

IX Fórum 9

SPRING: Technology, Applications, and Demo

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AGENDA

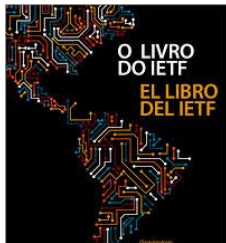
- SPRING / Segment routing overview
- Node segments
 - How they work
 - JUNOS router CLI demo
- Adjacency segments
 - How they work
 - JUNOS router CLI demo
- Binding segments
 - How they work
- Status of SPRING

INTRODUCTION TO SPRING

WHAT IS SPRING?

- SPRING is also called Segment Routing
- Name SPRING comes from IETF SPRING working group
 - Source Packet Routing in Networking
- Simplest description:
 - Advertising MPLS labels in IGP (ISIS or OSPF)
- SPRING as another useful tool for distributing MPLS labels
 - Like RSVP, LDP, and BGP labeled unicast
- SPRING as catalyst for re-evaluating assumptions about what can be done with MPLS labels and label stacks.

IETF 95 IN LATIN AMERICA (FIRST TIME)

- Where and when?
 - Buenos Aires, Argentina
 - April 3-8, 2016 (Sunday through Friday)
 - <https://ietf.org/meeting/95/index.html>
 - Newcomer Session in Portuguese (on Sunday)
 - Existing Mentor program for new participants
 - Remote Participation (since 2014)
 - “Remote Hubs”: group with common interests
 - Attend the meeting together to share experiences and ideas.
 - IETF LAC Task Force (LACNOG)
 - <http://mail.lacnic.net/mailman/listinfo/ietf-lac>
 - Next Steps
 - Focus on a few working groups
 - Read active documents in WG
 - Join IETF mailing lists
 - Participate in discussions
 - Build a local community
- 



www.cgi.br/publicacao/o-livro-do-ietf/

SPRING WORK AT IETF

- SPRING Working Group
 - datatracker.ietf.org/wg/spring
 - Architecture and issues common to both IGPs
- ISIS Working Group
 - datatracker.ietf.org/wg/isis
 - ISIS extensions for segment-routing / SPRING
- OSPF Working Group
 - datatracker.ietf.org/wg/ospf
 - OSPF extensions for segment-routing / SPRING
- Other working groups
 - IDR: carrying segment-routing info in BGP
 - PCE: pushing SPRING label stacks with PCEP
 - RTGWG: Topology-independent LFA and micro-loop avoidance

SEGMENT TYPES AND ENCAPSULATIONS

Node Segment Advertisements

- LDP-like hop-by-hop shortest-path forwarding (label swap)

Adjacency Segment Advertisements

- 1-hop forwarding across individual links (label pop)

Binding Segment Advertisements

- Advertise a label that corresponds to TE LSPs into SPRING
- Advertise a label as a context-id for egress node protection
- Advertise a label for LDP LSPs on behalf of nodes that don't support SPRING (Mapping Server)

