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CCIE LAB

Note 1: There are two sections, Section A and Section B. There is some overlap between the Sections.
Note 2: Section A contains 9 labs. Section B contains 8 Labs. Total number of labs is 17.
Lab Preparation Scenario: Frame Relay

Topic Covered

- Encapsulation
- LMI
- Point-to-Point
- Multipoint
- Frame-Relay Switch
- Split-Horizon
- EIGRP

Difficulty Level: CCIE TM

Average Completion Time: 1 Hour

Standard Topology

Standard TCP/IP Addressing and SPID Information

R1 (3629)
Loop0 192.168.1.1 /24  Loopback
E0/0 172.16.136.1 /26  Ethernet Segment to Catalyst 3/1
T0/0 172.16.15.1 /28  Token Ring Segment to 2920
S1/1 172.16.31.1 /30  Serial to R3
S1/0  unassigned  Frame-relay

R2 (3620)
Loop0 192.168.2.2 /24  Loopback
T0/0 172.16.2.2 /24  Token Ring Segment to 3920
BRI0/0 172.16.230.2 /24  BRI to R3
S1/1 172.16.32.2/24  Serial to R3
S1/0  unassigned  Frame-relay

R3 (2610)
Loop0 192.168.3.3 /24  Loopback
E0/0 172.16.136.3 /26  Ethernet Segment to Catalyst 3/3
BRI0/0 172.16.230.3 /24  ISDN to R2
S1/3 172.16.35.1 /30  Serial to R5
S1/2 172.16.32.3/24  Serial to R2
S1/0  unassigned  Frame-relay

R4 (2610)
Loop0 192.168.4.4 /24  Loopback
E0/0 10.1.4.4 /22  Ethernet Segment to BB1
S0/0  unassigned  Frame-relay

R5 /3620)
Loop0 192.168.5.5 /24  Loopback
E0/0 172.16.136.5 /26  Ethernet Segment to Catalyst 3/5
T0/0 172.16.15.5 /28  Token Ring Segment to 3920
S0/0 172.16.35.2 /30  Serial link to R3
A1/0 172.16.56.5 /30  ATM-R6

R6 (3640)
Loop0 192.168.6.6 /24  Loopback
FA0/0 172.16.136.6 /26  Ethernet segment -R2
E2/0 10.2.6.6 /23  Ethernet segment -BB2
A1/0 172.16.56.6 /30  ATM-R5

ISDN Information
Switch Type  Basis N1

R2
Technical Tasks

A. Shutdown all LAN, ISDN, and ATM Interfaces. The frame-relay cloud should be configured with R2 as the hub with R1, R3, and R4 as spokes. Make use of no other DLCI’s than those necessary to accomplish this. Configure the routers with addressing from the 172.16.234.0/24 subnet. Ensure that R2 will not broadcast at a rate faster than 5120 bits per second.

B. Back-back frame-relay. You must use the same DLCI on both ends. One side needs to assume the frame relay DCE function. Whichever router will be the DCE must first enable frame-relay switching globally. This does not have to be the same end that provides clock.

C. There are two types of frame-relay encapsulation, Cisco and IETF.

D. There are three types of LMI. ANSI uses DLCI 0.

E. You may want to disable auto-summary under EIGRP. If you have problems getting routes to R4, check split-horizon.

Technical Verification

Technical Verification For Task A

r1#sh fram map
Serial1/0 (up): ip 172.16.234.2 dlci 122(0x7A,0x1CA0), static, broadcast, CISCO, status defined, active
Serial1/0 (up): ip 172.16.234.3 dlci 122(0x7A,0x1CA0), static, broadcast, CISCO, status defined, active
Serial1/0 (up): ip 172.16.234.4 dlci 122(0x7A,0x1CA0), static, broadcast, CISCO, status defined, active

r2#sh fram map
Serial1/0 (up): ip 172.16.234.1 dlci 221(0xDD,0x34D0), static. broadcast, CISCO, status defined, active
Serial1/0 (up): ip 172.16.234.3 dlci 223(0xDF,0x34F0), static, broadcast, CISCO, status defined, active
Serial1/0 (up): ip 172.16.234.4 dlci 224(0xE0,0x3800), static, broadcast, CISCO, status defined, active

r3#sh fram map
Serial1/0 (up): ip 172.16.234.1 dlci 322(0x142,0x5020), static, broadcast, CISCO, status defined, active
Serial1/0 (up): ip 172.16.234.2 dlci 322(0x142,0x5020), static, broadcast, CISCO, status defined, active
Serial1/0 (up): ip 172.16.234.4 dlci 322(0x142,0x5020), static, broadcast, CISCO, status defined, active

r2#sh int s1/0
Serial 1/0 is up, line protocol is up

Hardware is DSCC4 Serial
Internet address is 172.16.234.2/24
MTU 1500 bytes, BW 2048 Kbit, DLY 20000 usec,
  reliability 255/255m, txload 1/255, rxload 1/255
Encapsulation FRAME-RELAY, loopback not set
Keepalive set (10 sec)
  LMU enq sent 224, LMI stat recvd 255, LMI upd recvd 0, DTE LMI ip
  LMI enq recvd 0, LMI stat sent 0, LMI upd sent 0
  LMI DLCI 0 LMI type is ANSI Annex D frame relay DTE
  FR SVC disabled, LAPF satte down
  Broadcast queue 0/100, broadcast sent/dropped 582/0, interface broadcast 19

The output does hot show the byte size but it does show the packet size has changed from the default value of 64.

Technical Verification For Task B

r3#sh fram map | begin Serial1/1
Serial1/1 (up): ip 172.16.31.1 dlci 31(0x1F,0x4F0), dynamic. broadcast,, status defined, active
Serial1/1 (up): ip 172.16.32.2 dlci 32(0x20,0x800), dynamic, broadcast,, status defined, active

Technical Verification For Task C

r3#sh fram map | begin Serial1/3
Technical Verification For Task D

```
r3#sha int s1/3
Serial 1/3 is up, line protocol is up
  Hardware is CD2430 in sync mode
  Internet address is 172.16.35.1/30
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
      reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation FRAME-RELAY IETF, loopback not set
  Keepalive set (10 sec)
  LMI eng sent 0, LMI stat recvd 0, LMI upd recvd 0
  LMI eng recvd 127, LMI stat sent 127, LMI upd sent 0, DCE LMI up
  LMI CLCI 0 LMI type is ANSI Annex D frame relay DCE
```

Technical Verification For Task E
The routing tables of all routers are included here. The legend normally provided in router output has been deleted.

Router 1

```
r2#sh ip ro
172.16.0.0/16 is variably subnetted, 4 subnets, 2 masks
C  172.16.234.0/24 is directly connected, Serial1/0
C  172.16.32.0/24 is directly connected, Serial1/1
D 172.16.35.0/30 [90/21024000] via 172.16.32.3, 00:13:15, Serial 1/1
    [90/21024000] via 172.16.234.3, 00:13:16, Serial1/0
D 172.16.31.0/30 [90/2273792] via 172.16.234.1, 00:13:15, Serial1/0
D 192.168.4.0/24 [90/1889792] via 172.16.234.4, 00:12:42, Serial1/1
D 192.168.5.0/24 [90/21152000] via 172.16.32.3, 00:13:16, Serial1/1
    [90/21152000] via 172.16.234.3, 00:13:16, Serial1/0
D 192.168.1.0/24 [90/1889792] via 172.16.234.1, 00:13:16, Serial1/0
C 192.168.2.0/24 is directly connected, Loopback0
D 192.168.3.0/24 [90/1889792 via 172.16.32.3, 00:13:16, Serial1/1
    [90/1889792] via 172.16.234.3, 00:13:16, Serial1/0
```

Router 3

```
r3#sh ip ro
```

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172.16.0.0/16 is variably subnetted, 4 subnets, 2 masks
C  172.16.234.0/24 is directly connected, Serial1/0
C  172.16.32.0/24 is directly connected, Serial1/2
C  172.16.35.0/30 is directly connected, Serial1/3
C  172.16.31.0/30 is directly connected, Serial1/1
D  192.168.4.0/24 [90/21152000] via 172.16.32.2, 00:12:50, Serial1/2
    [90/21152000] via 172.16.234.2, 00:12:50, Serial1/0
D  192.168.5.0/24 [90/2681856] via 172.16.36.2, 00:13:20, Serial1/3
D  192.168.1.0/24 [90/21024000] via 172.16.31.1, 00:13:21, Serial1/1
D  192.168.2.0/24 [90/21024000] via 172.16.32.2, 00:12:21, Serial1/2
    [90/20640000] via 172.16.234.2, 00:13:21, Serial1/0
C  192.168.3.0/24 is directly connected, Loopback0

