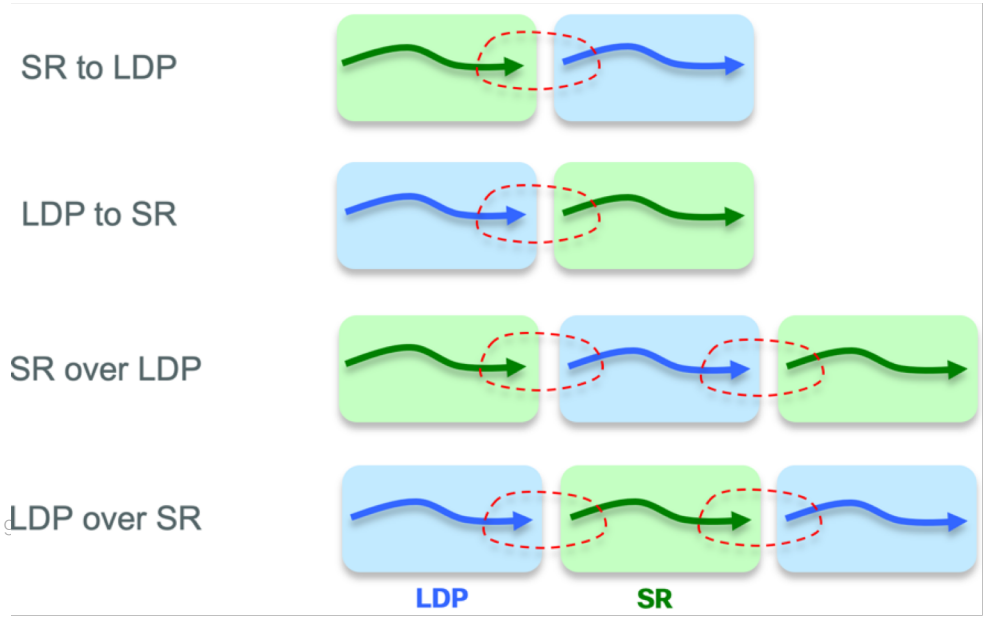
SR Pre-Tests Review

March 2019

Questions & Answers

1. What is segment routing in your own words ?
   - SR is the latest Transport Technology which applies source routing based methodology and allows network programmability, simplifies network protocol layer and protection
2. What is post-convergence path is ?
   - The path that will be used after the IGP has converged following failure
3. Please lists four of the possibility Segment Routing Interworking Deployment Model



Questions & Answers

4. What is Binding SID and how is the Binding SID useful ?

- Binding SID is a SID label to represent a stack of SID List in a SR Policy.
- Binding SID can be automatically assigned or manually defined in the SR Policy.
- Binding SID can be used for Stitching SID List in order to reduce number of SID list label and also can be used to interwork between SR Policy and RSVP-TE

5. Which of three information explicit path that can be configured in the SR-TE candidate paths ?

- IP addresses
- MPLS Labels
- IP addresses and MPLS labels

6. When a mapping server is necessary needed / not needed In the SR Over LDP Interworking Model ?

- Yes , if SR LSPs go from SR island and terminate in the LDP island
- No, if no SR Label Switched Path(s) go from SR island and terminate in LDP island

Questions & Answers

7. What is the different between IGP prefix segment with IGP adjacency segment (minimum three) ?

- IGP Prefix segment :
  - Global segment (global significance)
  - Forward to the shortest path to the IGP prefix (loopback)
  - ECMP aware
  - Advertised as an index
  - Must manually allocated / configured
- IGP Adjacency segment :
  - Local segment (local significance)
  - Forward to the IGP adjacency
  - Advertised as a label value
  - Automatically allocated for each adjacency

Questions & Answers

8. Why is Segment Routing better than MPLS LDP in term of label number scalability ?
   - SR ID or SID Label method of Prefix SID and Adjacency SID will use much lower number of used label number than MPLS LDP label number which allocate local label for every route learned from the Interior Gateway Protocol (IGP) / prefix
9. Why is Segment Routing better than MPLS LDP in term of faster convergence ?
   - MPLS LDP must have synchronization with IGP and it will take more time, process and dependency while SR is already embedded in the IGP OSPF and IGP. Hence SR Label convergence will be much faster and much simpler process.
10. Why is Segment Routing TE / SR Policy better than MPLS RSVP-TE ?
    - SR TE / SR Policy only needs TE Head-End Node calculation and stateful process and this will benefit far simpler network scalability and resource without having Mid-End and Tail-End dependency to maintain the TE session
    - SR-TE is ECMP Aware.
    - Moreover SR Policy has much more flexibility and feature integration with SR PCE, BGP TE and REST API Policy triggered.