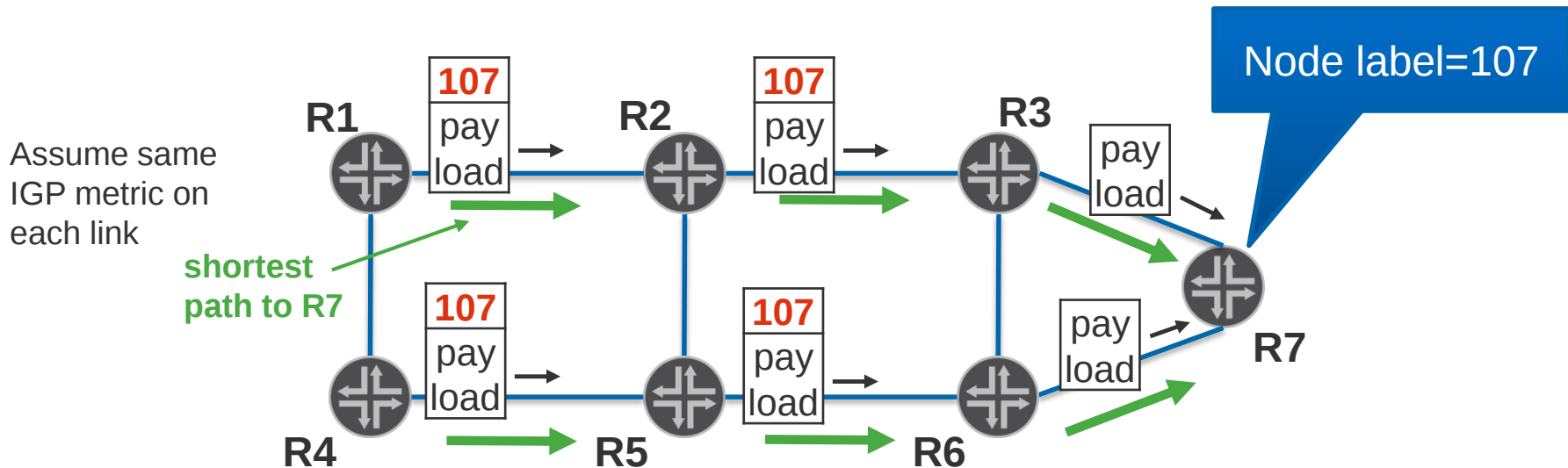
Encapsulations

- stack of MPLS labels
- stack of IPv6 headers

Not covered in
this presentation

NODE LABELS: SHORTEST PATH FORWARDING

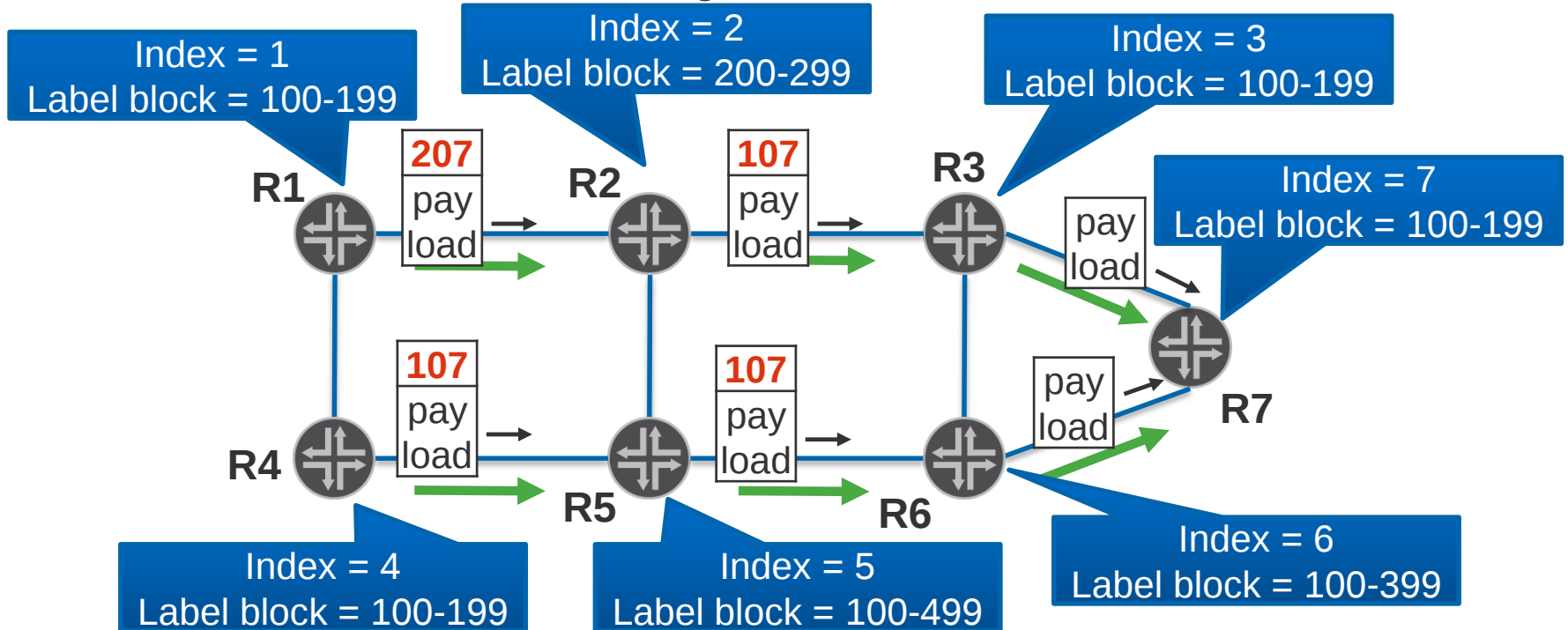
TYPES OF ADVERTISEMENT : NODE LABEL (GLOBAL NODE LABEL VERSION)



- In simplest version, each router would advertise a global node label in the IGP.
- Whenever a router receives a packet with label=107, it forwards the packet (without modifying the label) along the shortest path to R7.
- **Problem:** Global node label is not compatible with the local label assignment used by MPLS protocol suite (RSVP, LDP, BGP-LU, etc.)
 - In MPLS, a router decides the values of the labels that other routers must use to send traffic via it.
 - What if R2 has already used label=107 to advertise a VPN label?

TYPES OF ADVERTISEMENT : NODE SEGMENT (LOCAL LABEL RANGES WITH GLOBAL INDEXES)

- Solution:** Each node advertises global index and local label block in IGP.



R1's shortest path to R7 is via path (R2, R3, R7).

incoming label to R2 = R2's label-base + index of destination = $200 + 7 = 207$

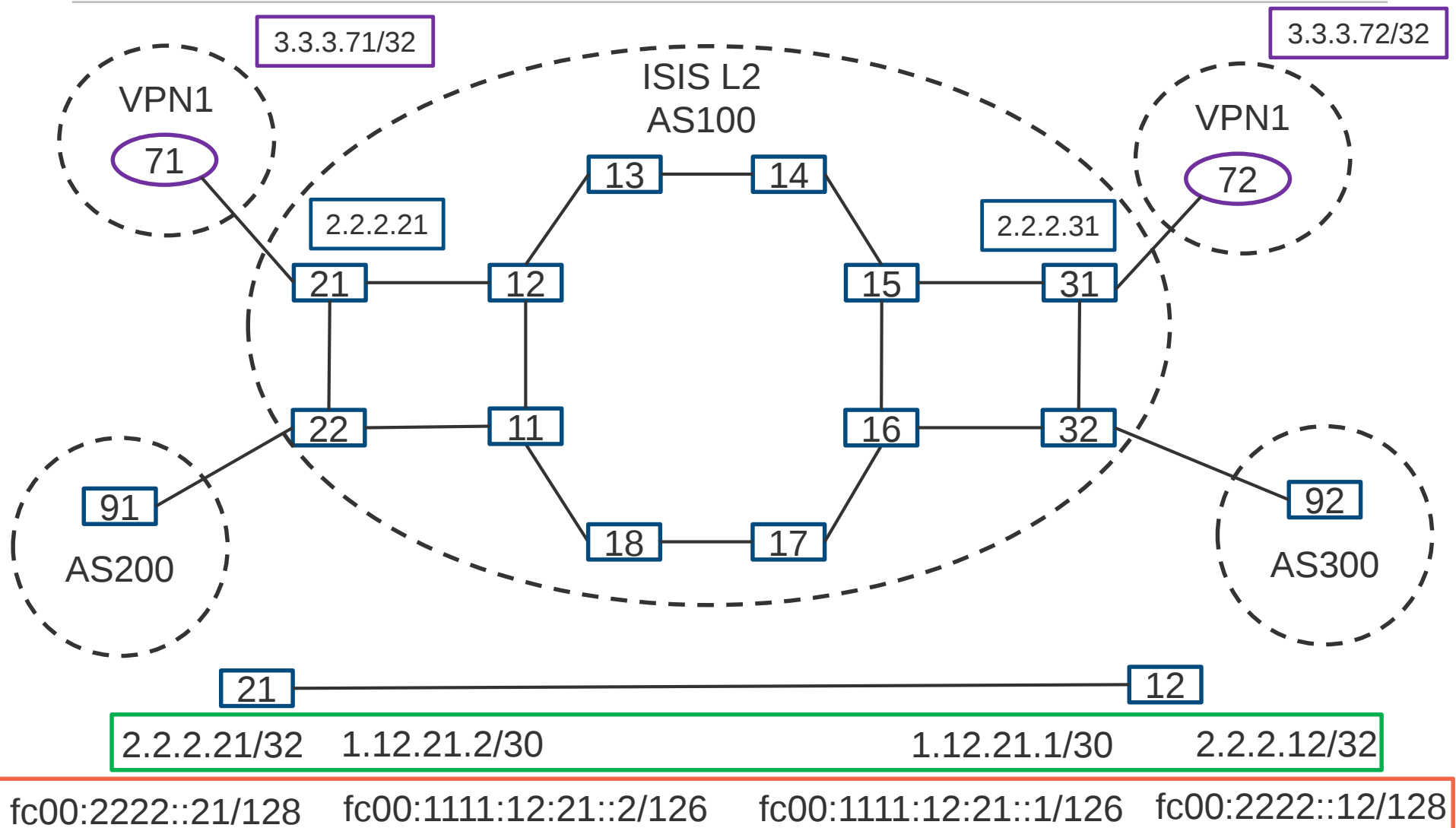
outgoing label to R3 = R3's label-base + index of destination = $100 + 7 = 107$

