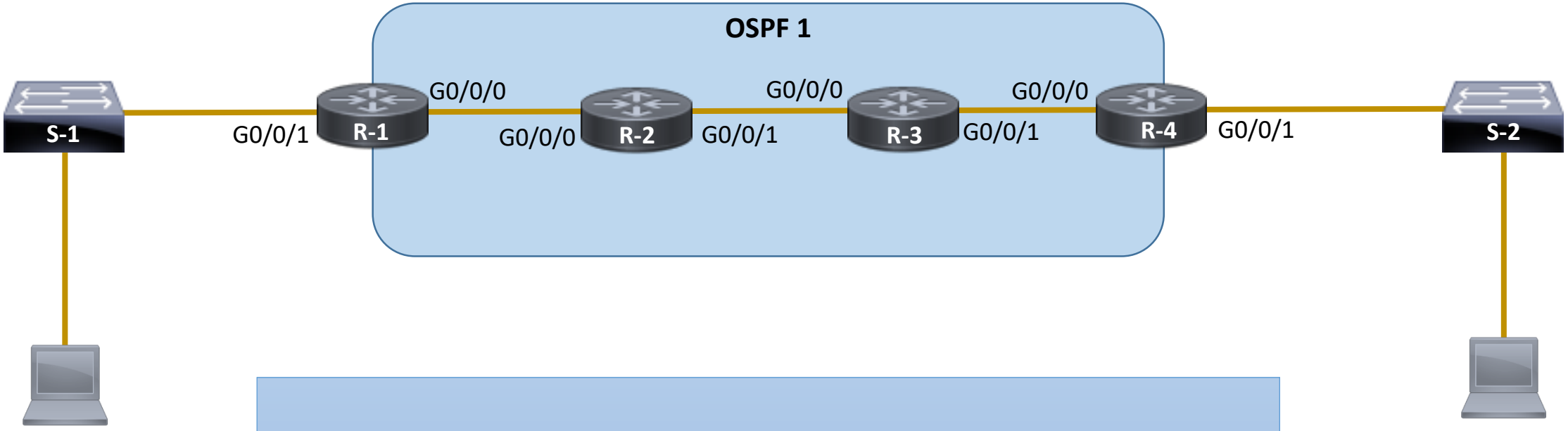
MPLS OVERVIEW

Why MPLS?

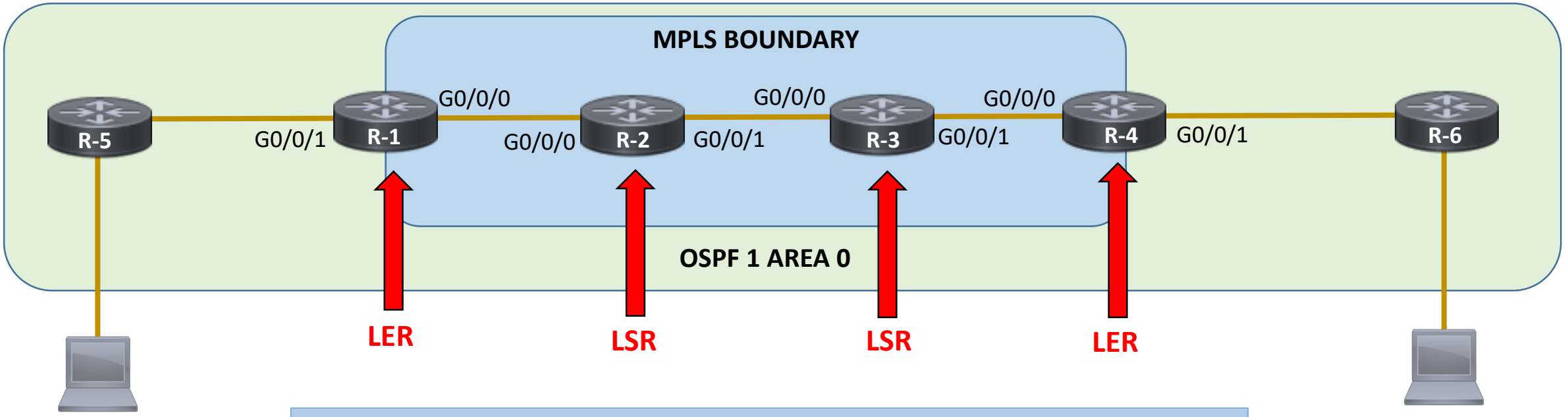
- Logical separation of traffic can be imposed at the PE, and maintained through the Service Provider Core
  - VRF's, Multi-protocol BGP
- The use of one unified network infrastructure
  - Hybrid systems of IP / ATM / Frame-Relay are unnecessary
  - MPLS encapsulation can contain a variety of payloads, IP, IPv6, Ethernet, HDLC, PPP
    - L3VPN, VPLS, Pseudowire, etc.
- Optimal / Flexible traffic flow
  - SP Core network IGP will dynamically determine best path vs. static assignments (Frame-Relay / ATM)
  - SP networks can implement static LSP determination (Traffic Engineering)

