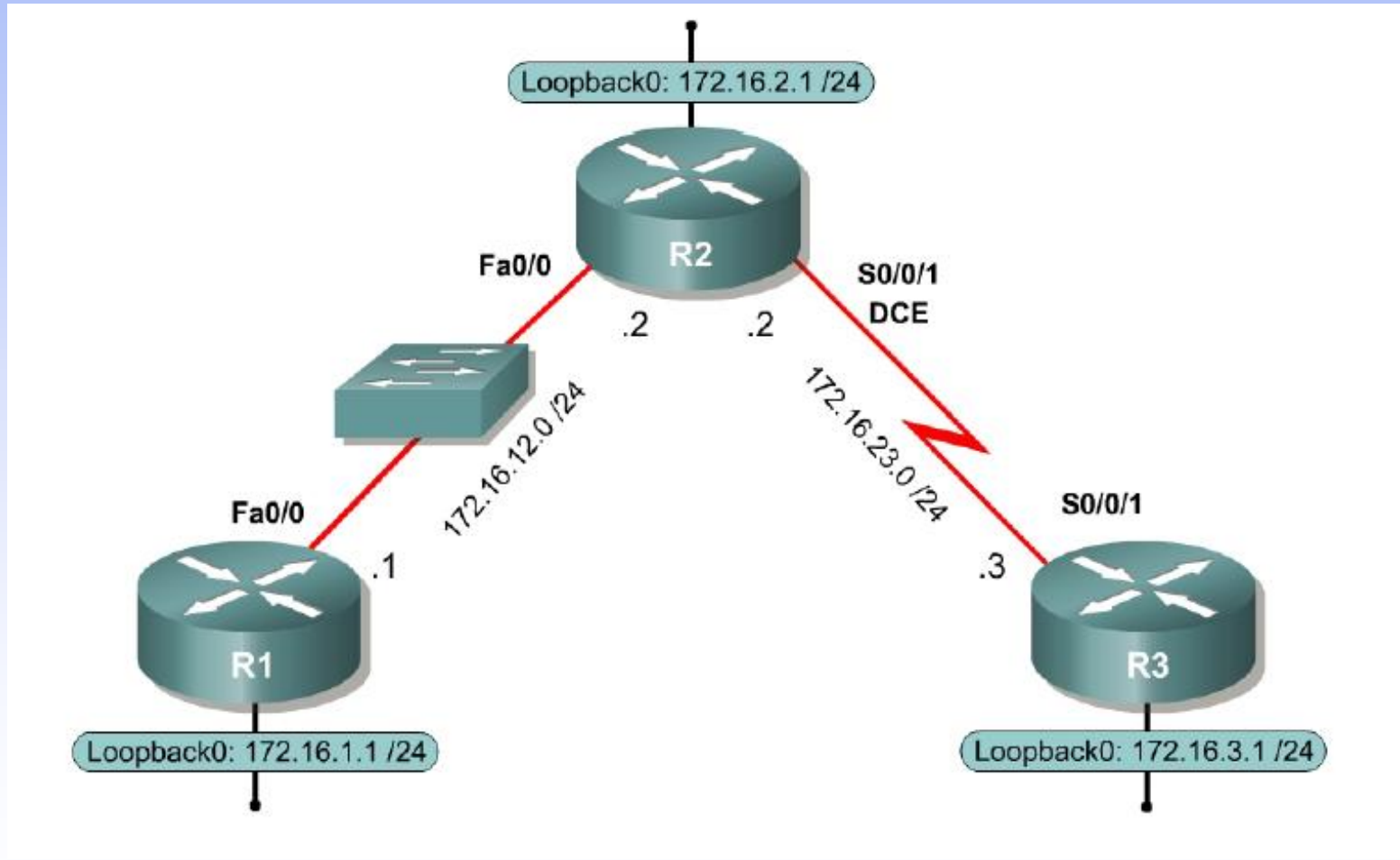
MPLS Lab

- This lab is mostly copied from a Cisco Networking Academy CCNP level lab titled
  - Lab 4.1 Configuring Frame Mode MPLS

MPLS Lab

- Here is the topology to create in GNS3

MPLS Lab



MPLS Lab

- In this lab, you will configure a network using EIGRP as the routing protocol
- Then run MPLS over the IP internetwork to fast-switch Layer 2 frames
- Here is the configuration for each router