R2 does label swap operation (incoming label = 207, outgoing label = 107)

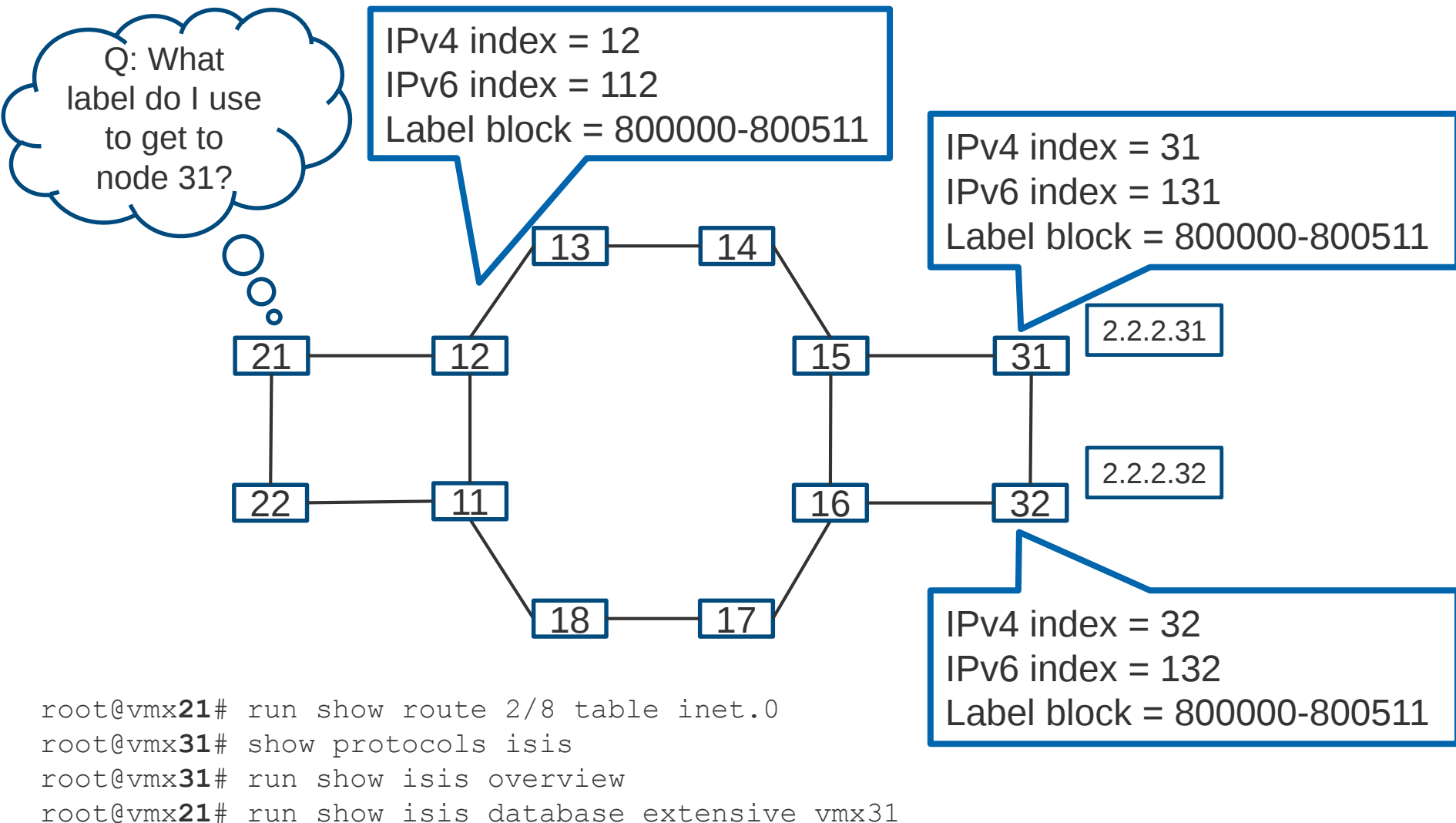
The background is an abstract composition of various shades of green, ranging from light mint to deep forest green. These colors are layered in a way that creates a sense of depth and movement, with sharp, angular shapes and soft, blurred transitions. The overall effect is modern and organic, reminiscent of a stylized landscape or a complex geometric pattern.

SPRING DEMO

SPRING DEMO – BASIC TOPOLOGY



NODE INDEX AND LABEL BLOCK ADVERTISEMENTS



LDP-LIKE (SHORTEST PATH) FORWARDING USING NODE SEGMENTS

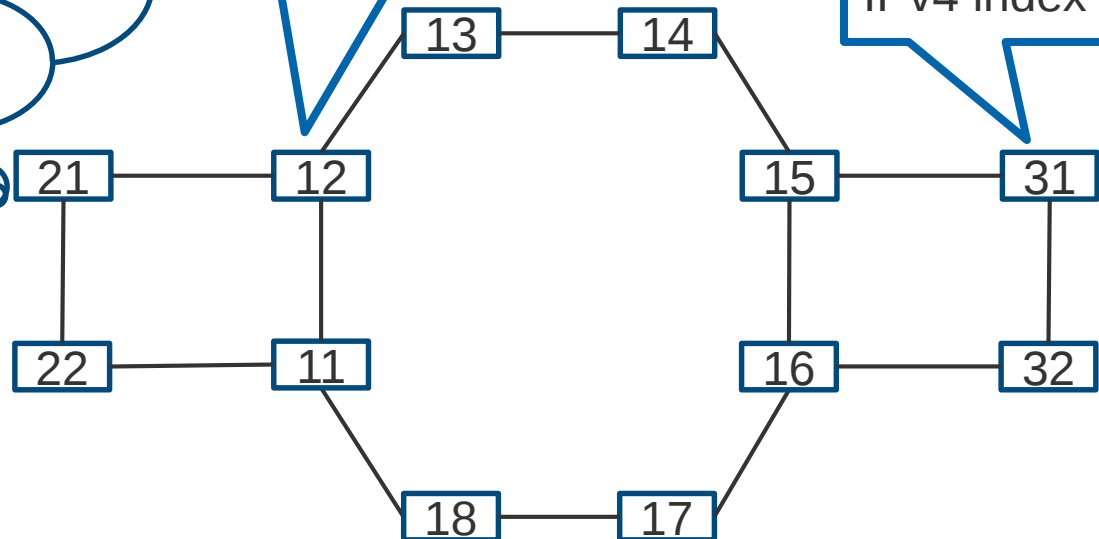
A: Use label
(800000+31) = 800031
on shortest path
(vmx12) to get to node
31.