Questions & Answers

11. How many percent of network protocol layer simplification does SR provide and elaborate your answer ?

- SR provides 50% and more network protocol layer simplification by eliminating LDP and RSVP function into SR only and also possible to eliminate BGP LU function by integrating SR with SR PCE

12. What is SR Mapping Server (SRMS) and when do we need SRMS ?

- SR Mapping Server is used in the interworking MPLS LDP domain and SR domain. SR MS Advertise Prefix-to-SID mappings in IGP on behalf of other non-SR-capable nodes

13. What is Microloop Packet Loss and how does SR protect this kind of packet loss ?

- Microloop packet loss is day-1 IP drawback. It is transient packet loops during network convergence. Microloops can happen in the link up event and link down event and it can lead to packet loss.
- SR will automatically setup SR Policy to avoid the micro loop and once the routing convergence is in place, the dynamic SR Policy will disappear and let node to follow final route table.

Questions & Answers

14. What is Segment Routing Anycast SID and how does it help in the network ?

- More than one SR Node use the same Prefix SID. SR Anycast can be used for the benefit of SR node High Availability , Redundancy, SR Node Disjoint Plane , load balancing

15. Why do we need to assign the same SRGB in the network ?

- Simple, Predictable, Much easier to troubleshoot and Simplifies SDN Programming

16. Please state other four SR Policy Path sources after dynamic and explicit path ?

- dynamic IGP metric / TE metric / delay metric / hopcount
- explicit path – segment-list (ERO hop by hop)
- SR PCE - PCEP trigger
- BGP trigger

```
RP/0/RSP0/CPU0:ASR9K(config-sr-te-policy-path-pref)#pwd

Mon Mar  4 22:36:12.903 SGT
segment-routing
 traffic-eng
  policy SR-TE
   candidate-paths
    preference 100
RP/0/RSP0/CPU0:ASR9K(config-sr-te-policy-path-pref)#explicit ?
  segment-list  Specify Segment-list
RP/0/RSP0/CPU0:ASR9K(config-sr-te-policy-path-pref)#dynamic ?
  metric  Path metric configuration
  pcep    Path Computation Element Protocol related configuration
  <cr>
RP/0/RSP0/CPU0:ASR9K(config-sr-te-policy-path-pref)#dynamic metric type ?
  hopcount  Hopcount metric type
  igp       IGP metric type
  latency   Latency metric type
  te        TE metric type
```

Questions & Answers

17. What is the final SR configuration you need to set on the SR Node in the LDP to SR Migration so that the node will use SR Label Forwarding Table ?

```
router isis 1
 address-family ipv4 unicast
  segment-routing mpls sr-prefer
 !
 address-family ipv6 unicast
  segment-routing mpls sr-prefer
 !
!
router ospf 1
 segment-routing sr-prefer
!
end
```

18. How do we get unequal load balance in SR Policy WECMP ?

- By applying multiple explicit candidate path using same preference value with each explicit path using different weight value.

```
segment-routing
 traffic-eng
  policy SR-TE
   color 10 end-point ipv4 10.10.10.10
   candidate-paths
    preference 100
     explicit segment-list via_R1
     !
     explicit segment-list via_R2
     weight 2
     !
     explicit segment-list via_R3
     weight 3
     !
```

Questions & Answers

19. How do you migrate MPLS LDP Network to SR Network ? Please elaborate the step ?

- First we need to enable and configure SRGB and Prefix SID for SR-ready network node without selecting the Label Forwarding Table with SR.
- Then we ensure all the SR label convergence within this SR-ready network.
- If the other domain network still use MPLS LDP network, we need to apply additional steps:
  - For flat IGP network, we need to build SR Mapping Server (SRMS) Node function
  - For Multi-IGP Domain, we need to enable BGP LU for end-to-end reachability OR we can leverage SR PCE.
- Finally we can enable sr-prefer configuration to activate Label Forwarding table with SR

20. What is the main advantage of SR Policy against RSVP-TE interface tunnel ?

- No tunnel interface and no head end steering in SR policy. It is automated steering based on color and destination end-point.

21. A multidomain stateful PCE learns topology and SIDs using which protocol ?

- BGP Link State

Questions & Answers

22. Which command can be used to verify the IS-IS adjacency-SID and prefix-SID announcements ?

- show isis database verbose

```
RP/0/RSP0/CPU0:ASR9K#show isis database PE1.00-00 verbose | i "Prefix-SID|ADJ|SRGB"
Mon Mar  4 23:16:48.925 SGT
    Prefix-SID Index: 1, Algorithm:0, R:0 N:1 P:0 E:0 V:0 L:0
    Segment Routing: I:1 V:0, SRGB Base: 16000 Range: 8000
    ADJ-SID: F:0 B:1 V:1 L:1 S:0 P:0 weight:0 Adjacency-sid:64006
    ADJ-SID: F:0 B:0 V:1 L:1 S:0 P:0 weight:0 Adjacency-sid:64007
```

