI Tunnel Attribute (PTA) = core is P2MP mLDP



- Carries (*,*) — PE config driven
  - Advertised when profile-14 is configured
  - 1 per PE, per VRF
  - Meaning = I'm a PE willing to do Profile 14 (Partitioned MDT) for this VRF
- Carries (S,G) or (*,G) — PIM/IGMP driven
  - Advertised when learned about (S,G) or (*,G)
  - Many per PE, per VRF
  - Meaning = I'm a PE willing to do create extra Partitioned MDT for one (S,G) or (*,G)
    - Aka Data MDT

BGP Signaling: Route-Type 6

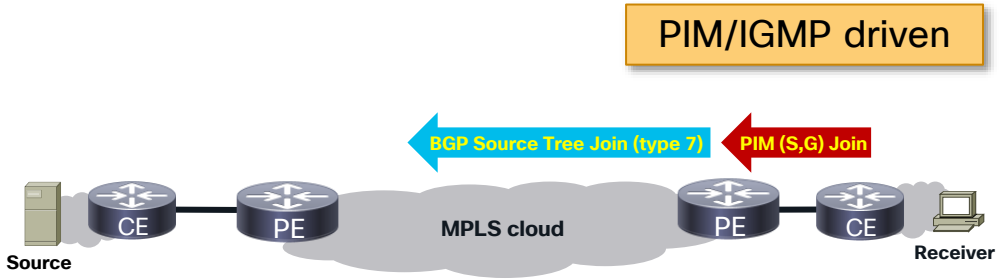
Relay PIM Join



- Carries (*,G)
- Triggered by PIM PE-CE signalling
- Meaning:
  - BGP update = equivalent of a (*,G) PIM Join (state)
  - BGP withdraw = equivalent of a (*,G) PIM Prune (state)