Label block = 800000-800511

IPv4 index = 31

2.2.2.31

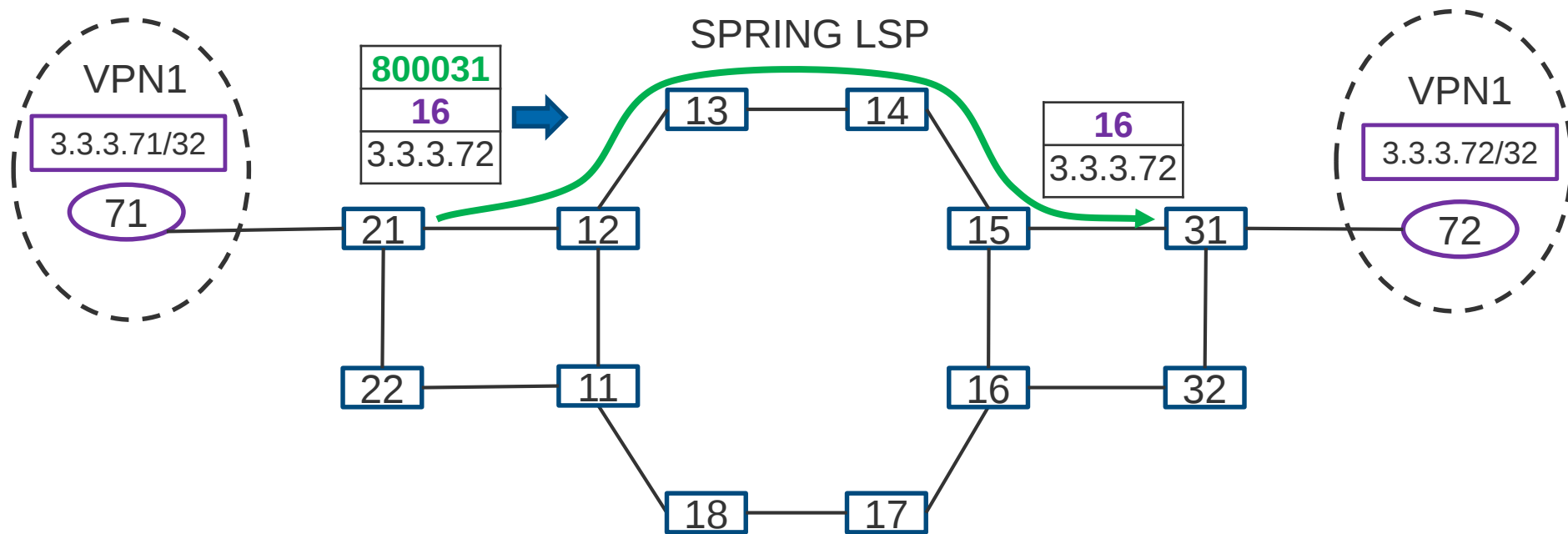
2.2.2.32



```
root@vmx21# run show route 2.2.2.31 table inet.3
```

```
root@vmx12# run show route table mpls.0 label 800031
```

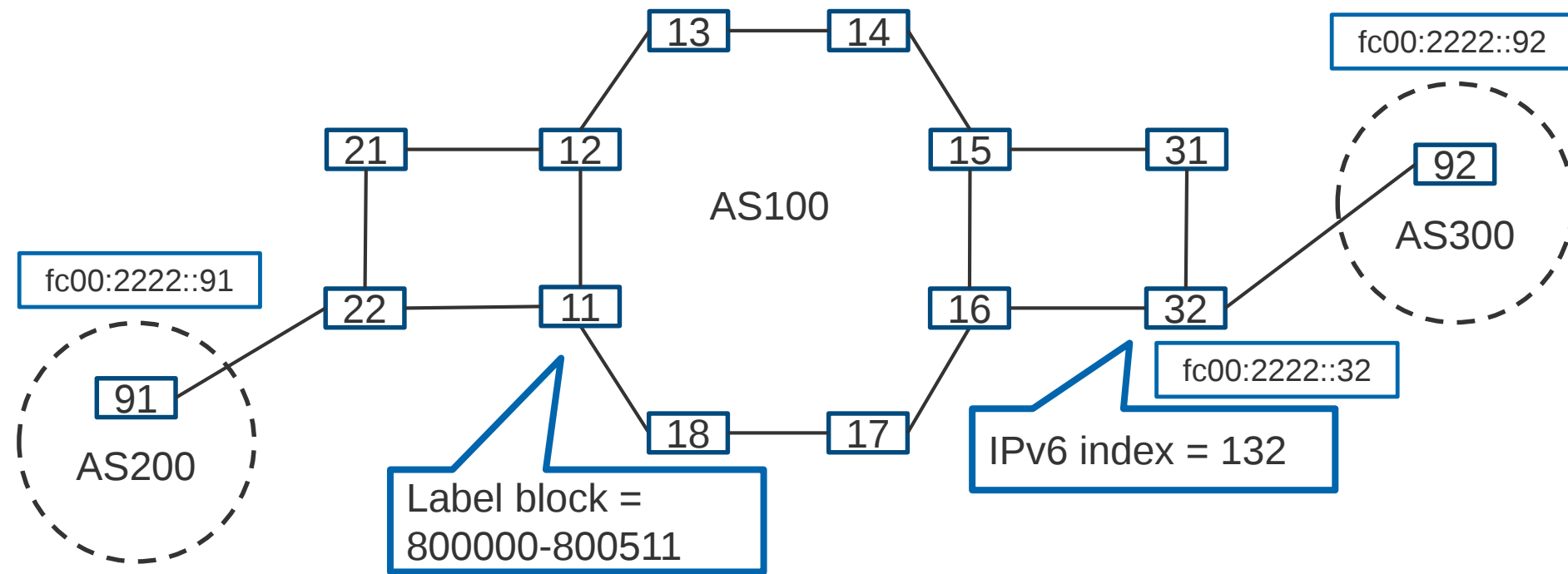
USING SPRING LSPS TO CARRY MPLS-BASED SERVICES



```
root@vmx21# run show route 3.3.3.72 table vpn01.inet
root@vmx21# run show route 2.2.2.31
root@vmx71# run show route 3/8
root@vmx71# run ping 3.3.3.72 rapid size 1400 count 10000
root@vmx21# run monitor interface traffic
```

- MPLS-based services (like L3VPN and L2VPN) currently carried over LDP or RSVP LSPs “just work” over SPRING LSPs