A. Router 4

R4#sh ip ro
172.16.0.0/16 is variably subnetted, 4 subnets, 2 masks
C  172.16.234.0/24 is directly connected, Serial0/0
D  172.16.32.0/24 [90/2681856] via 172.16.234.2, 00:12:56, Serial0/0
D  172.16.35.0/30 [90/21536000] via 172.16.234.2, 00:12:56, Serial0/0
D  172.16.31.0/30 [90/3193856] via 172.16.234.2, 00:12:56, Serial0/0
C  192.168.4.0/24 is directly connected, Loopback0
D  192.168.5.0/24 [90/21024000] via 172.16.234.2, 00:12:56, Serial0/0
D  192.168.1.0/24 [90/2809856] via 172.16.234.2, 00:12:58, Serial0/0
D  192.168.2.0/24 [90/2297856] via 172.16.234.2, 00:12:58, Serial0/0
D  192.168.3.0/24 [90/1889792] via 172.16.234.2, 00:12:48, Serial0/0

B. Router 5

R5#sh ip ro
192.16.0.0/16 is variably subnetted, 4 subnets, 2 masks
D  172.16.32.0/24 [90/21024000] via 172.16.35.1, 00:21:07, Serial0/0
C  172.16.35.0/30 is directly connected, Serial0/0
D  172.16.31.0/30 [90/21240000] via 172.16.35.1, 00:21:07, Serial0/0
D  192.168.4.0/24 [90/21664000] via 172.16.35.1, 00:13:07, Serial0/0
C  192.168.5.0/24 is directly connected, Loopback0
D  192.168.1.0/24 [90/21664000] via 172.16.35.1, 00:13:07, Serial0/0
D  192.168.2.0/24 [90/21520000] via 172.16.35.1, 00:20:14, Serial0/0
D  192.168.3.0/24 [90/1889792] via 172.16.35.1, 00:21:09, Serial0/0

C. Router 1

r1#sh run
interface Loopback0
  ip address 192.168.1.1 255.255.255.0
!
interface Ethernet0/0
  no ip address
  shutdown
  half-duplex
!
interface TokenRing0/0
  no ip address
  shutdown
  ring-speed 16
!
interface Serial1/0
  ip address 172.16.234.1 255.255.255.0
  encapsulation frame-relay
  frame-relay map ip 172.16.234.2 122 broadcast
  frame-relay map ip 172.16.234.3 122 broadcast
  frame-relay map ip 172.16.234.4 122 broadcast
  no frame-relay inverse-arp
!
interface Serial1/1
  ip address 172.16.31.1 255.255.255.252
  encapsulation frame-relay
  frame-relay interface-dlci 31
!
router eigrp 1
  network 172.16.0.0
  network 192.168.1.0
  no auto-summary
  no eigrp log-neighbor-changes

Router 2

r2#sh run
interface Loopback0
  ip address 192.168.2.2 255.255.255.0
!
interface BRIO/0
  no ip address
  shutdown
!
interface Ethernet0/0
  no ip address
  shutdown
half-duplex

!  
interface TokenRing0/0
   no ip address
   shutdown
   ring-speed 16

!  
interface Serial1/0
   ip address 172.16.234.2 255.255.255.0
   encapsulation frame-relay
   no ip split-horizon eigrp 1
   frame-relay map ip 172.16.234.1 221 broadcast
   frame-relay map ip 172.16.234.3 223 broadcast
   frame-relay map ip 172.16.234.4 224 broadcast
   no frame-relay inverse-arp
   frame-relay broadcast-queue 100 5120 100

!  
interface Serial1/1
   ip address 172.16.32.2 255.255.255.0
   encapsulation frame-relay
   frame-relay interface-dlci 32

!

Router 3

r3#sh run
frame-relay switching
!
interface Loopback0
   ip address 192.168.3.3 255.255.255.0
!
interface Ethernet0/0
   no ip address
   shutdown
   half-duplex
!
interface BRI0/0
   no ip address
   shutdown
!
interface Serial1/0
   ip address 172.16.234.3 255.255.255.0
   encapsulation frame-relay
   frame-relay map ip 172.16.234.1 322 broadcast
   frame-relay map ip 172.16.234.2 322 broadcast
frame-relay map ip 172.16.234.4 322 broadcast
no frame-relay inverse-arp
!
interface Serial1/1
  ip address 172.16.31.2 255.255.255.252
  encapsulation frame-relay
clockrate 64000
  frame-relay interface-dlci 31
  frame-relay intf-type dce
!
interface Serial1/2
  ip address 172.16.32.3 255.255.255.0
  encapsulation frame-relay
clockrate 64000
  frame-relay interface-dlci 32
  frame-relay intf-type dce
!
interface Serial1/3
  ip address 172.16.35.1 255.255.255.252
  encapsulation frame-relay IETF
clockrate 64000
  frame-relay interface-dlci 35
  frame-relay lmi-type ansi
  frame-relay intf-type dce
!
router eigrp 1
  network 172.16.0.0
  network 192.168.3.0
  no auto-summary
  no eigrp log-neighbor-changes

Router 4

r4#sh run
  interface Loopback0
    ip address 192.168.4.4 255.255.255.0
  !
  interface Ethernet0/0
    no ip address
    shutdown
    half-duplex
  !
  interface Serial0/0
    ip address 172.16.234.4 255.255.255.0

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encapsulation frame-relay
frame-relay map ip 172.16.234.1 422 broadcast
frame-relay map ip 172.16.234.2 422 broadcast
frame-relay map ip 172.16.234.3 422 broadcast
no frame-relay inverse-arp

! interface Serial0/0
   no ip address
   shutdown
!
router eigrp 1
   network 172.16.0.0
   network 192.168.4.0
   no auto-summary
   no eigrp log-neighbor-changes

Router 5

r4#sh run
interface Loopback0
   ip address 192.168.5.5 255.255.255.0
!
interface Ethernet0/0
   no ip address
   shutdown
   half-duplex
!
interface Serial0/0
   ip address 172.16.35.2 255.255.255.252
   encapsulation frame-relay IETF
   frame-relay interface-dlci 35
   frame-relay lmi-type ansi
!
interface TokenRing0/0
   no ip address
   shutdown
   ring-speed 16
!
interface Serial0/1
   no ip address
   shutdown
!
interface ATM1/0
   no ip address
   shutdown

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no atm ilmi-keepalive
!
router eigrp 1
    network 172.16.0.0
    network 192.168.5.0
    no auto-summary
    no eigrp log-neighbor-changes
Lab Preparation Scenario: OSPF

Topics Covered

- OSPF over Frame-Relay
- Stub Areas
- DR/BDR Election
- Virtual-links
- OSPF over ISDN
- Route Summarization
- OSPF Cost Calculation
- OSPF LSA Filtering

Difficulty Level: CCIE TM

Average Completion Time: 2 Hours

Standard Topology

Standard TCP/IP Addressing and SPID Information
R1 (3620)
Loop0 192.168.1.1 /24 Loopback
E0/0 172.16.136.1 /26 Ethernet Segment to Catalyst 3/1
T0/0 172.16.15.1 /28 Token Ring Segment to 3920
S1/0 172.16.31.1 /30 Serial to R3
S1/0 unassigned Frame-relay

R2 (3620)
Loop0 192.169.2.2 /24 Loopback
T0/0 172.16.2.2 /24 Token Ring Segment to 3920
BRI0/0 172.16.230.2 /24 BRI to R3
S1/1 172.16.32.2/24 Serial to R3
S1/0 unassigned Frame-relay

R3 (2610)
Loop0 192.168.3.3 /24 Loopback
E0/0 172.16.136.3 /26 Ethernet Segment to Catalyst 3/3
BRI0/0 172.16.230.3 /24 ISDN to R2
S1/3 172.16.35.1 /30 Serial to R5
S1/2 172.16.32.3/24 Serial to R2
S1/1 172.16.31.2/30 Serial to R1
S1/0 unassigned Frame-relay

R4 (2610)
Loop0 192.168.4.4 /24 Loopback
E0/0 10.1.4.4 /22 Ethernet Segment to BB1
S0/0 unassigned Frame-relay

R5 (3620)
Loop0 192.168.5.5 /24 Loopback
E0/0 172.16.136.5 /26 Ethernet Segment to Catalyst 3/5
T0/0 172.16.15.5 /28 Token Ring Segment to 3920
S0/0 172.16.35.2 /30 Serial link to R3
A1/0 172.16.56.5 /30 ATM – R6

R6 (3640)
Loop0 192.168.6.6 /24 Loopback
FA0/0 172.16.136.6 /26 Ethernet segment – R2
E2/0 10.2.6.6 /23 Ethernet segment – BB2
A1/0 172.16.56.6 /30 ATM – R5

ISDN Information
Switch Type Basic-NI1
R2
SPID1: 42255501210101
SPID2: 42255501220101

R3
SPID1: 42255501310101
SPID2: 42255501320101

Technical Tasks

A. Configure the frame-relay interfaces in the OSPF backbone area.
   Do not use any DLCI’S other than those necessary to make R3 the hub with R1, R2, and R4 as spokes.
   Do not create any sub-interfaces.
   Use the default OSPF network type.
   Use IP addresses from subnet 172.16.234.0/29.
B. Configure subnets 172.16.32.0/25 and 172.16.230.0/24 in the backbone area.
   The ISDN circuit should suppress the OSPF hello protocol.
C. Configure subnet 172.16.136.0/26 as area 1.
   All four routers (R1, R3, R5, and R6) should participate.
   All routers must be capable of becoming the DR.
   R5 should be the DR under normal circumstances.
D. Configure subnet 172.16.2.0/24 in area 2.
E. Configure subnets 172.16.15.0/28 and 172.16.35.0/30 in area 1.
F. Configure subnet 172.16.31.0/30 in area 31.
G. Configure subnet 10.1.4.0/22 in area 4.
   Non-Cisco routers with limited cpu and memory capacity may be added to this subnet at a later time.
H. Configure subnet 10.2.6.0/23 as area 6.
   Some routers in area 6 could be generating type 6 LSA’s.
   Configure R6 to disregard this traffic.
   Configure R6 to accurately differentiate between 100M and 1000M links.
I. Ensure that R2 and R4 have entries for 172.16.136.0/24 in their routing tables.
J. Configure loopback Interfaces in whatever area you deem appropriate.
   Loopback interfaces should not appear as host routes.