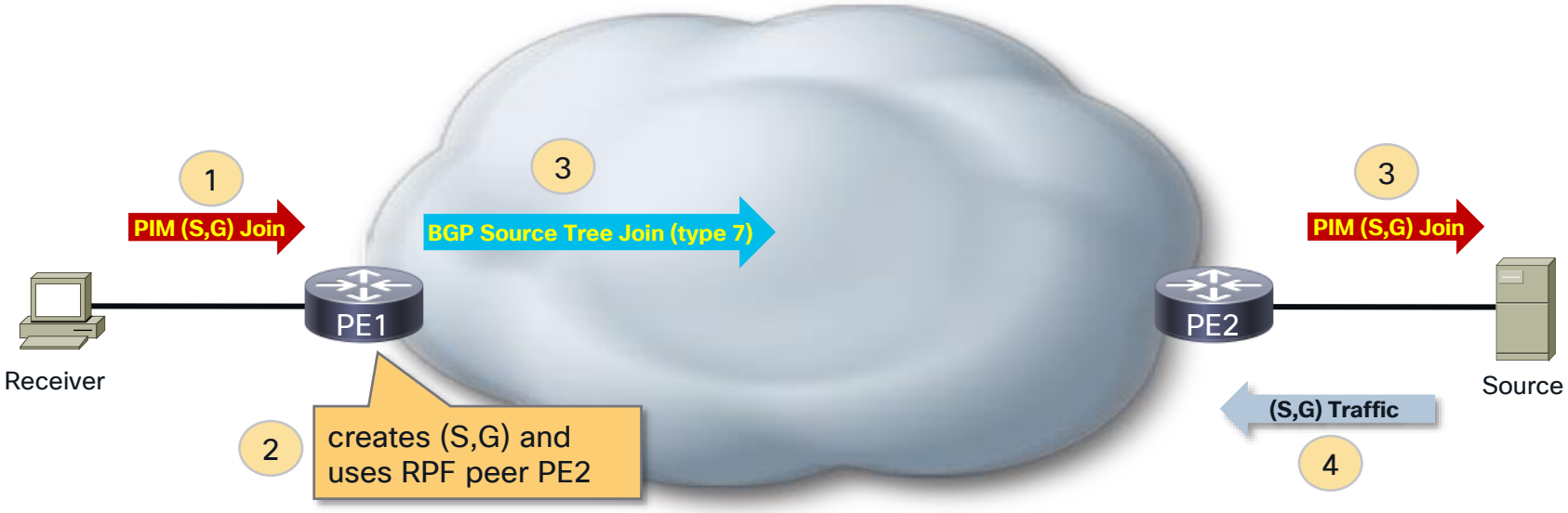
BGP Signaling: Route-Type 7

Relay PIM Join

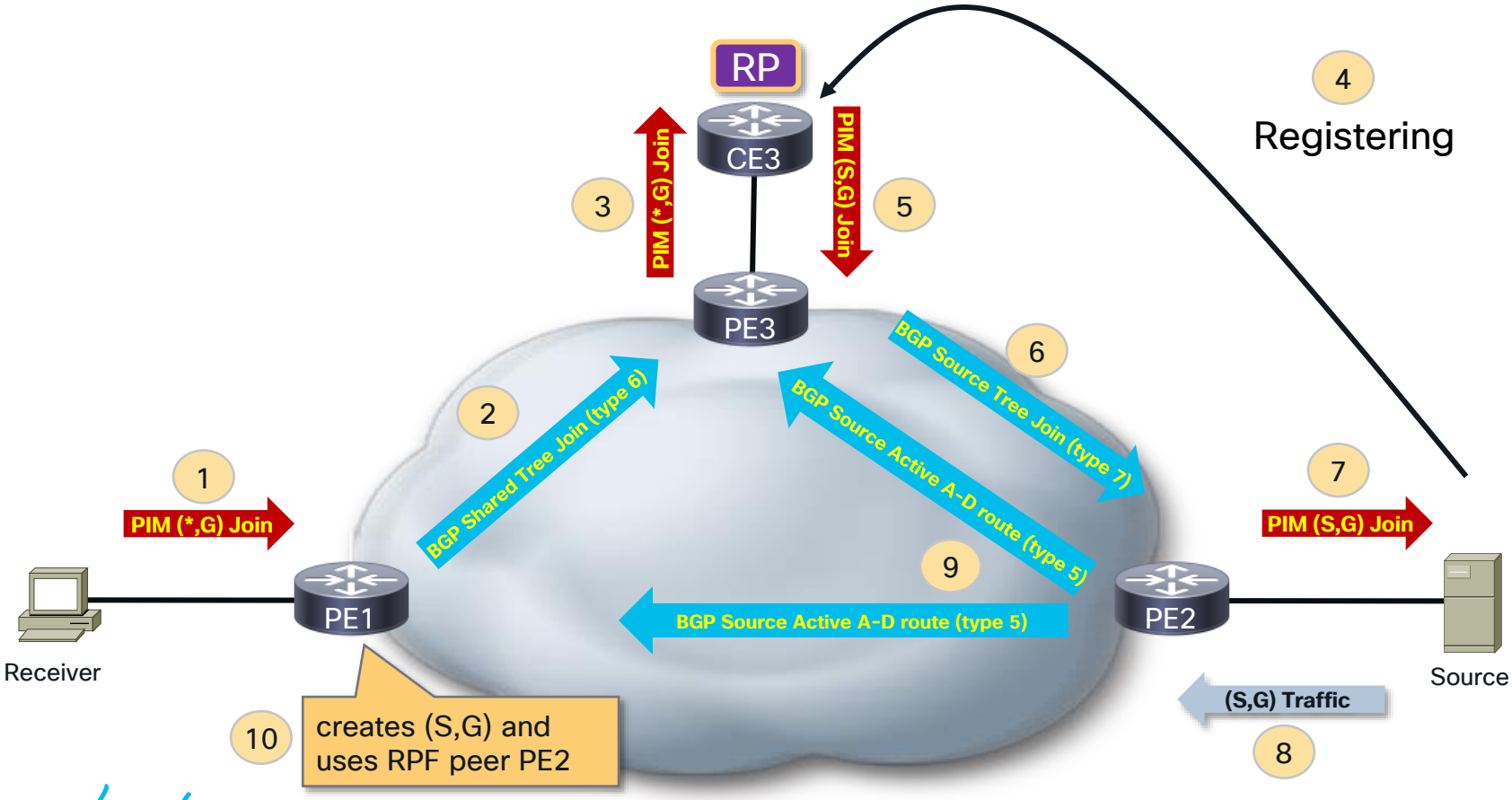


- Carries (S,G)
- Triggered by PIM PE-CE signalling
- Meaning:
  - BGP update = equivalent of a (S,G) PIM Join (state)
  - BGP withdraw = equivalent of a (S,G) PIM Prune (state)