23. Please list possibility use-case of Binding-SID (minimum three) ?

- Multi domain : inter-domain , inter-AS
- Large scale within a single domain : PE to AGG , AGG to PE , CSR to PAG , etc
- Label stack "compression" : nesting and stitching SR-TE policies
- BGP SR-TE dynamic use local Binding-SID

24. What component that uniquely Identifying the SR policy and explain each its component ?

- SR policy uniquely identified by a tuple (head-end , color and end-point)
- Head-end: where the SR Policy is instantiated (implemented)
- Color: a numerical value to differentiate multiple SRTE Policies between the same pair of nodes
- End-point: the destination of the SR Policy

Question

25. Please explain each steps in the on-demand SR policy workflow to instantiate SR-TE based on delay color as depicted in figure / configuration below

```
router bgp 1
 neighbor 1.1.1.10
  address-family vpnv4 unicast
!
segment-routing
 traffic-eng
  on-demand color 20
   dynamic
    metric
     type delay
```

SR Policy template
Low-delay (color 20)

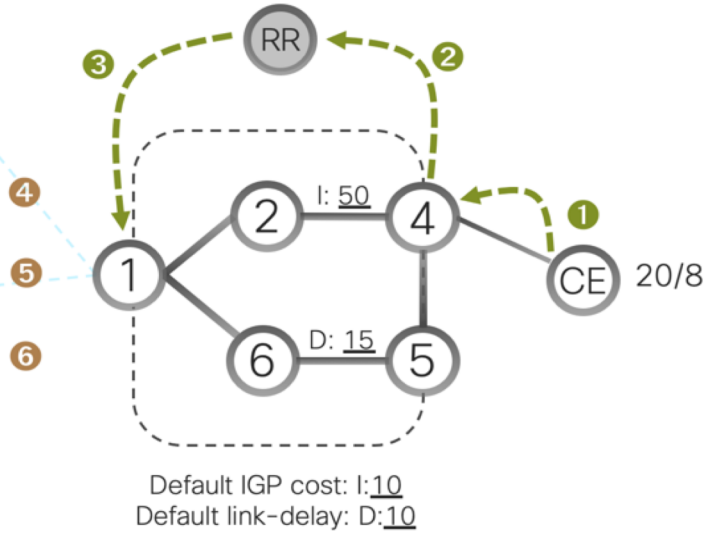
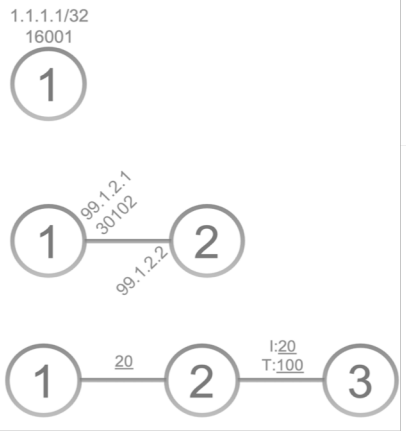


Illustration Conventions

- For NodeX:
  - Loopback address: 1.1.1.X/32
  - SRGB: [16000 – 23999]
  - Prefix-SID: 16000 + X
- For link NodeX→NodeY:
  - Interface address: 99.X.Y.X/24 (where X<Y)
  - Adjacency-SID: 30X0Y
- Link metric notation
  - IGP & TE metric: xx (default: 10)
  - IGP metric: I:xx (default: I:10)
  - TE metric: T:yy (default: T:10)



Answers (On-demand SR Policy work-flow)

❺

```
router bgp 1
 neighbor 1.1.1.10
  address-family vpnv4 unicast
!
segment-routing
 traffic-eng
  on-demand color 20
   dynamic
    metric
     type delay
```

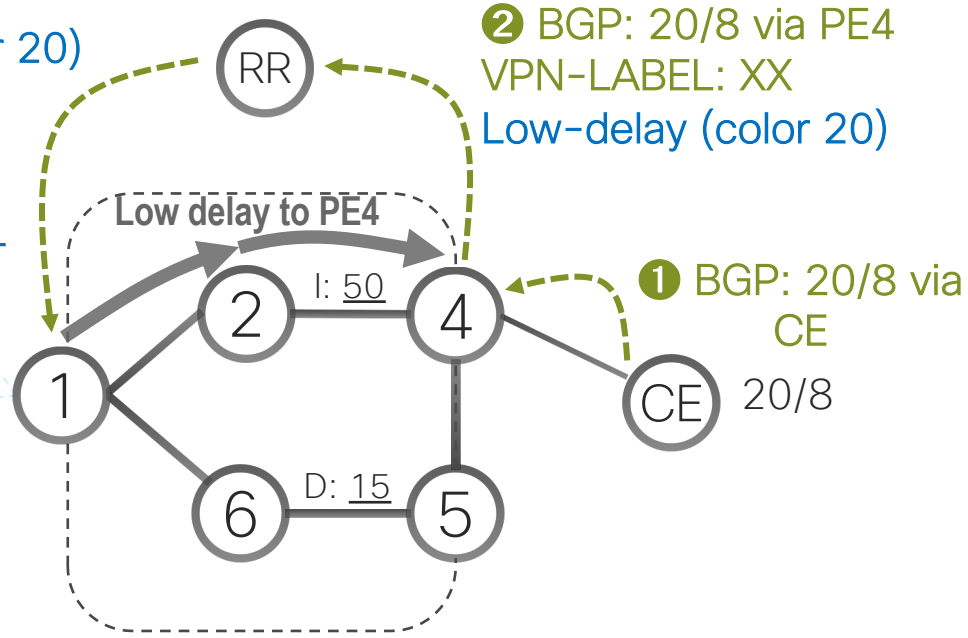
SR Policy template
Low-delay (color 20)