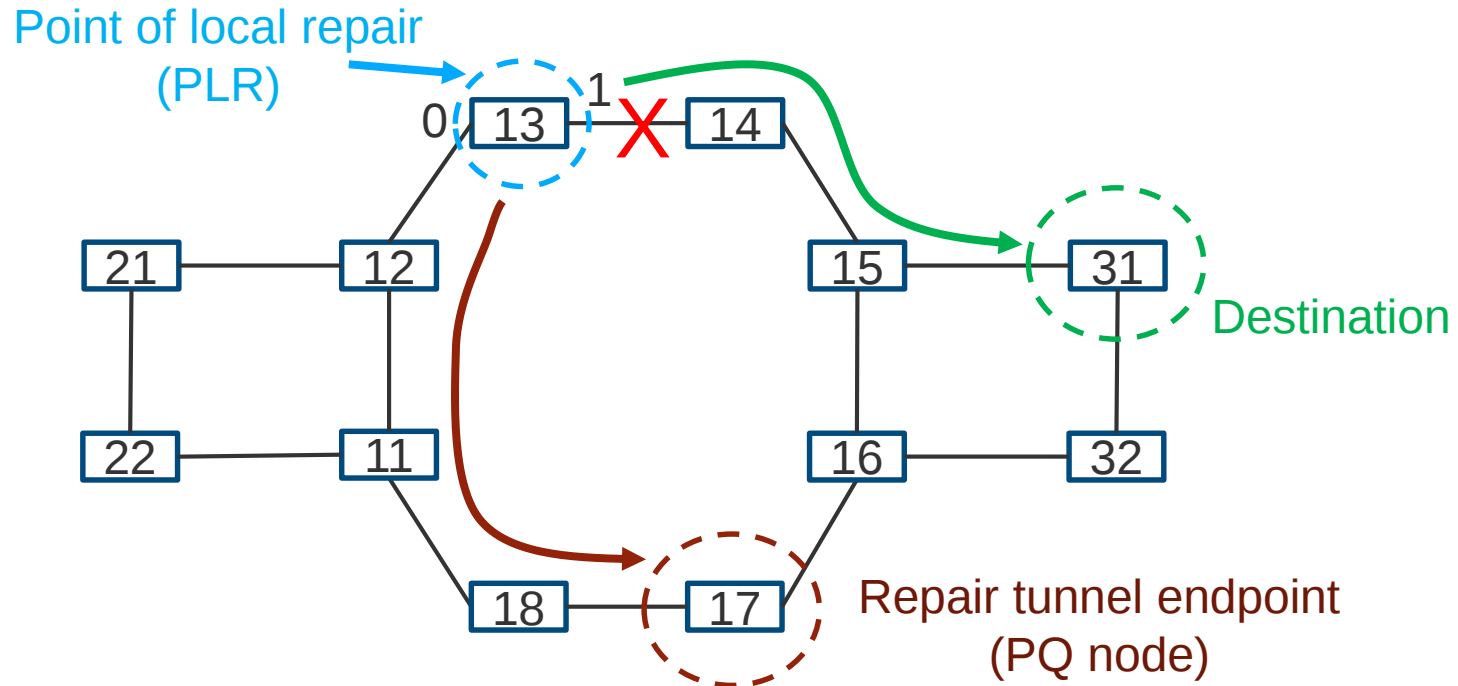
IPv6 SHORTEST PATH FORWARDING USING NODE SEGMENTS



```
root@vmx22# run show route fc00:2222::/64
root@vmx22# run show route fc00:2222::32
root@vmx22# run show route fc00:2222::92
root@vmx91# run show route table inet6.0
root@vmx91# run ping fc00:2222::92 source fc00:2222::91
```

- Alternative to using ipv6-tunneling or LDP with extensions for IPv6

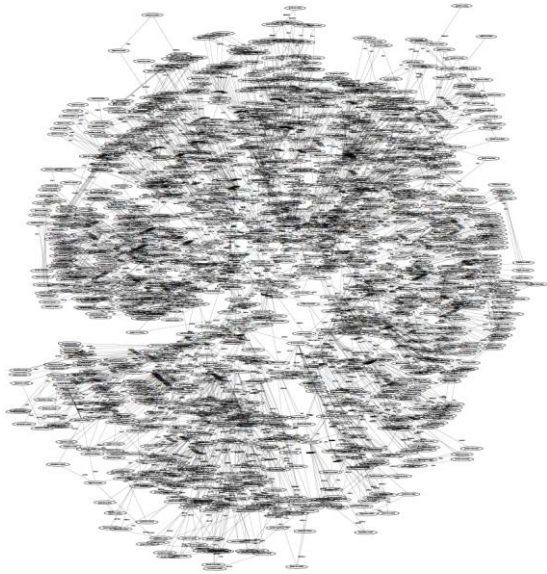
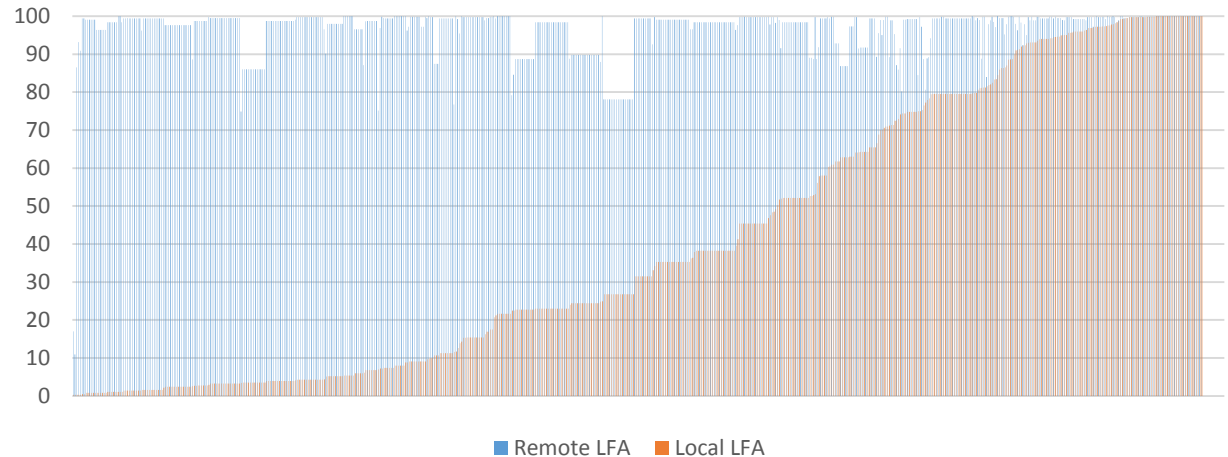
ELIMINATING TARGETED LDP SESSIONS IN REMOTE LFA