BGP Signaling for SSM Mode

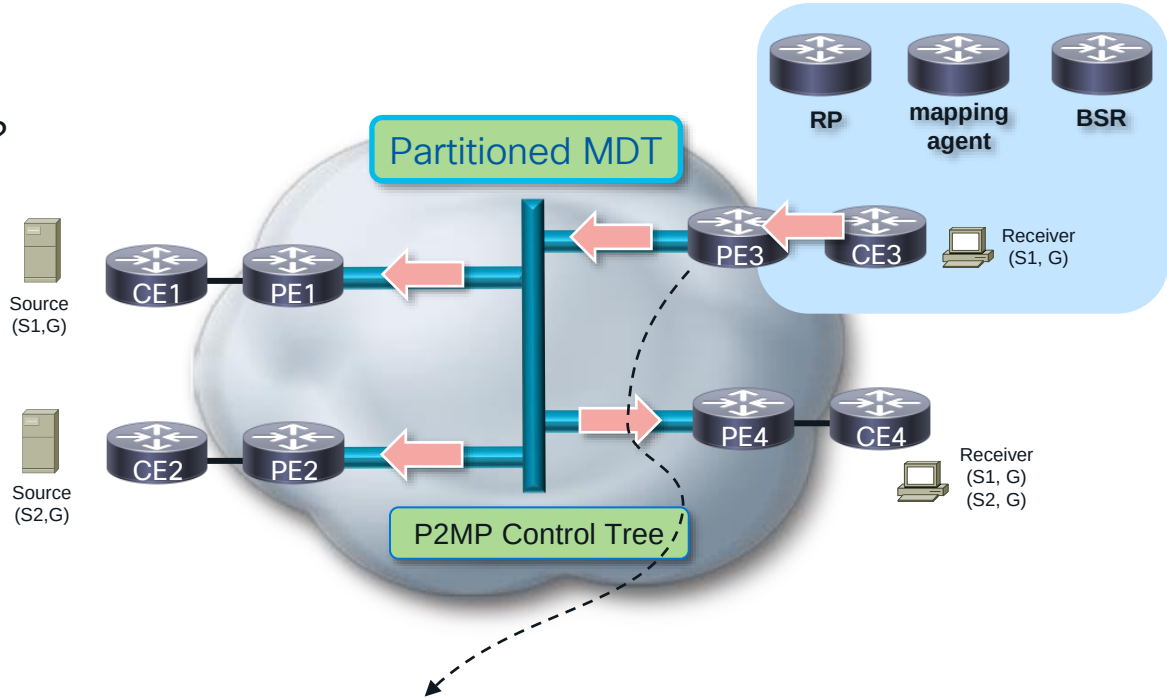


BGP Signaling for Sparse mode



Auto-RP / BSR

- C-PIM is SM or BiDir
- How do the PE & C-routers learn RP?



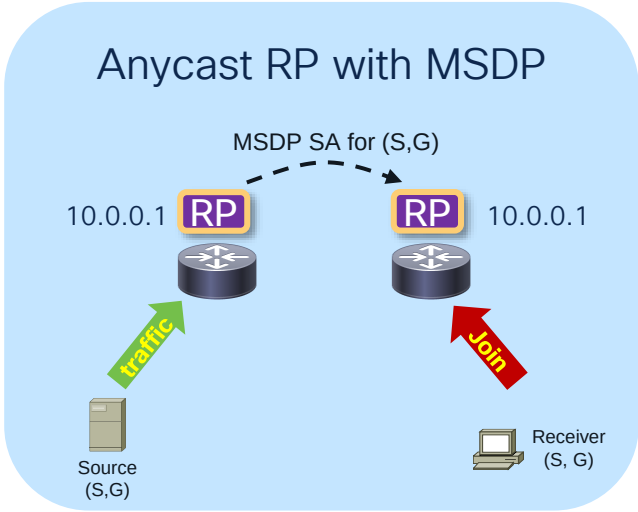
- No extra configuration needed
- Automatic: control tree built when PE sees RP info
- Control-tree = additional P2MP tree
- Only for RP discovery (Auto-RP or BSR)