R1

- enable
- config t
- interface loopback 0
- ip address 172.16.1.1 255.255.255.0
- interface fastethernet 0/0
- ip address 172.16.12.1 255.255.255.0
- no shutdown
- exit

R1

- router eigrp 1
- no auto-summary
- network 172.16.0.0
- interface fastethernet 0/0
- mpls ip
- exit
- end

R2

- enable
- config t
- interface loopback 0
- ip address 172.16.2.1 255.255.255.0
- interface fastethernet 0/0
- ip address 172.16.12.2 255.255.255.0
- no shutdown

R2

- interface serial 1/0
- ip address 172.16.23.2 255.255.255.0
- clockrate 64000
- no shutdown
- exit

R2

- router eigrp 1
- no auto-summary
- network 172.16.0.0
- interface fastethernet 0/0
- mpls ip
- exit
- end

R3

- enable
- config t
- interface loopback 0
- ip address 172.16.3.1 255.255.255.0
- interface serial 1/0
- ip address 172.16.23.3 255.255.255.0
- no shutdown
- exit

R3

- router eigrp 1
- no auto-summary
- network 172.16.0.0
- interface fastethernet 0/0
- mpls ip
- exit
- end

Check Connectivity

- When everything is configured, ping from R1 to R3
  - ping 172.16.3.1
- Check the routing table
  - show ip route

Check Connectivity

```
R1# show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 5 subnets
D       172.16.23.0 [90/2172416] via 172.16.12.2, 00:01:56, FastEthernet0/0
C       172.16.12.0 is directly connected, FastEthernet0/0
C       172.16.1.0 is directly connected, Loopback0
D       172.16.2.0 [90/156160] via 172.16.12.2, 00:01:56, FastEthernet0/0
D       172.16.3.0 [90/2300416] via 172.16.12.2, 00:01:51, FastEthernet0/0
```

Check Connectivity

- On R1, if you perform a traceroute to the R3's loopback, you see the path the packet follows
- Observe this
- This output changes slightly once we configure MPLS

Check Connectivity

```
R1# traceroute 172.16.3.1

Type escape sequence to abort.
Tracing the route to 172.16.3.1

  1 172.16.12.2 0 msec 0 msec 0 msec
  2 172.16.23.3 16 msec 12 msec *
```

MPLS Configuration

- As discussed earlier MPLS is a standardized protocol that allows routers to switch packets based on labels, rather than route switch packets based on standards in the protocol's routing formula

MPLS Configuration

- Under normal IP routing, every intermediate system looks up the destination prefix of an IP packet in the Routing Information Base of a router or in the Forwarding Information Base of a fast switch at every Layer 3 node

MPLS Configuration

- Instead of switching that is based on prefix, the first router running MPLS can encapsulate the IP packet in an MPLS frame and then further encapsulate the packet in the Layer 2 frame before sending it across one of many supported Layer 2 media

MPLS Configuration

- At the next MPLS-enabled LSR - Label Switch Router, the MPLS frame is read and the IP packet is switched as an MPLS frame from router to router with little rewrite at each node

MPLS Configuration

- This allows routers to switch multiple protocols - hence the name - using the same switching mechanism, as well as perform some other functionality not available in traditional destination-based forwarding, including Layer 2 VPNs - ATM, Layer 3 VPNs, and traffic engineering

MPLS Configuration

- Configuring the interface-level command mpls ip on an interface tells the router to switch MPLS packets inbound and outbound on that interface as well as attempt to bring up MPLS adjacencies with the LDP - Label Distribution Protocol out that egress interface

MPLS Configuration

- LDP facilitates communication between MPLS peers by allowing them to inform each other of labels to assign packets to particular destinations based on Layer 2, Layer 3, or other significant information

Verify MPLS Configuration

- MPLS has many show commands that you can use to verify proper MPLS operation
- Issue the
  - show mpls interfaces
- command to see a quick summary of interfaces configured with MPLS
- Keep in mind that you will see this output because you applied the mpls ip command to these interfaces

Verify MPLS Configuration

```
R1# show mpls interfaces
Interface              IP           Tunnel   Operational
FastEthernet0/0        Yes (ldp)    No       Yes


R2# show mpls interfaces
Interface              IP           Tunnel   Operational
FastEthernet0/0        Yes (ldp)    No       Yes
Serial0/0/1            Yes (ldp)    No       Yes

R3# show mpls interfaces
Interface              IP           Tunnel   Operational
Serial0/0/1            Yes (ldp)    No       Yes
```