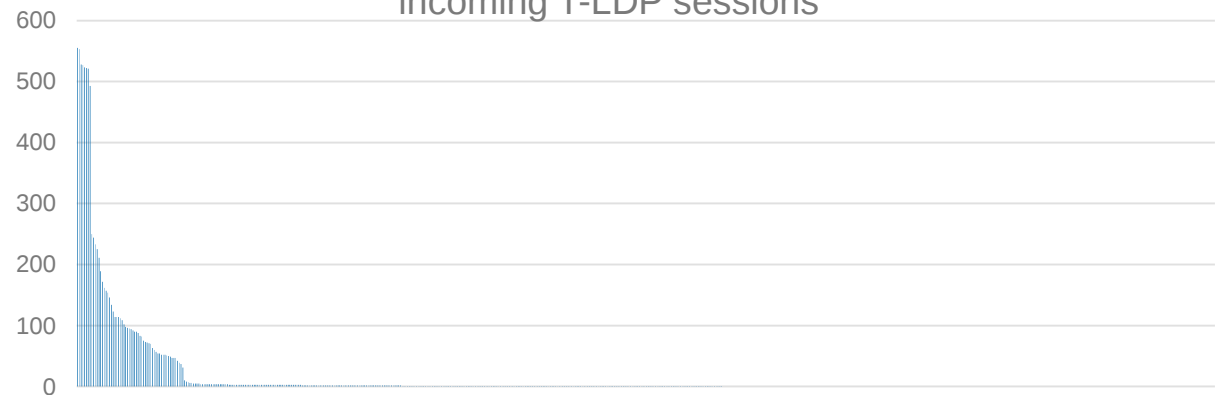
```
root@vmx13# run show route 2.2.2.31
set protocols isis interface ge-0/0/1.0 node-link-protection
set protocols isis backup-spf-options remote-backup-calculation
set protocols isis backup-spf-options use-source-packet-routing
run show isis backup spf results vmx31
run show route 2.2.2.31
```