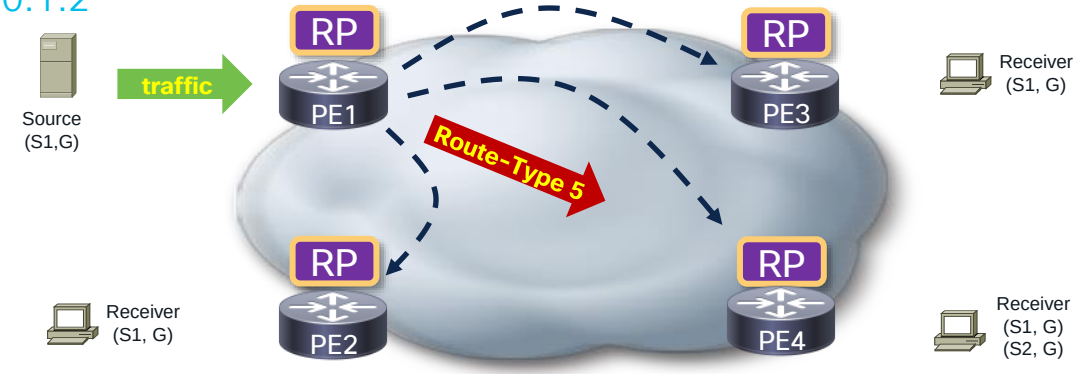
BGP-AD Route Type 3

(*,224.0.0.13) for BSR announcements
(*,224.0.1.39) for AutoRP-CRP announcements (ip pim send-rp-announce)
(*,224.0.1.40) for AutoRP-MA announcements (ip pim send-rp-discovery)