All subnets must be reachable from all routers.

Instructor’s Comments and Technical Tips

A. You will need to use frame-relay map statements.
   The default OSPF network type is NBMA.
   You cannot use any other DLCI’s so remember to disable inverse-arp-
You also need to prevent the spokes from becoming the DR/BDR.
Finally, you must manually configure neighbors at R3.
B. You have to configure OSPF demand-circuit.
   This command goes on one router only.
C. Configure a higher priority on R5.
D. N/A.
E. N/A.
F. N/A.
G. Low-end routers would benefit from stub configuration.
   Totally-stubby areas are applicable in pure Cisco environments.
H. Number of issues here.
   You will need a virtual-link to support area 6.
   This can point to R3 or R1.
   You need to adjust the reference-bandwidth to account for Gigabit.
   100 is the default.
   When this value is changed on one router, it should be changed on all routers.
   You also need to use the “Ignore” command to disregard M OSPF – Type 6 LSA’s.
I. This requires a summarization statement on multiple routers.
   You would place it on multiple routers incase of a single router failure.
J. “Loopback” is a special OSPF network type that produces a host route.
   At the interface level you can modify the network type to alter this behavior.
   This option may not be available on all routers or code levels.

Technical Verification

Technical Verification A

r3#sh ip on

<table>
<thead>
<tr>
<th>Neighbor ID</th>
<th>Pri</th>
<th>State</th>
<th>Dead Time</th>
<th>Address</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>192.168.4.4</td>
<td>0</td>
<td>FULL/DROTHER</td>
<td>00:01:56</td>
<td>172.16.234.4</td>
<td>Serial1/0</td>
</tr>
<tr>
<td>192.168.2.2</td>
<td>0</td>
<td>FULL/DROTHER</td>
<td>00:01:55</td>
<td>172.16.234.2</td>
<td>Serial1/0</td>
</tr>
<tr>
<td>192.168.1.1</td>
<td>0</td>
<td>FULL/DROTHER</td>
<td>00:01:56</td>
<td>172.16.234.1</td>
<td>Serial1/0</td>
</tr>
</tbody>
</table>

Technical Verification B

r3#sh run | begin BRI0/0
interface BRI0/0
   ip address 172.16.230.3 255.255.255.0
   encapsulation ppp
   ip ospf demand-circuit
   dialer idle-timeout 300
   dialer map ip 172.16.230.2 name r2 broadcast 5550121
   dialer-group 1

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isdn switch-type basic-ni
isdn spid1 42255501310101 5550131
isdn spid2 42255501320101 5550132
ppp authentication chap

Technical Verification C

r5#sh ip o int e0/0
Ethernet0/0 is up, line protocol is up
Internet Address 172.16.136.5/26, Area 1
    Process ID 1, Router ID 192.168.5.5, Network Type BROADCAST, Cost: 100
    Transmit Delay is 1 sec, State DR, Priority 2
    Designated Router (ID) 192.168.5.5, Interface address 172.16.136.5
    Backup Designated Router (ID) 192.168.6.6 Interface address 172.16.136.6
    Timer Intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:04
    Index 1/1, flood queue length 0
    Next 0x0(0)/0x0(0)
    Last flood scan length is 0, maximum is 7
    Last flood scan time is 0 msec, maximum is 0 msec
    Neighbor Count is 3, Adjacent neighbor count is 3
    Adjacent with neighbor 192.168.1.1
    Adjacent with neighbor 192.168.3.3
    Adjacent with neighbor 192.168.6.6 (Backup Designated Router)
    Suppress hello for 0 neighbors(s)

Technical Verification D

r2#sh ip o int to 0/0
TokenRing0/0 is up, line protocol is up
Internet Address 172.16.2.2/24, Area 2
    Process ID 1, Router ID 192.168.2.2, Network Type BROADCAST, Cost: 62
    Transmit Delays is 1 sec, State DR, Priority 1
    Designated Router (ID) 192.168.2.2, Interface address 172.16.2.2
    No backup designated router on this network
    Timer intervals configured, Hello 10, Dead 40, Wait 50, Retransmit 5
    Hello due in 00:00:04
    Index 1/4, flood queue length 0
    Next 0x0(0)/0x0(0)
    Last flood scan length is 0, maximum is 0
    Last flood scan time is 0 msec, maximum is 0 msec
    Neighbor Count is 0, Adjacent neighbor count is 0
    Suppress hello for 0 neighbors(s)
Technical Verification E

r5#sh ip o int to 0/0
TokenRing0/0 is up, line protocol is up
Internet Address 172.16.15.5/28, Area 1
Process ID 1, Router ID 192.168.5.5, Network Type BROADCAST, Cost: 62
Transmit Delay is 1 sec, State DR, Priority 1
Designated Router (ID) 192.168.5.5, Interface address 172.16.15.5
Backup Designated router (ID) 192.168.1.1, Interface address 172.16.15.1
Timer Intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
   Hello due in 00:00:04
Index 3/3, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 13
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
   Adjacent with neighbor 192.168.1.1 (Backup Designated Router)
Suppress hello for 0 neighbor(s)

r5#sh ip o int s0/0
Serial0/0 is up, line protocol is up
Internet Address 172.16.35.2/30, Area 1
Process ID 1, Router ID 192.168.5.5, Network Type POINT_TO_POINT, Cost: 488
Transmit Delay is 1 sec, State POINT_TO_POINT,
Timer Intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
   Hello due in 00:00:02
Index 2/2 flood queue length 0
Next flood scan length is 1, maximum is 13
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
   Adjacent with neighbor 192.168.3.3
Suppress hello for 0 neighbors(s)

Technical Verification F

r1# ip o int s1/1
Serial1/1 is up, line protocol is up
Internet Address 172.16.31.1/30, Area 31
Process ID 1, Router ID 192.168.1.1, Network Type POINT_TO_POINT, Cost: 488
Transmit Delay is 1 sec, State POINT_TO_POINT,
Timer Intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
   Hello due in 00:00:00
Index 1/4, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 11
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 192.168.3.3
Suppress hello for 0 neighbors(s)

Technical Verification G

r4# sh ip o int e0/0
Ethernet0/0 is up, line protocol is up
  Internet Address 10.1.4.4/22, Area 4
  Process ID 1, Router ID 192.168.4.4, Network Type BROADCAST, Cost: 100
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 192.168.4.4, Interface address 10.1.4.4.
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:02
Index 1/2 flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 0, maximum is 0
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 0, Adjacent neighbor count is 0
Suppress hello for 0 neighbors(s)

r4#sh ip o
Routing Process “ospf 1” with ID 192.168.4.4 and Domain ID 0.0.0.1
  Supports only single TOS(TOSO) routes
  Supports opaque LSA
  It is an area border Router
  SPF schedule delay 5 secs, Hold time between two SPF's 10 secs
  Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
  Number of external LSA 0. Checksum Sum 0x0
  Number of opaque AS LSA 0. Checksum Sum 0x0
  Number of DCbitless external and opaque AS LSA 0
  Number of DoNotAge external and opaque AS LSA 0
  Number of areas in this router is 2. 1 normal 1 stub 0 nssa
  External flood list length is 0
  Area BACKBONE(0)
    Number of interfaces in this area is 2
    Area has no authentication
    SPF algorithm executed 31 times
    Area ranges are
    Number of LSA 26. Checksum Sum 0xD51A8
Number of opaque link LSA 0. Checksum Sum 0x0
Number of DCbitless LSA 0
Number of indication LSA 0
Number of DoNotAge LSA 7
Flood list length 0

**Area 4**

Number of interfaces in this area is 1

*It is a stub area*
- generates stub default route with cost 1
- Area has no authentication
- SPF algorithm executed 3 times
- Area ranges are
- Number of LSA 18. Checksum Sum 0x9E2D1
- Number of opaque link LSA 0. Checksum Sum 0x0
- Number of DCbitless LSA 0
- Number of indication LSA 0
- Number of DoNotAge LSA 0
- Flood list length 0

**Technical Verification H**

r6# sh ip o int e2/0
Ethernet2/0 is up, line protocol is up
  Internet Address 10.2.6.6/23, **Area 6**

  Process ID 1, Router ID 192.168.6.6, Network Type BROADCAST, Cost: 100
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 192.168.6.6, Interface address 10.2.6.6
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:04
  Index 1/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 0
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbors(s)

**Technical Verification I**

r2# sh ip ro 172.16.136.0 255.255.255.0
Routing entry for 172.16.136.0/24
  Known via “ospf 1″, distance 110, metric 588, type inter area
  Last update from 172.16.234.3 on Serial1/0, 00:47:38 ago
  Routing Descriptor Blocks:
Technical Verification J

Routing tables of all routers are included here. The legend normally provided in router output has been deleted.