REMOTE LOOP-FREE ALTERNATES (RLFA) AND TARGETED LDP SESSIONS

Node protection for remote LFA vs. local LFA only

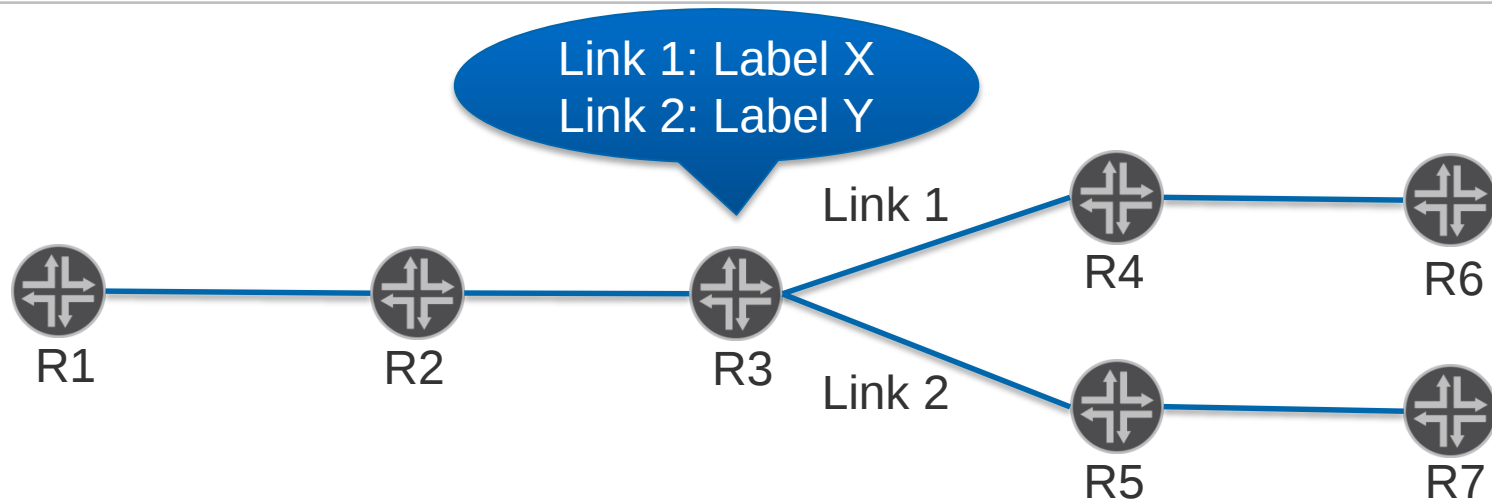


incoming T-LDP sessions



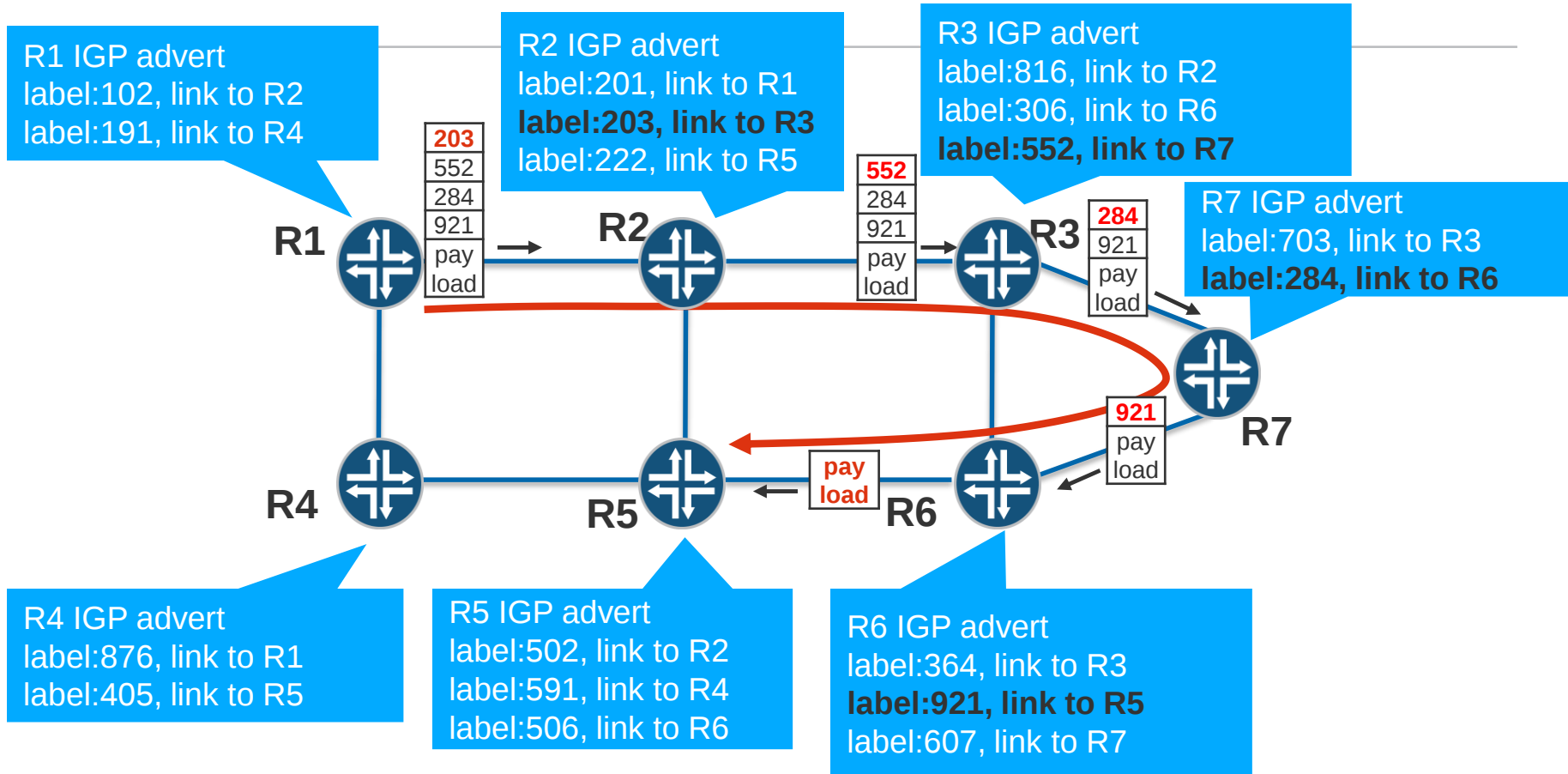
ADJACENCY LABELS

TYPES OF ADVERTISEMENT : ADJACENCY LABEL



- For each link that a router advertises in the IGP, it also advertises an associated MPLS label value. All routers in the domain see this advertisement.
- R3 advertises:
 - label value X, associated with its link to R4.
 - label value Y, associated with its link to R5.
- The advertisement means that if R3 receives an MPLS packet with top label X, it will POP the label and forward the packet to R4 on link 1.

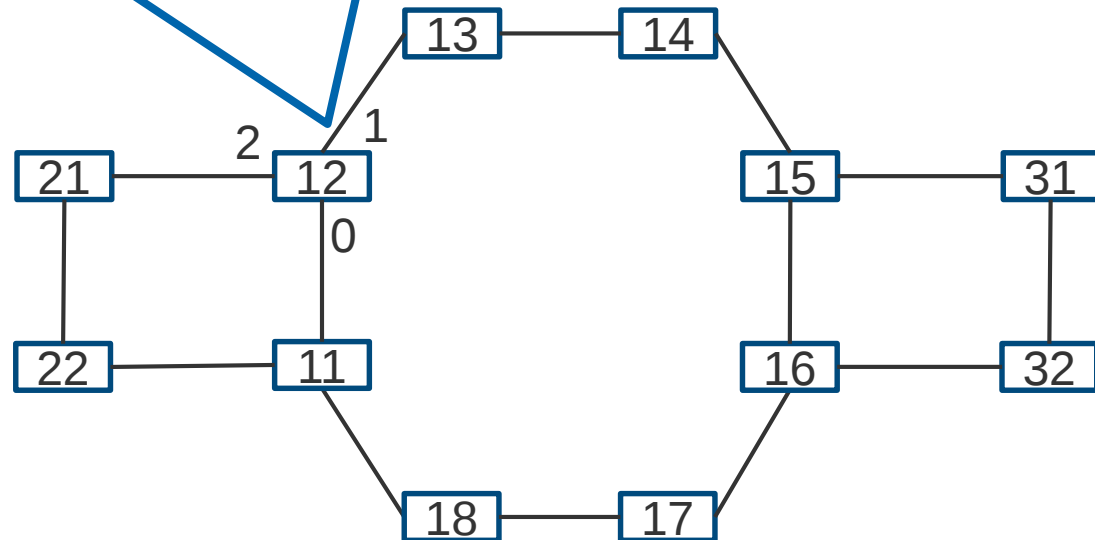
EXPLICIT PATH WITH ADJACENCY LABEL STACK



- To send a packet to R5 along the path (R2,R3,R7,R6,R5), R1 sends packet to R2 with label stack = <203,552,284,921>.
- Each router determines next-hop from top label, then POPs the label.

ADJACENCY SEGMENT ADVERTISEMENTS AND FORWARDING ON TRANSIT ROUTERS

Use label 299776 for vmx12 to vmx11
Use label 299808 for vmx12 to vmx13
Use label 299840 for vmx12 to vmx21



```
root@vmx12# show protocols isis
run show isis database extensive vmx12
run show isis database extensive vmx12| match "IS extended neighbor|IPv4 Adj-SID "
run show route table mpls.0 label 299776
```