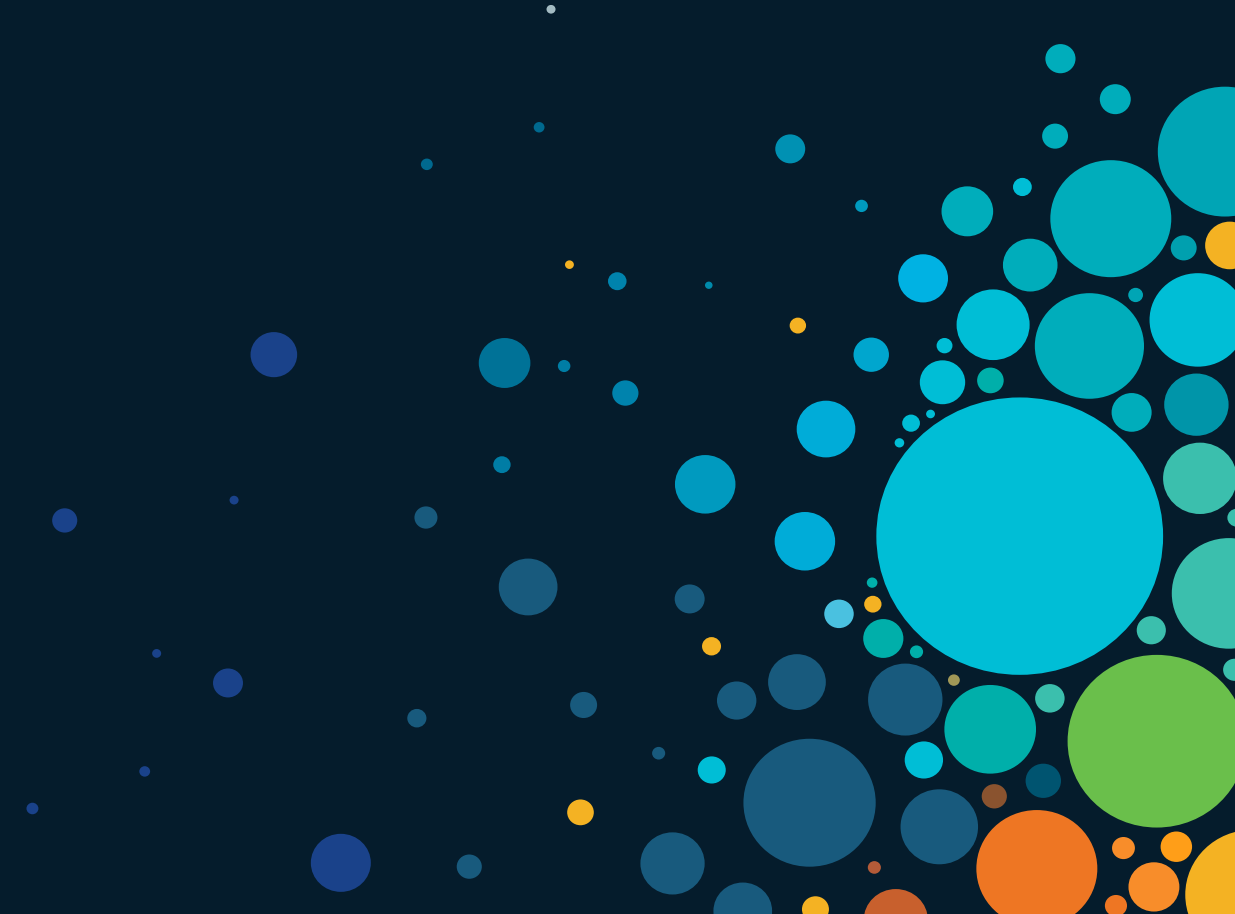
Replace MSDP for Anycast RP

- BGP AD does anycast RP
  - Anycast RP address must be present on all PEs
  - All PEs are RP
  - BGP Route-Type 5 replaces MSDP or PIM (RFC 4610)
    - Route-Type 5 advertised by Ingress PE when (S,G) is present (so, there is a source behind it)
    - This is Source Announcement with BGP
- RFC 6513 10.1.2