❸ BGP: 20/8 via PE4
VPN-LABEL: XX
Low-delay (color 20)

❹ PE4 with Low-delay (color 20)?

❺ use template color 20

❻ → SID-list <16002, 30204>



Default IGP cost: I:10
Default link-delay: D:10

Questions & Answers

26. What is SR-PCE ?

- SR PCE is an IOS XR multi-domain stateful SR-optimized PCE
  - IOS XR: SR PCE functionality is available on any physical or virtual IOS XR node, activated with a single configuration command
- Multi-domain: Real-time reactive feed via BGP-LS/ISIS/OSPF from multiple domains; computes inter-area/domain/AS paths
- Stateful: takes control of SRTE Policies, updates them when required
- SR-optimized: native SR-optimized computation algorithms

27. Please list levels of disjoint path that can be configured ?

- Link disjointness: the paths transit different links (but may not be node or SRLG disjoint)
- Node disjointness: the paths transit different nodes and different links (but may not be SRLG disjoint)
- SRLG disjointness: the paths transit different links that do not share SRLG (but may not be node disjoint)
- Node+SRLG disjointness: the paths transit different links that do not share SRLG and transit different nodes

Questions & Answers

28. What is the process in IOS-XR that managing the label and please list default Label Range that provided by that process as well ?

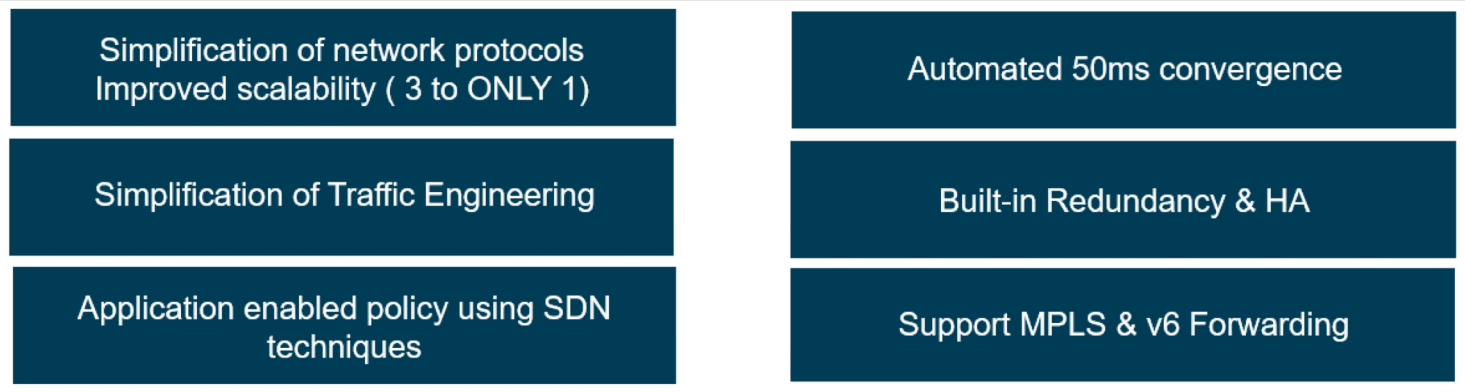
- Local label allocation is managed by Label Switching Database (LSD) process
  - Label range [0-15] reserved for special-purposes
  - Label range [16-15,999] reserved for static MPLS labels
  - Label range [16,000-23,999] preserved for SRGB
  - Label range [24,000-max] used for dynamic label allocation

29. What is Segment Routing On-Demand Nexthop ?

- Segment Routing On Demand Nexthop is Cisco Innovation which allows Customer Traffic will automatically get specific SLA that needs such as low latency path or optimal bandwidth cost with SR automated Steering and it can be also enhanced by integration to SR PCE for multi-igp domain network.