Benefits of MPLS

- Dynamic traffic flow
  - the provider's IGP will chose the best path across the core, without having to configure virtual circuits for every connection
- Traffic Engineering – RSVP-TE
  - The ability to assign traffic to links that not the "best path" to make usage of all the links in the core
  - Gives us the ability to map one FEC (LSP) traffic over SATCOM and another FEC over LOS
  - Adds the ability to do source routing
  - MPLS-TE Fast Reroute (FRR)
  - Attribute flag tunneling



MPLS uses an existing IP network with information derived from a link-state protocol. Without this underlying IP network the MPLS process on the router does not have routes to assign MPLS labels to.



Any devices running MPLS is a “Label Switched Router” (LSR) but devices that exist at the edge of an MPLS boundary are “Label Edge Routers” (LER)

MPLS boundaries can be different than OSPF boundaries. An OSPF domain can continue to extend past the last router running MPLS at any edge. MPLS labels are removed at that last “Label Edge Router” and traffic is simply routing beyond that point using standard OSPF and IP routing.

LDP

- Label Distribution Protocol
- Open Standard per RFC 3036, 5036
- Two LSRs adjacent and exchanging label information are “LDP Peers”
- Stages of LDP operation:
  - IGP Convergence
  - Assign an LDP local binding to all IGP learned prefixes
  - Assign a default LFIB action = POP
  - Form LDP Neighbor (based on LDP router-id learned in first hello packet)
    - Neighbor discovery via link-local multicast (224.0.0.2 – UDP port 646)
    - Session built via TCP port 646
  - Exchange local-bindings
  - Modify the LFIB default actions per LDP peer exchanged binding
- All label entries are stored in the LIB (Label Information Base)

MPLS FORWARDING TABLE

OUTGOING LABELS ARE SHARED WITH THE ROUTER BY MPLS NEIGHBORS. THIS IS THE LABEL THAT SHOULD BE SENT TO THE NEIGHBOR SO THEY KNOW WHAT DESTINATION NETWORK YOU ARE TRYINTG TO REACH, IF THE LABEL SAYS “POP LABEL”, THAT MEANS THAT THIS ROUTER SHOULD REMOVE ANY MPLS LABELS BEFORE SENDING TO THE NEIGHBOR.

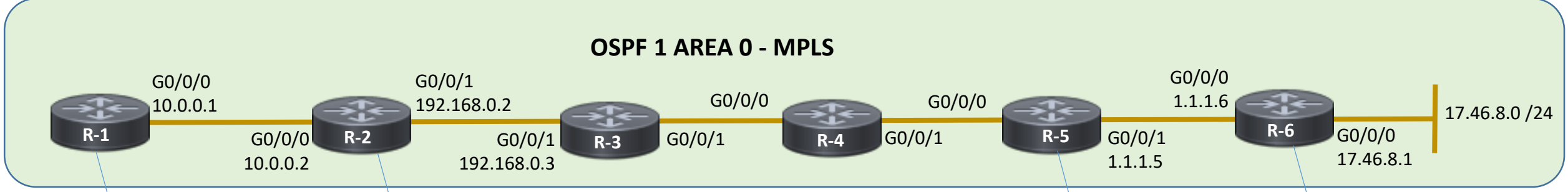
THE OUTGOING INTERFACE IS THE EXIT INTERFACE THAT THE PACKET SHOULD BE SENT TO

LOCAL LABELS ARE ASSIGNED BY THE ROUTER LOCALLY. THIS IS THE LABEL THEY SHARE WITH THEIR MPLS NEIGHBORS TELLING THEM WHICH LABEL TO USE IF THEY NEIGHBOR IS SENDING TRAFFIC TOWARDS THIS ROUTER