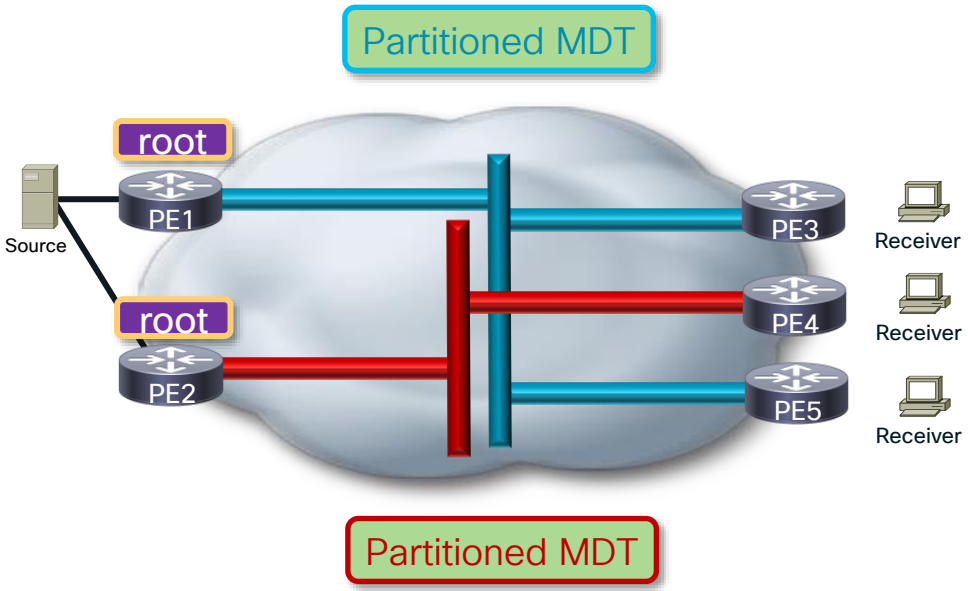




mVPN



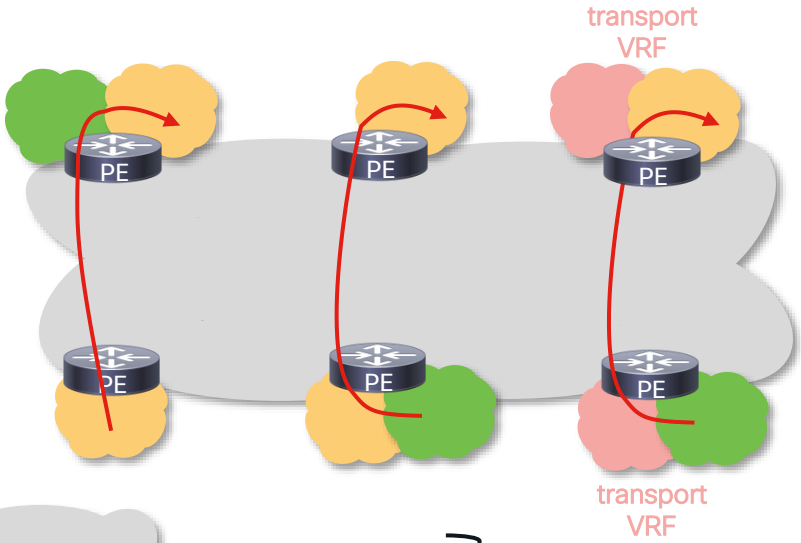
Partitioned MDT

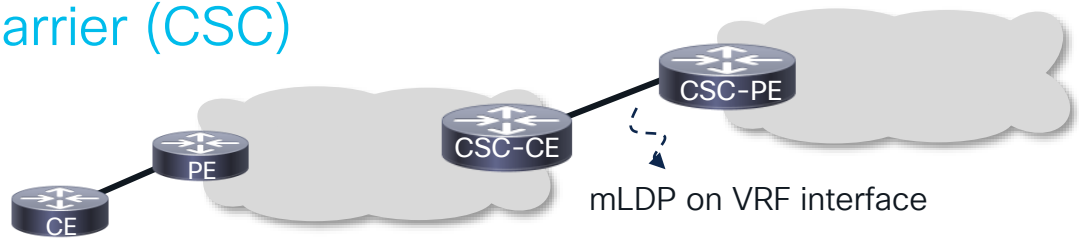


- Unidirectional
- Connects subset of PEs
- BGP AD is needed
- BGP Overlay signaling for (*,G) and (S,G)
- MDT built on-demand when customer traffic is present
  - Optimized for sources mostly co-located in few sites
  - Supports Anycast sources
    - It is possible to have two different trees/roots forwarding the same (S,G)
    - With Default MDT → Asserts

More mVPN

- Extranet
  - Source mVRF is on Receiver PE
  - The Receiver MVRF is on the Source PE
  - Transport (third) mVRF is used
- Inter-Autonomous
- Carrier's Carrier (CSC)





Redistribute loopbacks or use Recursive FEC

Profile 14 in Global Context

RFC 7716

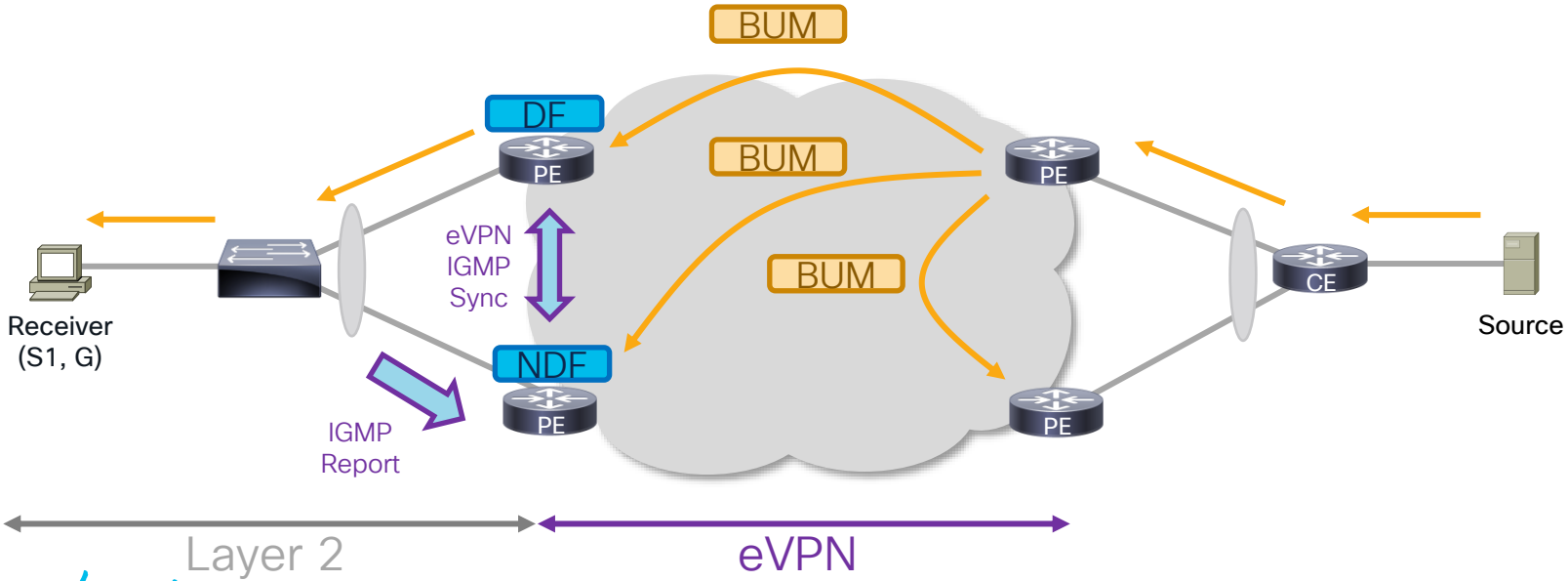
- Not so popular, but possible
- So, no VRF context on PE-CE link
- No RD
- Route-Targets in global context
- PIM/multicast-routing in global context
- Extra BGP command: global-table-multicast

```
route-policy global-one
  set core-tree mldp-partitioned-p2mp
end-policy
!
router bgp 1
!
 address-family ipv4 mvpn
  global-table-multicast
 !
multicast-routing
 address-family ipv4
  interface Loopback0
   enable
  !
mdt source Loopback0
  export-rt 1:1
  import-rt 1:1
  bgp auto-discovery mldp
  !
mdt partitioned mldp ipv4 p2mp

router pim
 address-family ipv4
  rpf topology route-policy global-one
  mdt c-multicast-routing bgp
```