Questions & Answers

30. Please explain SIX Segment Routing Value Proposition to your Customer ?



31. What is the three benefits of Multi Domain ODN (on demand next-hop)?

- Scalable – PE only gets the inter-domain paths that it needs
- Simple – no BGP-LU pushing all routes everywhere
- No complex steering configuration
  - Automated steering of BGP routes on the right SLA path
  - Data plane performant

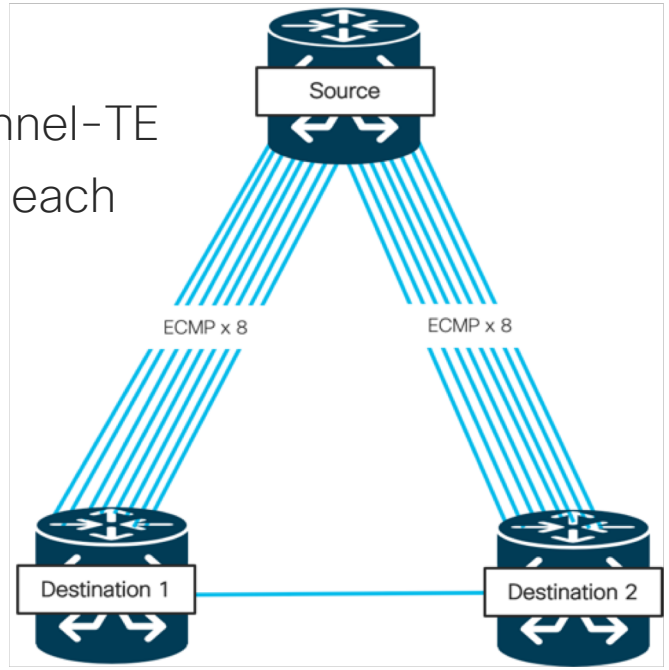
Questions & Answers

32. What is the benefit of automated steering in SR Policy ?

- Automated Steering in SR Policy allows to provide specific SLA path based on BGP next hop and color of a route/prefix. Thus, automated steering SR policy simplify the operation and remove the dependency to manual steering the traffic into the SR Policy/TE

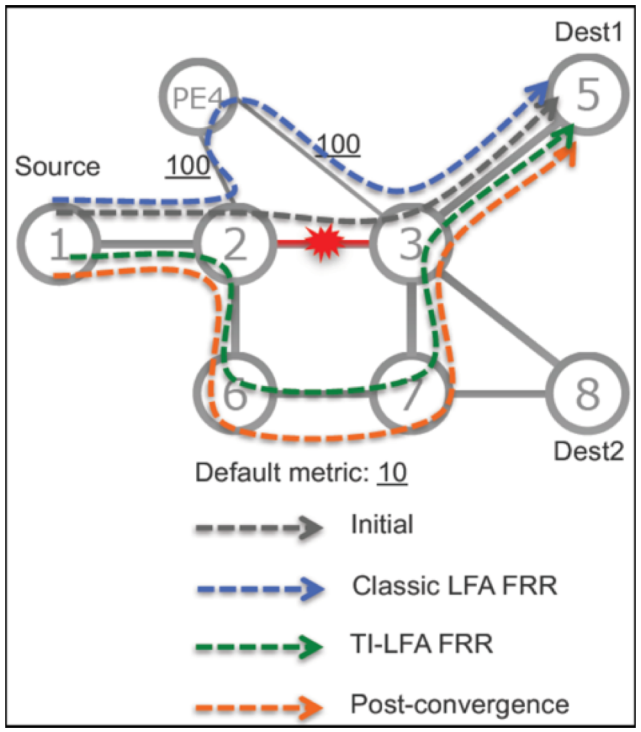
33. How many tunnel-TE RSVP vs SR policy (With its candidate path) that must created from Source Router toward both destination 1 & 2 considering all of possible path must be covered (all link have same IGP metric) ?

- Total RSVP tunnel-TE that must created 32 Tunnel-TE
- Total SR Policy that must created are two with each SR policy has only two candidate paths



Questions & Answers

34. Please explain what is the different between classic LFA behaviour and what TI-LFA is solving at as depicted use case below (Protecting destination Node 5 on Node 2 against failure of link 2-3)



Classic LFA behavior:

- Node 2 switches all traffic destined to node 5 towards the edge node PE4.
- Low BW (high metric) links and edge node are used to protect the failure of a core link.
- A common planning rule is to avoid edge node for transit traffic.
- Classic LFA does not respect this rule
- Repair/backup path is different than post-convergence path.

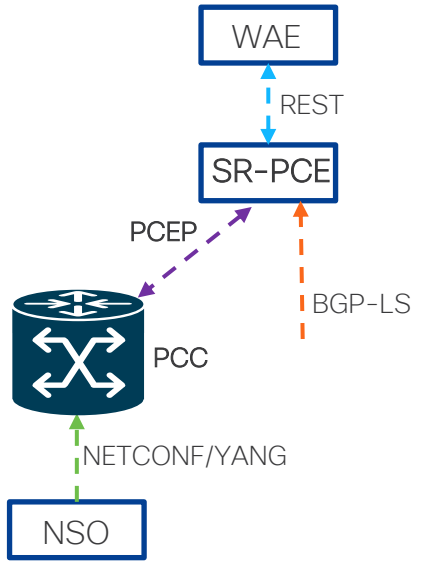
TI-LFA:

- Node 2 switches all traffic destined to Node 5 via high BW core links (forward to Node 7 SID).
- Repair/backup path is same with post-convergence path.