NEXT HOP IS THE IP ADDRESS OF THE MPLS NEIGHBOR THAT WILL BE REACHED VIA THE OUTGOING INTERFACE

```
MPLS-P_6#show mpls forwarding-table
Local      Outgoing   Prefix           Bytes Label   Outgoing    Next Hop
Label      Label      or Tunnel Id     Switched      interface
14250      Pop Label  14.195.57.0/24   0             Gi1/0/2     14.195.67.7
14251      34003      14.195.48.0/24   0             Gi1/0/2     14.195.67.7
14254      No Label   14.197.200.251/32   \
                                       0             Gi1/0/3     14.196.16.1
14256      34030      14.195.59.0/24   0             Gi1/0/2     14.195.67.7
14259      34011      14.194.13.254/32 0             Gi1/0/2     14.195.67.7
14262      Pop Label  14.240.33.0/24   0             Gi1/0/2     14.195.67.7
14264      Pop Label  10.173.23.48/32[V]    \
                                       0             aggregate/EXAM-2
14265      Pop Label  172.19.254.0/32[V]    \
                                       0             Gi1/0/1     172.19.254.5
14266      Pop Label  172.25.0.231/32[V]    \
                                       2742779       Gi1/0/0     172.19.254.6
14267      Pop Label  14.197.221.0/24   0             Gi1/0/3     14.196.16.1
14269      Pop Label  14.194.13.253/32 0             Gi1/0/2     14.195.67.7
14272      34029      14.195.8.0/32    0             Gi1/0/2     14.195.67.7
14280      Pop Label  14.195.47.0/24   0             Gi1/0/2     14.195.67.7
14281      34031      14.195.9.0/32    0             Gi1/0/2     14.195.67.7
MPLS-P_6#
```

THE PREFIX OR TUNNEL ID SHOWS THE SUBNET OR CIRCUIT ASSOCIATED WITH EACH LABEL.



R1#

I WANT TO GET TO 17.46.8.0 /24 USING THIS MPLS NETWORK.

MY MPLS DATABASE SAYS MY LOCAL LABEL FOR THAT ROUTE IS “1001” SO THAT IS THE LABEL I GIVE TO MY MPLS NEIGHBORS IF THEY’RE USING ME TO GET TO 17.46.8.0 /24.

MY MPLS FORWARDING TABLE SAYS MY OUTGING LABEL FOR THAT ROUTE IS “2157” AND I SEND IT OUT MY G0/0/0 INTERFACE TO A NEXT HOP IP ADDRESS 10.0.0.2.

SO I PUT A LABEL OF “2157” ON IT AND SEND IT OUT G0/0/0

R2#

I RECEIVED AN MPLS PACKET FROM R1 MARKED WITH THE LABEL “2157”

MY MPLS DATABASE SAYS THAT’S MY LABEL FOR 17.46.8.0 /24.

MY MPLS FORWARDING TABLE SAYS MY OUTGOING LABEL FOR THAT ROUTE IS “3085” AND I SEND IT OUT MY G0/0/1 INTERFACE TO A NEXT HOP IP ADDRESS OF 192.168.0.3

SO I PUT A LABEL OF “3085” ON IT AND SEND IT OUT G0/0/1

R5#

I RECEIVED AN MPLS PACKET FROM R4 MARKED WITH THE LABEL “5551”

MY MPLS DATABASE SAYS THAT’S MY LABEL FOR 17.46.8.0 /24.

MY MPLS FORWARDING TABLE SAYS MY OUTGOING INTERFACE IS G0/0/1 WITH A NEXT HOP OF 1.1.1.6, AND THAT THE NEXT ROUTER IS THE MPLS EDGE FOR THAT ROUTE.

SO I’M GOING TO POP THE LABEL OFF AND JUST SEND IT TO OUT G0/0/1 AS IP.

R6#

I RECEIVED AN IP PACKET FROM R5 WITH A DESTINATION OF 17.46.8.100.

THAT NETWORK IS CONNECTED TO ME ACCORDING TO MY ROUTING TABLE SO I SEND THE PACKET OUT MY G0/0/2 INTERFACE.

MPLS Commands

- Configuration

```
R20(config)#ip cef
R20(config)#mpls label protocol ldp
R20(config)#mpls ldp router-id loopback0 force
R20(config)#mpls label range 20000 20999
R20(config)#mpls ip
R20(config)#int g0/0
R20(config-if)#mpls ip
```

- Verification:
  - Show mpls interface
  - Show mpls ldp discovery
  - Show mpls ldp neighbor
  - Show mpls ldp bindings
  - Show mpls forwarding-table
  - Show mpls ip binding
  - Show ip cef x.x.x.x
  - Traceroute x.x.x.x (notice MPLS: Label XX in output)