Router 1

r1#sh ip ro

Gateway of last resort is not set

172.16.0.0&26 is variably subnetted, 9 subnets, 5 masks

O  172.16.136.0/24 is a summary, 00:48:20, Null0
C  172.16.136.0/26 is directly connected, Ethernet0/0
C  172.15.234.0/29 is directly connected, Serial1/0
O  172.16.230.0/24 [110/16113] via 172.16.234.3, 00:49:10, Serial1/0
    [110/16113] via 172.16.234.2, 00:48:10, Serial1/0
O  172.16.32.0/24 [110/976] via 172.16.234.2, 00:49:10, Serial1/0
O  172.16.35.0/30 [110/550] via 172.16.15.5, 00:49:20, TokenRing0/0
C  172.16.31.0/30 is directly connected, Serial1/1
C  172.16.15.0/28 is directly connected, TokenRing0/0
O IA 172.16.2.0/24 [110/550] via 172.16.234.2, 00:49:11, Serial1/1
O  192.168.4.0/24 [110/489] via 172.234.4, 00:49:11, Serial1/0
O  192.168.5.0/24 [110/63] via 172.16.234.3, 00:49:13, Serial1/0

10.0.0.0/0 is variably subnetted, 2 subnets, 2 masks
O IA 10.2.6.0/23 [110/688] via 172.16.234.3, 00:49:13, Serial1/0
O IA 10.1.4.0/22 [110/588] via 172.16.124.4, 00:49:13, Serial1/0
O  192.168.6.0/24 [110/101] via 172.16.136.6, 00:49:23, Ethernet0/0

C  192.168.1.0/24 is directly connected, Loopback0
O  192.168.2.0/24 [110/489] via 172.16.234.2, 00:49:13, Serial1/0
O  192.168.3.0/24 [110/589] via 172.16.234.3, 00:49:13, Serial1/0

D. Router 2

r2#sh ip ro

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Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 9 subnets, 5 masks
O IA  172.16.136.0/26 [110/598] via 172.16.234.3, 00:50:32, Serial1/0
     [110/598] via 172.16.32.3, 00:50:32, Serial1/1
O IA  172.16.136.0/24 [110/588] via 172.16.234.1, 00:50:32, Serial1/0
     [110/588] via 172.16.32.3, 00:50:32, Serial1/1
     [110/588] via 172.16.234.3, 00:50:32, Serial1/0
C  172.16.234.0/29 is directly connected, Serial1/0
C  172.16.230.0/29 is directly connected, BRIO/0
C  172.16.32.0/24 is directly connected, Serial1/1
O IA  172.16.35.0/30 [110/1038] via 172.16.234.1 00:50:33, Serial1/0
O IA  172.16.31.0/30 [110/976] via 172.16.234.1, 00:50:33, Serial1/0
O IA  172.16.15.0/28 [110/550] via 172.16.234.1, 00:50:33, Serial1/0
C  172.16.2.0/24 is directly connected, TokenRing0/0
O IA  192.168.4.0/24 [110/489] via 172.16.234.4, 00:50:34, Serial1/0
O IA  192.168.5.0/24 [110/551] via 172.16.234.1, 00:50:34, Serial1/0
     172.16.2.0/24 is directly connected, BRIO/0
     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O IA  10.2.6.0/23 [110/688] via 172.16.234.3, 00:50:34, Serial1/0
     [110/688] via 172.16.32.3, 00:50:34, Serial1/1
O IA  10.1.4.0/22 [110/589] via 172.16.234.1, 00:50:34, Serial1/0
     [110/589] via 172.16.32.3, 00:50:34, Serial1/1
     [110/589] via 172.16.234.3, 00:50:34, Serial1/0
O IA  192.168.1.0/24 [110/489] via 172.16.234.1 00:50:34, Serial1/0
C  192.168.2.0/24 is directly connected, Loopback0
O IA  192.168.3.0/24 [110/489] via 172.16.32.3, 00:50:34, Serial1/0
     [110/489] via 172.16.234.3, 00:50:34, Serial1/0

Router 3

r3#sh ip ro

Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 9 subnets, 5 masks
O  172.16.136.0/24 is a summary, 00:51:20, Null0
C  172.16.136.0/26 is directly connected, Ethernet0/0
C  172.16.234.0/29 is directly connected, Serial1/0
C  172.16.230.0/29 is directly connected, BRIO/0
C  172.16.32.0/24 is directly connected, Serial1/2
C  172.16.35.0/30 is directly connected, Serial1/3
C  172.16.31.0/30 is directly connected, Serial1/1
O  172.16.15.0/28 [110/162] via 172.16.136.5, 00:51:21, Ethernet0/0
     [110/162] via 172.16.136.1, 00:51:21, Ethernet0/0
O IA  172.16.2.0/24 [110/7874] via 172.16.32.2, 00:51:11, Serial1/2

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[110/7874] via 172.16.234.2, 00:51:11, Serial1/0
O 192.168.4.0/24 [110/7813] via 172.16.234.4, 00:51:11, Serial1/0
O 182.168.5.0/24 [110/101] via 172.16.136.5, 00:51:22, Ethernet0/0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O IA 10.2.6.0/23 [110/200] via 172.16.136.6, 00:51:12, Ethernet0/0
O IA 10.1.4.0/22 [110/7012] via 172.16.234.4, 00:51:12, Serial1/0
O 192.168.6.0/24 [110/101] via 172.16.136.6, 00:51:22, Ethernet0/0
O 192.168.1.0/24 [110/7813] via 172.16.234.1, 00:51:12, Serial1/0
O 192.168.2.0/24 [110/7813] via 172.16.32.2, 00:51:12, Serial1/2
[110/7813] via 172.16.234.2, 00:51:12, Serial1/0
C 192.168.3.0/24 is directly connected, Loopback0

Router 4

rr#sh ip ro
172.16.0.0/16 is variably subnetted, 9 subnets, 5 masks
O IA 172.16.136.0/26 [110/757] via 172.16.234.3, 00:51:29, Serial0/0
O IA 172.16.136.0/24 [110/747] via 172.16.234.1, 00:51:29, Serial0/0
[110/747] via 172.16.234.3, 00:51:29, Serial0/0
C 172.16.234.0/29 is directly connected, Serial0/0
O 172.16.230.0/24 [110/16272] via 172.16.234.3, 00:51:29, Serial0/0
[110/16272] via 172.16.234.2, 00:51:29, Serial0/0
O 172.16.32.0/24 [110/1135] via 172.16.234.2, 00:51:30, Serial0/0
O IA 172.16.35.0/30 [110/1197] via 172.16.234.1, 00:51:30, Serial0/0
O IA 172.16.31.0/30 [110/1135] via 172.16.234.1, 00:51:30, Serial0/0
O IA 172.16.15.0/28 [110/709] via 172.16.234.1, 00:51:30, Serial0/0
O IA 172.16.2.0/24 [110/709] via 172.16.234.2, 00:51:30, Serial0/0
C 192.168.4.0/24 is directly connected, Loopback0
O IA 192.168.5.0/24 [110/710] via 172.16.234.2, 00:51:30, Serial0/0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O IA 10.2.6.0/23 [110/847] via 172.16.234.3, 00:51:31, Serial0/0
C 10.1.4.0/22 is directly connected, Ethernet0/0
O IA 192.168.6.0/24 [110/748] via 172.16.234.1, 00:51:31, Serial0/0
[110/748] via 172.16.234.3, 00:51:31, Serial0/0
O 192.168.1.0/24 [110/648] via 172.16.234.1, 00:51:31, Serial0/0
O 192.168.2.0/24 [110/648] via 172.16.234.2, 00:51:31, Serial0/0
O 192.168.3.0/24 [110/648] via 172.16.234.3, 00:51:31, Serial0/0

Router 5

r5#sh ip ro
Gateway of last resort is not set
172.16.0.0/16 is variably subnetted, 9 subnets, 5 masks