Questions & Answers

35. Please explain what is PCE , PCC and PCEP ?

- Path Computation Element (PCE) : An entity of computing paths for a single service or a set of services (RFC 5440)
- Path Computation Client (PCC) : Entity using the services of PCE
- Path Computation Element Protocol (PCEP) : Protocol for communicating between a PCC and a PCE



36. How do you convince your customer that Segment Routing is not proprietary and can work with other vendor ??

- SPRING RFC https://tools.ietf.org/html/rfc7855
- SR Architecture RFC https://tools.ietf.org/html/rfc8402
- SR EANTC 2018 Interop Test
  - http://www.eantc.de/fileadmin/eantc/downloads/events/2017-2020/MPLS2018/EANTC-MPLSSDNNFV2018-WhitePaper-final.pdf

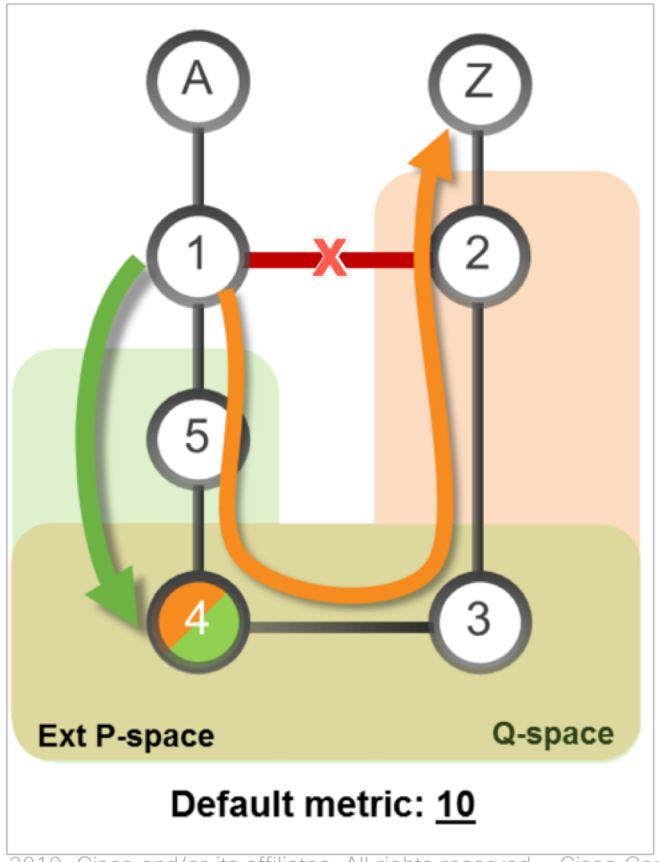
Questions & Answers

37. SR-TE Path can be computed local (distributed) or centralized , please compare and list all of computation possibility / contraints / policy model that can be done by these methods

Policy	Distributed	Centralized
Low delay/Latency	YES	YES
Disjoint from same node	YES	YES
Disjoint from different node	NO	YES
Avoiding topological resources	YES	YES
Capacity optimization	Limited	YES
Maintenance	NO	YES
Multidomain	NO	YES
Multi-Layer (IP+Optical)	NO	YES

Questions & Answers

38. Please explain TI-LFA computation process for destination Z source 1 for case single-segment as depicted in figure below ?



- The point of local repair is R1 and it is protecting the link to R2
- Notice that with these metrics , R1 cannot send the packets toward R5 for protection , because R5 will loop the packets back to R1, due to the metrics (R5 is not an LFA in this case)
- TI-LFA at R1 Starts with calculating the P and Q Nodes , which overlap in this case:
  - Remove the primary link for Z (R1-R2) and compute the SPF on the resulting topology. This gives the post convergence path from R1 to Z (R5,R4,R3,R2)
  - R4 is in the P space (R1 can send a packet destined to R4 without any risk of having that packet flow back through the protected link R1-R2
  - R4 is in the Q Space (R4 can send a packet to R2 without any risk of having this packet flow back through the protected link R1-R2) .
  - TI-LFA select a PQ node on the post-convergence path which is R4
- Hence , the TI-LFA backup computed by R1 for destination Z is "forward the packet on interface to R5 and push the segment R4" (install in the backup path)