Profile 14 with eVPN

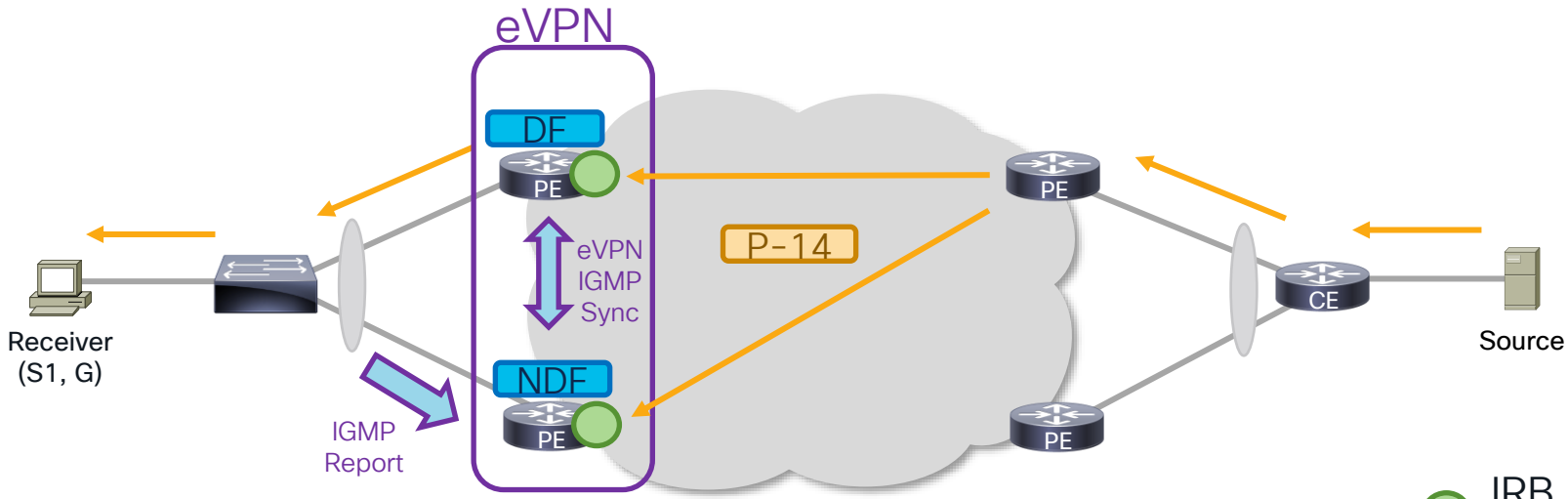
EVPN and Multicast

- eVPN is popular Layer 2 fabric
- eVPN treats multicast as part of BUM (Broadcast, Unknown Unicast, Multicast)
- BUM is implemented as ingress replication
- BUM is flooded to all PE routers



mVPN with EVPN Drop-Off

- IGMP snooping is a must
- IGMP state is synced between egress PE routers
  - eVPN Route-Type 7 (Join) & 8 (Leave)
- mVPN P-14 to carry multicast to only egress PEs
- Both PE routers:
  - Pull traffic: live-live-protection scheme
  - One egress PE forwards the multicast traffic



Key Take Aways

- Profile 14 is the way

Technical Session Surveys

- Attendees who fill out a minimum of four session surveys and the overall event survey will get Cisco Live branded socks!
- Attendees will also earn 100 points in the Cisco Live Game for every survey completed.
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