- Adjacency labels are usually only locally significant

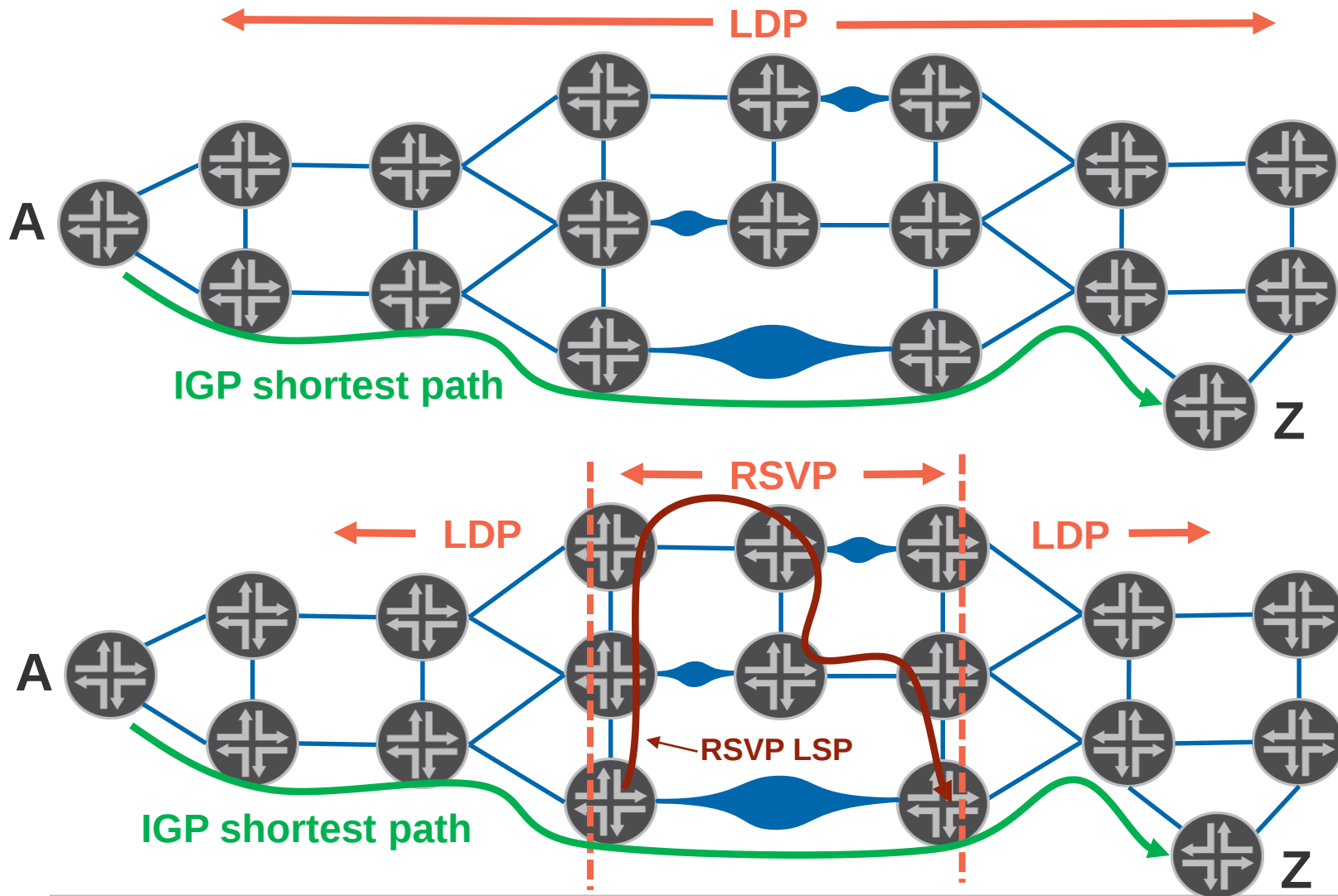
APPLYING SPRING LABELS FOR EXPLICIT PATHS

DISTRIBUTED VS. CENTRALIZED COMPUTATION OF SPRING PATHS

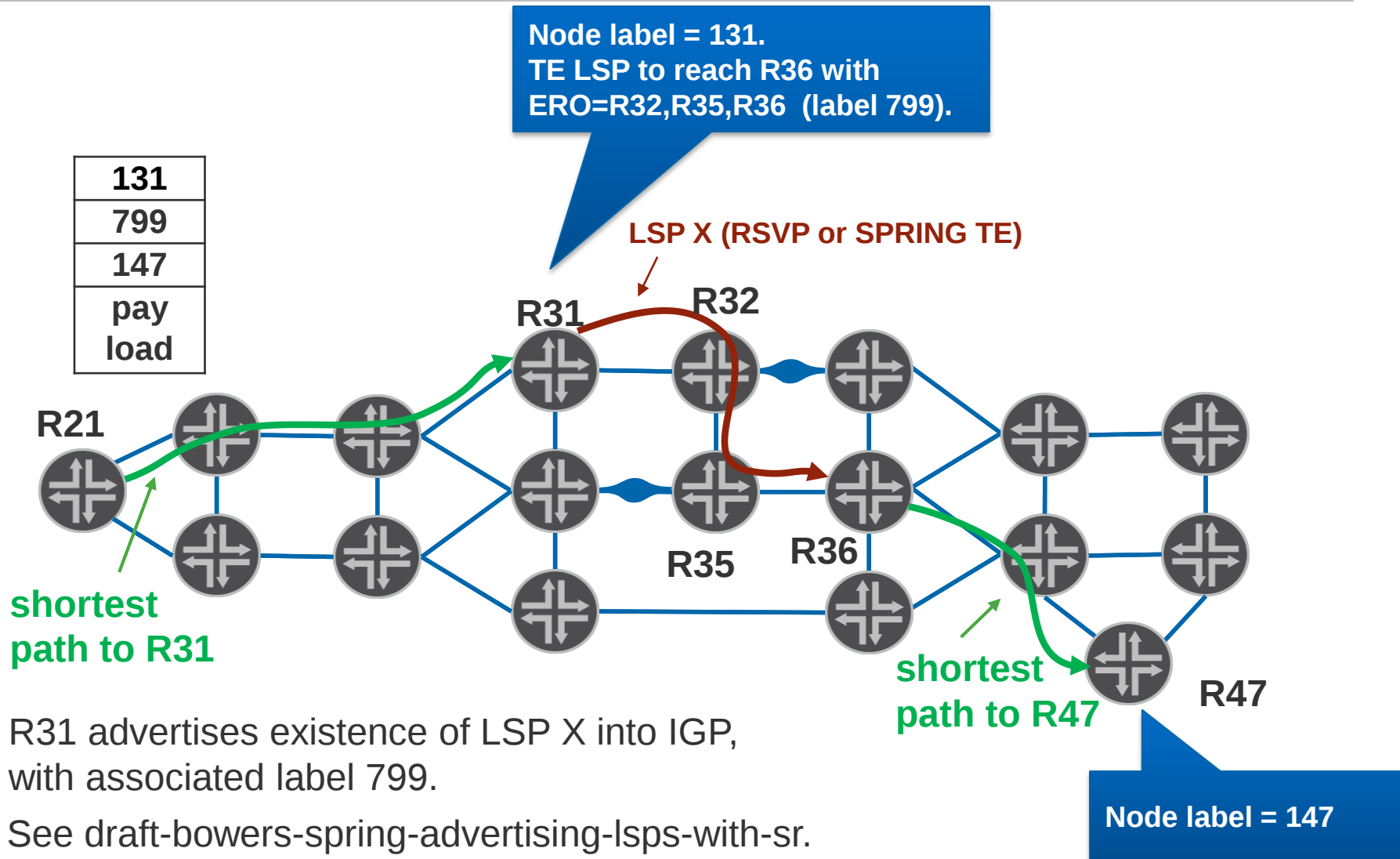
- Distributed path computation with SPRING.
 - No bandwidth accounting since SPRING LSPs are not signaled – no distributed auto-bandwidth.
 - Distributed path computation based on other constraints (color, latency, etc.) still makes sense.
- Centralized path computation with SPRING
 - Path computation element (PCE) learns labels from IGP or BGP-LS and pushes label stack to ingress router
 - PCE pushes path ERO and lets ingress router resolve labels
 - Supports bandwidth accounting.
 - Centralized control may simplify LSP hierarchy.

USING BINDING SEGMENTS TO REMOTELY LAUNCH TRAFFIC INTO A TE LSP

TRAFFIC ENGINEERING WITH LDP OVER RSVP



TRAFFIC ENGINEERING WITH SPRING NODE LABELS AND SPRING-LABELED TE TUNNELS



STATUS OF SPRING

STATUS OF SPRING

- Initial deployments beginning
 - Mainly using node labels for shortest path routing
 - Explicit paths with stacks of adjacency labels farther out
- SPRING proving to be a useful additional tool for distributing MPLS labels
- SPRING-inspired innovations
 - More predictable label values can be useful
 - More reliance on label popping paradigm can be useful
 - Network operators finding other ways to achieve similar things