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O IA 172.16.136.0/24 [110/210] via 172.16.136.6, 00:52:20, Ethernet0/0
C 172.16.136.0/26 is directly connected, Ethernet0/0
O IA 172.16.234.0/29 [110/550] via 172.16.15.1, 00:52:20, TokenRing0/0
O IA 172.16.230.0/24 [110/15725] via 172.16.136.3, 00:52:20, Ethernet0/0
O IA 172.16.32.0/24 [110/1038] via 172.16.15.1, 00:52:20, TokenRing0/0
C 172.16.35.0/30 is directly connected, Serial0/0
O IA 172.16.2.0/24 [110/612] via 172.16.15.1, 00:52:22, TokenRing0/0
O IA 192.168.4.0/24 [110/551] via 172.16.15.1, 00:52:22, TokenRing0/0
C 192.168.5.0/24 is directly connected, Loopback0

10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O IA 10.2.6.0/23 [110/200] via 172.16.136.6, 00:52:28, Ethernet0/0
O IA 10.1.4.0/22 [110/650] via 172.16.15.1, 00:52:23, TokenRing0/0
O 192.168.6.0/24 [110/101] via 172.16.136.6, 00:52:38, Ethernet0/0
O IA 192.168.1.0/24 [110/63] via 172.16.15.1, 00:52:23, TokenRing0/0
O IA 192.168.2.0/24 [110/551] via 172.16.15.1, 00:52:23, TokenRing0/0
O IA 192.168.3.0/24 [110/101] via 172.16.136.3, 00:52:23, Ethernet0/0

Router 6

r6#sh ip ro

Gateway of last resort is not set

172.16.0.0/16s is variably subnetted, 9 subnets, 5 masks
O IA 172.16.136.0/24 [110/110] via 172.16.136.3, 00:52:45, FastEthernet0/0
O 172.16.136.0/26 is directly connected, FastEthernet0/0
O 172.16.234.0/29 [110/7822] via 172.16.136.3, 00:52:45, FastEthernet0/0
O 172.16.230.0/24 [110/15635] via 172.16.136.3, 00:52:45, FastEthernet0/0
O 172.16.32.0/24 [110/7822] via 172.16.136.3, 00:52:45, FastEthernet0/0
O 172.16.35.0/30 [110/498] via 172.16.136.5, 00:52:55, FastEthernet0/0
O IA 172.16.15.0/28 [110/72] via 172.16.136.5, 00:52:55, FastEthernet0/0
O IA 172.16.136.0/24 [110/110] via 172.16.136.3, 00:52:45, FastEthernet0/0
O 172.16.136.0/26 is directly connected, FastEthernet0/0
O 172.16.234.0/29 [110/7822] via 172.16.136.3, 00:52:45, FastEthernet0/0
O 172.16.32.0/24 [110/7822] via 172.16.136.3, 00:52:45, FastEthernet0/0
O 172.16.35.0/30 [110/498] via 172.16.136.5, 00:52:55, FastEthernet0/0
O IA 172.16.15.0/28 [110/72] via 172.16.136.5, 00:52:55, FastEthernet0/0
O 10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O IA 10.2.6.0/23 [110/200] via 172.16.136.6, 00:52:28, Ethernet0/0
O IA 10.1.4.0/22 [110/650] via 172.16.15.1, 00:52:23, TokenRing0/0
O 10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O IA 10.2.6.0/23 [110/200] via 172.16.136.6, 00:52:28, Ethernet0/0
O IA 10.1.4.0/22 [110/650] via 172.16.15.1, 00:52:23, TokenRing0/0

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Configuration Verification

Only relevant portions of the configuration have been included.

Router 1

r1#sh run

interface Loopback0
  ip address 192.168.1.1 255.255.255.0
  ip ospf network point-to-point

interface Ethernet0/0
  ip address 172.16.136.1 255.255.255.192
  half-duplex

interface TokenRing0/0
  ip address 172.16.15.1 255.255.255.240
  ring-speed 16

interface Serial1/0
  ip address 172.16.234.1 255.255.255.248
  encapsulation frame-relay
  ip ospf priority 0
  frame-relay map ip 172.16.234.2 133 broadcast
  frame-relay map ip 172.16.234.3 133 broadcast
  frame-relay map ip 172.16.234.4 133 broadcast
  no frame-relay inverse-arp

interface Serial1/1
  ip address 172.16.31.1 255.255.255.252

router ospf 1
  log-adjacency-changes
  auto-cost reference-bandwidth 1000
  area 1 range 172.16.136.0 255.255.255.0
  network 172.16.15.0 0.0.0.15 area 1
Router 2

r2# sh run
interface Loopback0
  ip address 192.168.2.2 255.255.255.0
  ip ospf network point-to-point

interface BRI0/0
  ip address 172.16.230.2 255.255.255.0
  encapsulation ppp
  dialer idle-timeout 300
  dialer map ip 172.16.230.3 name r3 broadcast 5550131
  dialer-group 1
  isdn switch-type basic-ni
  isdn sid1 42255501210101 5550121
  isdn sid2 42255501220101 5550122
  ppp authentication chap

interface Ethernet0/0
  no ip address
  shutdown
  half-duplex

interface TokenRing0/0
  ip address 172.16.2.2 255.255.255.0
  ring-speed 16

interface Serial1/0
  ip address 172.16.234.2 255.255.255.248
  encapsulation frame-relay
  ip ospf priority 0
  frame-relay map ip 172.16.234.1 233 broadcast
  frame-relay map ip 172.16.234.3 233 broadcast
  frame-relay map ip 172.16.234.4 233 broadcast
  no frame-relay inverse-arp

interface Serial1/1
  ip address 172.16.32.2 255.255.255.0
router ospf 1
log-adjacency-changes
auto-cost reference-bandwidth 1000
network 172.16.2.0 0.0.0.255 area 2
network 172.16.32.0 0.0.0.255 area 0
network 172.16.230.0 0.0.0.255 area 0
network 172.16.234.0 0.0.0.7 area 0
network 192.168.2.0 0.0.0.255 area 0

**Router 3**

r3#sh run

interface Loopback0
  ip address 192.168.3.3 255.255.255.0
  ip ospf network point-to-point
!
interface Ethernet0/0
  ip address 172.136.3 255.255.255.192
  half-duplex
!
interface BRI0/0
  ip address 172.16.230.3 255.255.255.0
  encapsulation ppp
  ip ospf demand-circuit
  dialer idle-timeout 300
  dialer map ip 172.16.230.2 name r2 broadcast 5550121
dialer-group 1
  isdn switch-type basic-ni
  isdn spid1 42255501310101 5550131
  isdn spid2 42255501320101 5550132
  ppp authentication chap
!
interface Serial1/0
  ip address 172.16.234.3 255.255.255.248
  encapsulation frame-relay
  frame-relay map ip 172.16.234.1 331 broadcast
  frame-relay map ip 172.16.234.2 322 broadcast
  frame-relay map ip 172.16.234.4 334 broadcast
  no frame-relay inverse-arp
!
interface Serial1/1
  ip address 172.16.31.2 255.255.255.252
  clockrate 64000

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interface Serial1/2
  ip address 172.16.32.3 255.255.255.0
clockrate 64000
!
interface Serial1/3
  ip address 172.16.35.1 255.255.255.252
clockrate 64000
!
router ospf 1
  log-adjacency-changes
  auto-cost reference-bandwidth 1000
  area 1 range 172.16.136.0 255.255.255.0
  area 1 virtual-link 192.168.6.6
  network 172.16.31.0 0.0.0.3 area 31
  network 172.16.32.0 0.0.0.255 area 0
  network 172.16.35.0 0.0.0.3 area 1
  network 172.16.136.0 0.0.0.63 area 1
  network 172.16.230.0 0.0.0.255 area 0
  network 172.16.234.0 0.0.0.7 area 0
  network 192.168.3.0 0.0.0.255 area 0
  neighbor 172.16.234.4
  neighbor 172.16.234.2
  neighbor 172.16.234.1

Router 4

r4#sh run

interface Loopback0
  ip address 192.168.4.4 255.255.255.0
  ip ospf network point-to-point
!
interface Ethernet0/0
  ip address 10.1.4.4 255.255.252.0
  half-duplex
!
interface Serial0/0
  ip address 172.16.234.4 255.255.255.248
  encapsulation frame-relay
  ip ospf priority 0
  frame-relay map ip 172.16.234.1 433 broadcast
  frame-relay map ip 172.16.234.2 433 broadcast
  frame-relay map ip 172.16.234.3 433 broadcast

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no frame-relay inverse-arp
!
interface Serial0/1
  no ip address
  shutdown
!
router ospf 1
  log-adjacency-changes
  auto-cost reference-bandwidth 1000
  area 4 stub
  network 10.1.4.0 0.0.3.255 area 4
  network 172.16.234.0 0.0.0.7 area 0
  network 192.168.4.0 0.0.0.255 area 0

Router 5

r5#sh run

interface Loopback0
  ip address 192.168.5.5 255.255.255.0
  ip ospf network point-to-point
!
interface Ethernet0/0
  ip address 172.16.136.5 255.255.255.192
  ip ospf priority 2
  half-duplex
!
interface Serial0/0
  ip address 172.16.35.2 255.255.255.252
!
interface TokenRing0/0
  ip address 172.16.15.5 255.255.255.240
  ring-speed 16
!
interface Serial0/1
  no ip address
  shutdown
!
interface ATM1/0
  no ip address
  shutdown
  no atm ilmi-keepalive
!
router ospf1
log-adjacency-changes
auto-cost reference-bandwidth 1000
area 1 range 172.16.136.0 255.255.255.0
network 172.16.15.0 0.0.0.15 area 1
network 172.16.35.0 0.0.0.3 area 1
network 172.16.136.0 0.0.0.63 area 1
network 192.168.5.0 0.0.0.255 area 1