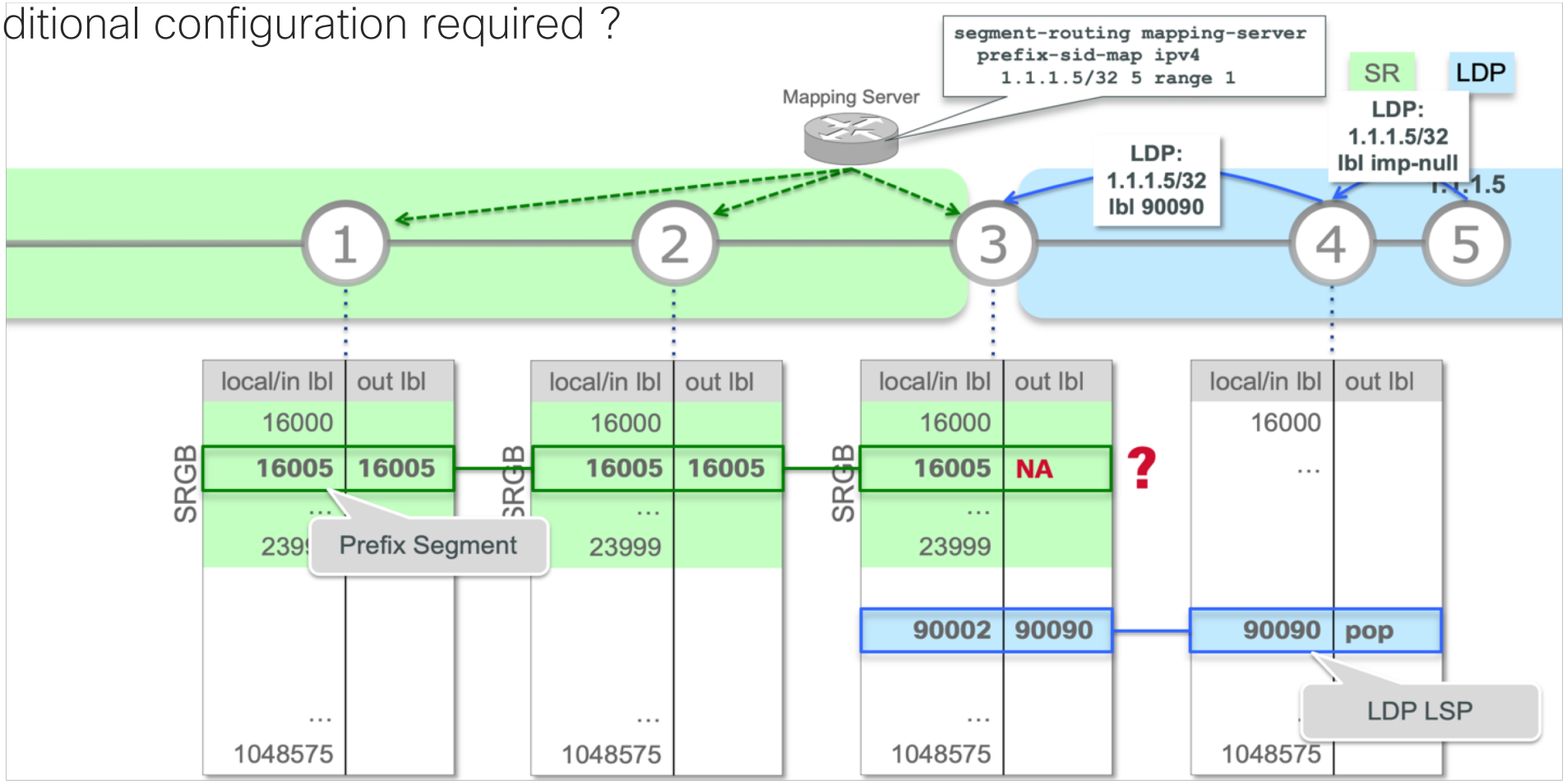
Questions & Answers

39. What is SR Protection / FRR feature ? And how is it better than the previous FRR technologies such as RSVP-TE FRR / IP Fast Reroute ?