Verify MPLS Configuration

- Issue the
  - show mpls ldp discovery
- command to find out local sources for LDP exchanges and the show mpls ldp neighbor command to show LDP adjacencies
- Notice that MPLS chooses its IDs based on loopback interfaces, similar to other protocols such as OSPF and BGP

Verify MPLS Configuration

```
R1# show mpls ldp discovery
 Local LDP Identifier:
    172.16.1.1:0
    Discovery Sources:
    Interfaces:
        FastEthernet0/0 (ldp): xmit/recv
            LDP Id: 172.16.2.1:0; no host route
```

Verify MPLS Configuration

- In the configuration you set up, all routers are acting as Label Switch Routers and running LDP
- On LSRs, each forwarding equivalence class - in this case, each routable IP prefix - is assigned an MPLS label
- LDP automatically distributes labels to peers to be used when sending traffic to specific destinations through the LSR

Verify MPLS Configuration

- Once labels have been distributed, switching for MPLS packets is done through the LIB - Label Information Base
- Display the contents of the LIB using
  - show mpls ldp bindings
- There is a binding for every routed prefix; however, the bindings may vary from router to router since they can get swapped at each hop

Verify MPLS Configuration

- In a larger network, the way labels are swapped is easier to see

Verify MPLS Configuration

```
R1# show mpls ldp bindings
  tib entry: 172.16.1.0/24, rev 6
        local binding:  tag: imp-null
        remote binding: tsr: 172.16.2.1:0, tag: 16
  tib entry: 172.16.2.0/24, rev 8
        local binding:  tag: 17
        remote binding: tsr: 172.16.2.1:0, tag: imp-null
  tib entry: 172.16.3.0/24, rev 10
        local binding:  tag: 18
        remote binding: tsr: 172.16.2.1:0, tag: 17
  tib entry: 172.16.12.0/24, rev 4
        local binding:  tag: imp-null
        remote binding: tsr: 172.16.2.1:0, tag: imp-null
  tib entry: 172.16.23.0/24, rev 2
        local binding:  tag: 16
        remote binding: tsr: 172.16.2.1:0, tag: imp-null
```

Verify MPLS Configuration

- As mentioned earlier, traceroute would differ slightly once MPLS was set up
- The output now includes labels for each hop
- Unfortunately, because of the size of this network, you only see one label
- In a larger network, you would see more hops, and therefore more labels

Verify MPLS Configuration

```
R1# traceroute 172.16.3.1

Type escape sequence to abort.
Tracing the route to 172.16.3.1

  1 172.16.12.2 [MPLS: Label 17 Exp 0] 44 msec 44 msec 48 msec
  2 172.16.23.3 12 msec 12 msec *
```

Verify MPLS Configuration

- Because you are adding in extra header information to packets, the MTU of packets can change
- Remember that each MPLS header is 4 bytes
- The default MTU size of MPLS packets is taken from the interface it is running on, which in the case of Ethernet is 1500 bytes

Verify MPLS Configuration

- For this lab, we will change the Ethernet connection between R1 and R2 to support 2 MPLS headers, so we will change the MPLS MTU to 1508 on their Fast Ethernet interfaces
- Verify the change using the
  - show mpls interfaces interface detail
- command used

Verify MPLS Configuration

```
R2(config)# interface fastethernet0/0
R2(config-if)# mpls mtu 1508

R1# show mpls interface fastethernet 0/0 detail
Interface FastEthernet0/0:
        IP labeling enabled (ldp):
          Interface config
        LSP Tunnel labeling not enabled
        BGP tagging not enabled
        Tagging operational
        Fast Switching Vectors:
          IP to MPLS Fast Switching Vector
          MPLS Turbo Vector
        MTU = 1508

R2# show mpls interface fastethernet 0/0 detail
Interface FastEthernet0/0:
        IP labeling enabled (ldp):
          Interface config
        LSP Tunnel labeling not enabled
        BGP tagging not enabled
        Tagging operational
        Fast Switching Vectors:
          IP to MPLS Fast Switching Vector
          MPLS Turbo Vector
        MTU = 1508
```

MPLS Lab

- As you can see, GNS3 running Dynagen and Dynamips is a very useful tool
- As you can also see, MPLS is easy to setup

Cisco Labs on GNS3

- http://gns3vault.com/labs/