Router 6

r6#sh run

interface Loopback0
 ip address 192.168.6.0 255.255.255.0
 no ip directed-broadcast
 ip ospf network point-to-point
!
interface FastEthernet0/0
 ip address 172.16.136.6 255.255.255.192
 no ip directed-broadcast
duplex auto
 speed auto
!
interface ATM1/0
 no ip address
 no ip directed-broadcast
 shutdown
 no atm ilmi-keepalive
!
interface Ethernet2/0
 ip address 10.2.6.6 255.255.254.0
 no ip directed-broadcast
!
router ospf 1
 ignore lsa mospf
 auto-cost reference-bandwidth 1000
area 1 virtual-link 192.168.3.3
network 10.2.6.0 0.0.1.255 area 6
network 172.16.136.0 0.0.0.63 area 1
network 192.168.0 0.0.0.255 area 1
Lab Preparation Scenario: IGRP/EIGRP

Topics Covered

- Classful/Classless routing
- Split-Horizon
- EIGRP Summarization
- Route Redistribution
- Default-Networks for IGRP
- EIGRP over Frame-Relay

Difficulty Level: CCIE TM

Average Completion Time: 2 Hours

Standard Topology

Standard TCP/IP Addressing and SPID Information

R1 (3620)
<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Subnet Mask</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.1.1</td>
<td>/24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E0/0</td>
<td>172.16.136.1</td>
<td>/26</td>
<td>Ethernet Segment to Catalyst 3/1</td>
</tr>
<tr>
<td>T0/0</td>
<td>172.16.15.1</td>
<td>/28</td>
<td>Token Ring Segment to 3920</td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.31.1</td>
<td>/30</td>
<td>Serial to R3</td>
</tr>
<tr>
<td>S1/1</td>
<td></td>
<td></td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

**R2 (3620)**

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Subnet Mask</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.2.2</td>
<td>/24</td>
<td>Loopback</td>
</tr>
<tr>
<td>T0/0</td>
<td>172.16.2.2</td>
<td>/24</td>
<td>Token Ring Segment to 3920</td>
</tr>
<tr>
<td>BRI0/0</td>
<td>172.16.230.2</td>
<td>/24</td>
<td>BRI to R3</td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.32.2</td>
<td>/24</td>
<td>Serial to R3</td>
</tr>
<tr>
<td>S1/0</td>
<td></td>
<td></td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

**R3 (2610)**

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Subnet Mask</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.3.3</td>
<td>/24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E0/0</td>
<td>172.16.136.3</td>
<td>/26</td>
<td>Ethernet Segment to Catalyst 3/3</td>
</tr>
<tr>
<td>BRI0/0</td>
<td>172.16.230.3</td>
<td>/24</td>
<td>ISDN to R2</td>
</tr>
<tr>
<td>S1/3</td>
<td>172.16.35.1</td>
<td>/30</td>
<td>Serial to R5</td>
</tr>
<tr>
<td>S1/2</td>
<td>172.16.32.3</td>
<td>/24</td>
<td>Serial to R2</td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.31.2</td>
<td>/30</td>
<td>Serial to R1</td>
</tr>
<tr>
<td>S1/0</td>
<td></td>
<td></td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

**R4 (2610)**

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Subnet Mask</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.4.4</td>
<td>/24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E0/0</td>
<td>10.1.4.4</td>
<td>/22</td>
<td>Ethernet Segment to BB1</td>
</tr>
<tr>
<td>S0/0</td>
<td></td>
<td></td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

**R5 (3620)**

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Subnet Mask</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.5.5</td>
<td>/24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E0/0</td>
<td>172.16.136.5</td>
<td>/26</td>
<td>Ethernet Segment to Catalyst 3/5</td>
</tr>
<tr>
<td>T0/0</td>
<td>172.16.15.5</td>
<td>/28</td>
<td>Token Ring Segment to 3920</td>
</tr>
<tr>
<td>S0/0</td>
<td>172.16.35.2</td>
<td>/30</td>
<td>Serial link to R3</td>
</tr>
<tr>
<td>A1/0</td>
<td>172.16.56.5</td>
<td>/30</td>
<td>ATM - R6</td>
</tr>
</tbody>
</table>

**R6 (3640)**

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Subnet Mask</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.6.6</td>
<td>/24</td>
<td>Loopback</td>
</tr>
<tr>
<td>FA0/0</td>
<td>172.16.136.6</td>
<td>/26</td>
<td>Ethernet segment - R2</td>
</tr>
<tr>
<td>E2/O</td>
<td>172.16.136.6</td>
<td>/26</td>
<td>Ethernet segment - R2</td>
</tr>
<tr>
<td>E2/O</td>
<td>10.2.6.6</td>
<td>/23</td>
<td>Ethernet segment - BB2</td>
</tr>
<tr>
<td>A1/0</td>
<td>172.16.58.6</td>
<td>/30</td>
<td>ATM - R5</td>
</tr>
</tbody>
</table>

**ISDN Information**

Switch Type: Basic-NI1
Lab Technical Tasks

A. Configure the frame-relay cloud with two point-to-point PVC’s as follows:

<table>
<thead>
<tr>
<th>Routers</th>
<th>DLCI’s</th>
<th>Subnet</th>
</tr>
</thead>
<tbody>
<tr>
<td>R2 – R3</td>
<td>223 – 322</td>
<td>172.16.23.0/30</td>
</tr>
<tr>
<td>RR – R1</td>
<td>221 – 122</td>
<td>172.16.21.0/30</td>
</tr>
</tbody>
</table>

Configure R3 – R4 using DLCI’s 224 – 422.
On R4 do not create any sub-interfaces.
Do not use any DLCI’s other than those specified.

B. Using AS 24, enable IGRP on all interfaces of R4.

C. Using AS 304 enable EIGRP on all other interfaces in your network except ISDN, ATM, and the loopback of R6.
The loopback of R6 must be in the routing table of R2 as an external route.
Do not send EIGRP traffic on subnets where it is not necessary.

D. Configure your network such that R4 has nine subnets in its routing table within the 172.16.0.0 network.
Ensure that your solution does not create any additional routes on R1 or R3.

E. Using one static route, make R2 is the gateway of last resort for R4.
Do not configure a static route to the all zeroes network.

F. You should have full routing from all routers.

All subnets/interfaces that participate in IGRP/EIGRP must be reachable from all routers.

Lab Instructor’s Comments and Technical Tips

A. You can create sub-interfaces on all routers except R4.
R4 will be a multiport interface.

B. Although not specifically called for, you will need to enable IGRP on R2 also.
Be sure to use the passive-interface command on R2 to avoid sending periodic updates to R1 and R3.

C. Use the passive-interface command on segments with no other EIGRP speakers.
The loopback of R6 must be redistributed into EIGRP.
Connected interfaces do not need a default-metric.

D. You need to summarize the subnets to a 24-bit mask to allow them to be advertised to R4.
This can be accomplished on R2 by adding ip summary-address statements to the loopback interface.
This will create routes to the null0 interface in the routing table of R2.
The routes will then be redistributed into IGRP.

You may have a problem with R2’s route to 192.168.6.0/24.
If R2 believes the next-hop is 172.16.24.4, then R4 is echoing the route back to R2.
This is caused by split-horizon being disabled on the physical interface of R4, which is the default for frame-relay.

E. You can use a default-network statement on R4.
   You should point to a classful network if possible, the loopback in this case.
F. You need to configure redistribution on R2.
   If the AS numbers were the same, the redistribution would be automatic.