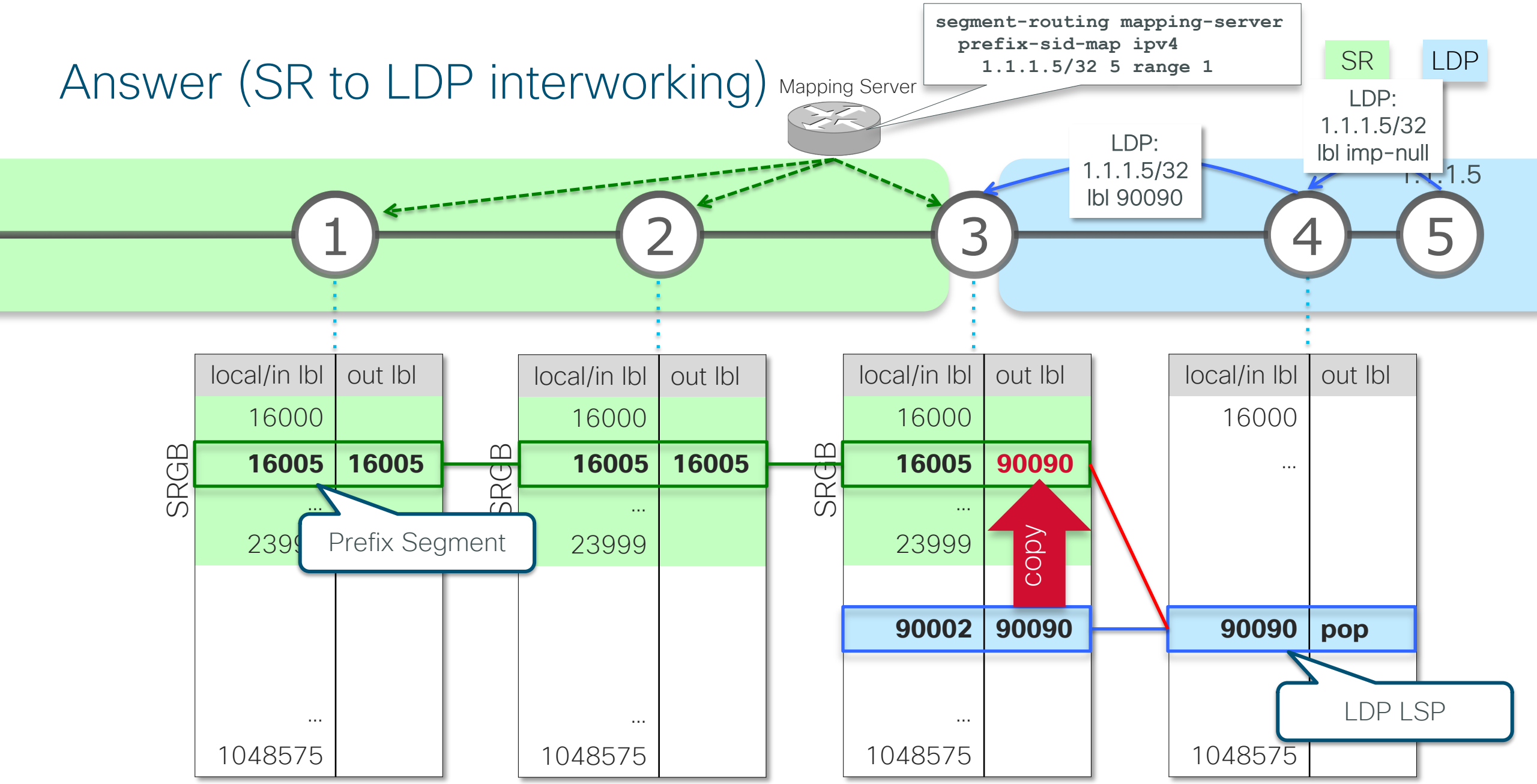
- SR TI-LFA is topology independent loop free alternate.
- RSVP-TE FRR will bring more complexity and scalability constraint.
- IP Fast Reroute or classic LFA only has partial coverage and topology dependent also not always providing most optimal backup path.
- TI-LFA has 100% topology independent backup path, simple integrated in IGP, and use most optimal backup path = post convergence path

Question

40. Please explain step by steps of the MPLS data plane interworking SR to LDP as depicted below (Source router 1 , destination router 5) and what is the final end to end label state ? Any additional configuration required ?



Answer (SR to LDP interworking)



Answer (SR to LDP interworking)

- Nodes 1 , 2 and 3 are SR capable nodes . These nodes using the default SRGB range from 16000-23999 .
- Nodes 4 and 5 are legacy LDP-only nodes , they don’t support SR. Therefore, they don't have an SRGB , and their dynamic label range starts at 16000
- Node 3 is also LDP capable . The dynamic label range of node 3 starts at 24000 , after the SRGB
- Nodes 3 and 4 have programmed the LDP forwarding entries for destination node 5 .
- LDP on node 5 advertises an implicit-null label binding for its loopback prefix to its neighbor , node 4
- LDP on node 4 has allocated label 90090 for the loopback of node 5 . This label is dynamic and it advertises the label binding to its neighbor , node 3
- LDP on node 3 has allocated dynamic label 90002 for the loopback of node 5
- A mapping server advertises a prefix SID , 16005 on behalf of node 5
- All SR capable nodes use the mapping servers's advertised prefix SID for node 5, 16005 to program the SR label entries to node 5.
- Because node 4 is not SR capable , node 3 cannot use the prefix SID of node 5 as an outgoing label to node 5. However , node 3 has another labeled path to node 5 , the LDP label-switched path to node 5
- Node 4 has allocated an LDP label 90090 for destination node 5
- Final state Node 3 will automatically connects the prefix segment to LDP LSP (copying 90090 to outgoing label of 16005) without any additional configuration required providing a seamless Label Switched Path from node 1 all the way to node 5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