Lab Technical Verification

Technical Verification For Task A

```
r1#sh fram map
Serial1/0.21(up): point-to-point dclci, dclci 122(0x7A,01CA0), broadcast
   status defined, active
```

```
r2#sh fram map
Serial1/0.24(up): point-to-point dclci, dclci 224(0xE0,0x3800], broadcast
   status defined, active
Serial1/0.21(up): point-to-point dclci, dclci 221(0xDD,0x34D0), broadcast
   status defined, active
Serial1/0.23(up): point-to-point dclci, dclci 223(0xDF,0x34F0), broadcast
   status defined, active
```

```
r3#sh fram map
Serial1/0.23(up): point-to-point dclci, dclci 322(0x142,0x5020), broadcast
   status defined, active
```

```
r4#sh fram map
Serial0/0(up): ip 172.16.24.2 dclci 422(0x1A6,0x6860), static,
   broadcast,
   CISCO, status defined, active
```

Technical Verification For Task B

```
r4#sh ip protocols
Routing Protocol is “igrp 24”
   Sending updates every 90 seconds, next due in 22 seconds
```
Invalid after 270 seconds, hold down 280, flushed 630
Outgoing update filter list for all interfaces is
Incoming update filter list for all interfaces is
Default networks flagged in outgoing updates
Default networks accepted from incoming updates
IGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
IGRP maximum hopcount 100
IGRP maximum metric variance 1
Redistributing: igrp 24

**Routing for Networks:**
- 10.0.0.0
- 172.16.0.0
- 192.168.4.0

**Routing Information Sources:**
- Gateway: 172.16.24.2
- Distance: 100
- Last Update: 00:00:48

Distance: (default is 100)

**Technical Verification For Task C**

```bash
r3#sh ip e i neighbors
IP-EIGRP neighbors for process 304
H    Address      Interface  Hold Uptime  SRTT   RTC  Q Seq Type
     (sec)         (ms)      Cnt Num
 6   172.16.136.5  E1/0/0    13 00:15:25  5  200 0 191
 5   172.16.35.2   Se1/3     10 00:15:26  36 1140 0 192
 4   172.16.35.1   Se1/1     14 00:15:26  40 1140 0 310
 3   172.16.136.1  E1/0/0    12 00:15:27  5  200 0 309
 2   172.16.32.2   Se1/2     12 00:15:27  40 1140 0 227
 1   172.16.23.2   Se1/0.23  10 00:15:28 24 1140 0 226
 0   172.16.136.6  E1/0/0    11 00:15:28  5  200 0 34
```

```bash
r5#sh ip e i neighbors
IP-EIGRP neighbors for process 304
H    Address      Interface  Hold Uptime  SRTT   RTC  Q Seq Type
     (sec)         (ms)      Cnt Num
 4   172.16.136.6  E1/0/0    10 00:12:27 266 1596 0 33
 3   172.16.136.3  E1/0/0    14 00:15:39 268 1608 0 319
 2   172.16.35.1   Se0/0     13 00:15:39 148 806 0 320
 0   172.16.15.1   To0/0     12 00:48:11 21 200 0 306
 1   172.16.136.1  E1/0/0    12 00:48:24 11 200 0 308
```

**Technical Verification For Task D**

This is verified in the Technical Verification of Task F.

**Technical Verification For Task E**

This is verified in the Technical Verification of Task F.
Technical Verification For Task F

The routing tables of all routers are included here. The legend normally provided in router output has been deleted.

Router 1

```
rl#sh ip ro
172.16.0.0/16 is variably subnetted, 9 subnets, 4 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
D 172.16.32.0/24 [90/2273792] via 172.16.21.2, 00:18:07, Serial1/0.21
D 172.16.35.0/30 [90/1787392] via 172.16.136.5, 00:16:35, Ethernet0/0
C 172.16.31.0/30 is directly connected, Serial1/1
D EX 172.16.4.0/24 [170/2273792] via 172.16.21.2, 00:16:12, Serial1/0.21
C 172.16.23.0/30 [90/2289920] via 172.16.21.2, 00:17:23, Serial1/0.21
C 172.16.15.0/24 is directly connected, TokenRing0/0
D 172.16.24.0/24 [170/2289920] via 172.16.21.2, 00:18:08, Serial1/0.21
D EX 192.168.4.0/24 [170/2401792] via 172.16.136.6, 00:14:51, Ethernet0/0
D 192.168.5.0/24 [90/409600] via 172.16.136.6, 00:16:36, Ethernet0/0
D 192.168.6.0/24 [90/409600] via 172.16.136.6, 00:14:51, Ethernet0/0
C 192.168.1.0/24 is directly connected, Ethernet0/0
D 192.168.2.0/24 [90/1889792] via 172.16.21.2, 00:18:08, Serial1/0.21
D 192.168.3.0/24 [90/409600] via 172.16.136.3, 00:18:09. Ethernet0/0
```

Router 2

```
r2#sh ip ro
172.16.0.0/16 is variably subnetted, 15 subnets, 4 masks
D 172.16.136.0/26 [90/1787392] via 172.16.23.1, 00:20:53, Serial1/0.23
[90/1787392] via 172.16.32.3, 00:20:53, Serial1/1
D 172.16.136.0/24 is a summary, 00:20:53, Null0
C 172.16.32.0/24 is directly connected, Serial1/1
D 172.16.35.0/30 [90/2289920] via 172.16.21.1, 00:01:01, Serial1/0.21
D 172.16.35.0/24 is a summary, 00:01:03, Null0
D 172.16.31.0/30 [90/2273792] via 172.16.21.1, 00:20:54, Serial1/0.21
D 172.16.31.0/24 is a summary, 00:20:54, Null0
C 172.16.24.0/24 is directly connected, Serial1/0.23
D 172.16.21.0/24 is a summary, 00:20:54, Null0
C 172.16.21.0/30 is directly connected, Serial1/0.21
D 172.16.23.0/24 is a summary, 00:18:49, Null0
```

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C  172.16.23.0/30 is directly connected, Serial1/0.23
D  172.16.15.0/24 is a summary, 00:10:18, Null0
D  172.16.15.0/28 [90/1777920] via 172.16.21.1, 00:10:18, Serial1/0.21
C  172.16.2.0/24 is directly connected, TokenRing0/0
I  192.168.4.0/24 [100/7392] via 172.16.24.4, 00:00:02, Serial1/0.24
D  192.168.5.0/24 [90/1905920] via 172.16.21.1, 00:01:04, Serial1/0.21
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
I  10.0.0.0/0 [100/6982] via 172.16.24.4, 00:00:02, Serial1/0.24
D  10.2.6.0/23 [90/1812992] via 172.16.21.1, 00:20:55, Serial1/0.21
[90/1812992] via 172.16.32.3, 00:20:55, Serial1/1
D EX  192.168.6.0/24 [170/1915392] via 172.16.21.1, 00:20:55, Serial1/0.21
[170/1915392] via 172.16.32.3, 00:20:55, Serial1/1
[170/1915392] via 172.16.23.1, 00:20:55, Serial1/0.23
D EX 192.168.1.0/24 [90/1889792] via 172.16.21.1, 00:20:56, Serial1/0.21
C  192.168.2.0/24 is directly connected, Loopback0
D  192.168.3.0/24 [90/1889792] via 172.16.23.1, 00:20:56, Serial1/0.23
[90/1889792] via 172.16.32.3, 00:20:56, Serial1/1

Router 3

r3#sh ip ro
172.16.0.0/16 is variably subnetted, 9 subnets, 4 masks
C  172.16.136.0/26 is directly connected, Ethernet0/0
C  172.16.32.0/24 is directly connected, Serial1/2
C  172.16.35.0/30 is directly connected, Serial1/3
C  172.16.31.0/30 is directly connected, Serial1/1
D EX  172.16.24.0/24 [170/2299392] via 172.16.136.1, 00:01:27, Ethernet0/0
D 172.16.21.0/30 [90/1787392] via 172.16.136.1, 00:01:27, Ethernet0/0
C  172.16.23.0/30 is directly connected, Serial1/0.23
D  172.16.15.0/28 [90/297728] via 172.16.136.1, 00:10:43, Ethernet0/0
[90/297728] via 172.16.136.5, 00:10:43, Ethernet0/0
D EX  192.168.4.0/24 [170/2427392] via 172.16.136.1, 00:01:28, Ethernet0/0
D  10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D EX  10.0.0.0/8 [170/2324992] via 172.16.136.1, 00:01:29, Ethernet0/0
D  10.2.6.0/23 [90/307200] via 172.16.136.6, 00:29:10, Ethernet0/0
D EX  192.168.1.0/24 [90/409600] via 172.16.136.1, 00:01:29, Ethernet0/0
D  192.168.1.0/24 [90/409600] via 172.16.136.1, 00:01:29, Ethernet0/0
C  192.168.3.0/24 is directly connected, Loopback0

Router 4

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E.  **R4#sh ip ro**

```
172.16.0.0/24 is subnetted, 9 subnets
I  172.16.136.0 [100/10576] via 172.16.24.1, 00:00:59, Serial0/0
I  172.16.32.0 [100/10476] via 172.16.24.2, 00:00:59, Serial0/0
I  172.16.35.0 [100/12539] via 172.16.24.2, 00:00:59, Serial0/0
I  172.16.31.0 [100/12476] via 172.16.24.2, 00:00:59, Serial0/0
C  172.16.24.0 is directly connected, Serial0/0
I  172.16.21.0 [100/10476] via 172.16.24.2, 00:00:59, Serial0/0
I  172.16.23.0 [100/10476] via 172.16.24.2, 00:01:00, Serial0/=
I  172.16.15.0 [100/10539] via 172.16.24.2, 00:01:00, Serial0/0
I  172.16.2.0 [100/8539] via 172.16.24.2, 00:01:00, Serial0/0
C  192.168.4.0/24 is directly connected, Loopback0
I  192.168.5.0/24 [100/11039] via 172.16.24.1, 00:01:00, Serial0/0
10.0.0.0/22 is subnetted, 1 subnets
C  10.1.4.0 is directly connected, Ethernet0/0
I  192.168.6.0/24 [100/11076] via 172.16.24.2, 00:01:01, Serial0/0
I  192.168.1.0/24 [100/10976] via 172.16.24.2, 00:01:01, Serial0/0
I*  192.168.2.0/24 [100/8976] via 172.16.24.2, 00:01:01, Serial0/0
I  192.168.3.0/24 [100/10976] via 172.16.24.2, 00:01:01, Serial0/=
```

**Router 5**

```
**R5#sh ip ro**

```
```
172.16.0.0/16 is variably subnetted, 9 subnets, 4 masks
C  172.16.136.0/26 is directly connected, Ethernet0/0
D  172.16.32.0/24 [90/2289920] via 172.16.15.1, 00:02:26, TokenRing0/0
C  172.16.35.0/30 is directly connected, Serial0/0
D  172.16.31.0/30 [90/1777920] via 172.16.15.1, 00:02:26, TokenRing0/0
D EX  172.16.24.0/24 [170/2289920] via 172.16.15.1, 00:02:26, TokenRing0/0
D  172.16.21.0/24 [90/2289920] via 172.16.15.1, 00:02:26, TokenRing0/0
D  172.16.23.0/24 [90/1777920] via 172.16.15.1, 00:02:26, TokenRing0/0
D  172.16.15.0/28 is directly connected, TokenRing0/0
D  172.16.2.0/24 [90/1794048] via 172.16.15.1, 00:02:26, TokenRing0/0
D EX  192.168.4.0/24 [170/2417920] via 172.16.15.1, 00:02:26, TokenRing0/0
C  192.168.5.0/24 is directly connected, Loopback0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D EX  10.0.0.0/8 [170/2315520] via 172.16.15.1, 00:02:26, TokenRing0/0
D  10.2.6.0/23 [90/307200] via 172.16.136.6, 00:02:28, Ethernet0/=
D EX  192.158.6.0/24 [170/409600] via 172.16.136.6, 00:02:28, Ethernet0/0
D  192.168.1.0/24 [90/304128] via 172.16.15.1, 00:02:28, TokenRing0/0
D  192.168.2.0/24 [90/1905920] via 172.16.15.1, 00:02:28, TokenRing0/0
D  192.168.3.0/24 [90/409600] via 172.16.136.3, 00:02:28, Ethernet0/0
```

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Router 6

R6#sh ip ro

172.16.0.0/16 is variably subnetted, 9 subnets, 4 masks
C 172.16.136.0/26 is directly connected, FastEthernet0/0
D 172.16.32.0/24
  [90/2276352] via 172.16.136.1, 00:02:54, FastEthernet0/0
D 172.16.35.0/30
  [90/1764352] via 172.16.136.5, 00:02:55, FastEthernet0/0
D 172.16.31.0/30
  [90/1764352] via 172.16.136.5, 00:02:55, FastEthernet0/0
D EX 172.16.24.0/24
  [170/2276352] via 172.16.136.1, 00:02:54, FastEthernet0/0
D 172.16.21.0/30
  [90/1764352] via 172.16.136.1, 00:02:54, FastEthernet0/0
D 172.16.23.0/30
  [90/2276352] via 172.16.136.1, 00:02:54, FastEthernet0/0
D 172.16.15.0/28 [90/179688] via 172.16.136.1, 00:12:11 FastEthernet0/0
  [90/178688] via 172.16.136.5, 00:12:11, FastEthernet0/0
D 172.16.2.0/24 [90/1780480] via 172.16.136.1, 00:02:55, FastEthernet0/0
D EX 192.168.4.0/24 [170/2404352] via 172.16.136.1, 00:02:55, FastEthernet0/0
D 192.168.5.0/24 [90/156160] via 172.16.136.5, 00:02:56, FastEthernet0/0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D EX 10.0.0.0/8 [170/2301952] via 172.16.136.1, 00:02:56, FastEthernet0/0
C 10.2.6.0/23 is directly connected, Ethernet2/0
D 192.168.6.0/24 is directly connected, Loopback0
D 192.168.1.0/24 [90/157160] via 172.16.136.1, 00:02:56, FastEthernet0/0
D 192.168.2.0/24 [90/1892352] via 172.16.136.1, 00:02:56, FastEthernet0/0
D 192.168.3.0/24 [90/156160] via 172.16.136.1, 00:30:30, FastEthernet0/0

Lab Configuration Verification

Only relevant portions of the configuration have been included

Router 1

r1#sh run

interface Loopback0
  ip address 192.168.1.1 255.255.255.0
!
interface Ethernet0/0
  ip address 172.16.136.1 255.255.255.192

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half-duplex
!
interface TokenRing0/0
  ip address 172.16.15.1 255.255.255.240
  ring-speed 16
!
interface Serial1/0
  no ip address
  encapsulation frame-relay
!
interface Serial1/0.21 point-to-point
  ip address 172.16.21.1 255.255.255.252
  frame-relay interface-dlci 122
!
interface Serial1/1
  ip address 172.16.31.1 255.255.255.252
!
router eigrp 304
  passive-interface Loopback0
  network 172.16.15.0 0.0.0.15
  network 172.16.21.0 0.0.0.3
  network 172.16.31.0 0.0.0.3
  network 172.16.136.0 0.0.0.63
  network 192.168.1.0
  no auto-summary
  no eigrp log-neighbor-changes

Router 2

r2#sh run
interface Loopback0
  ip address 192.168.2.2 255.255.255.0
  ip summary-address eigrp 304 172.16.136.0 255.255.255.0 5
  ip summary-address eigrp 304 172.16.35.0 255.255.255.0 5
  ip summary-address eigrp 304 172.16.31.0 255.255.255.0 5
  ip summary-address eigrp 304 172.16.23.0 255.255.255.0 5
  ip summary-address eigrp 304 172.16.21.0 255.255.255.0 5
  ip summary-address eigrp 304 172.16.15.0 255.255.255.0 5
!
interface BRI0/0
  no ip address
  shutdown
!
interface Ethernet0/0
  no ip address
shutdown
half-duplex
!
interface TokenRing0/0
  ip address 172.16.2.2 255.255.255.0
  ring-speed 16
!
interface Serial1/0
  no ip address
  encapsulation frame-relay
!
interface Serial1/0.21 point-to-point
  ip address 172.16.21.2 255.255.255.252
  frame-relay interface-dlci 221
!
interface Serial1/0.23 point-to-point
  ip address 172.16.23.2 255.255.255.252
  frame-relay interface-dlci 223
!
interface Serial1/0.24 point-to-point
  ip address 172.16.24.2 255.255.255.0
  frame-relay interface-dlci 224
!
interface Serial1/1
  ip address 172.16.32.2 255.255.255.0
!
router eigrp 304
  redistribute igrp 24
  passive-interface TokenRing0/0
  passive-interface Serial1/0.24
  network 172.16.2.0 0.0.0.255
  network 172.16.21.0 0.0.0.3
  network 172.16.23.0 0.0.0.3
  network 172.16.32.0 0.0.0.255
  network 192.168.2.0
  no auto-summary
  no eigrp log-neighbor-changes
!
router igrp 24
  redistribute eigrp 304
  passive-interface TokenRing0/0
  passive-interface Serial1/0.21
  passive-interface Serial1/0.23
  passive-interface Serial1/1
  network 172.16.0.0
Router 3

r3#sh run
interface Loopback0
  ip address 192.168.3.3 255.255.255.0
!
interface Ethernet0/0
  ip address 172.16.136.3 255.255.255.192
  half-duplex
!
interface BRI0/0
  no ip address
  shutdown
!
interface Serial1/0
  no ip address
  encapsulation frame-relay
!
interface Serial1/0.23 point-to-point
  ip address 172.16.23.1 255.255.255.252
  frame-relay interface-dlci 322
!
interface Serial1/1
  ip address 172.16.31.2 255.255.255.252
  clockrate 64000
!
interface Serial1/2
  ip address 172.16.32.3 255.255.255.0
  clockrate 6400
!
interface Serial1/3
  ip address 172.16.35.1 255.255.255.252
  clockrate 64000
!
router eigrp 304
  passive-interface Loopback0
  network 172.16.23.0 0.0.0.3
  network 172.16.31.0 0.0.0.3
  network 172.16.32.0 0.0.0.255
  network 172.16.35.0 0.0.0.3
  network 172.16.136.0 0.0.0.63
  no auto-summary
  no eigrp log-neighbor-changes

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Router 4

r4#sh run
interface Loopback0
 ip address 182.168.4.4 255.255.255.0
!
interface Ethernet0/0
 ip address 10.1.4.4 255.255.252.0
 half-duplex
!
interface Serial0/0
 ip address 172.16.24.4 255.255.255.0
 encapsulation frame-relay
 ip split-horizon
 frame-relay map ip 172.16.24.2 422 broadcast
 no frame-relay inverse-arp
!
interface Serial0/1
 no ip address
 shutdown
!
router igrp 24
 network 10.0.0.0
 network 172.16.0.0
 network 192.168.4.0
!
ip kerberos source-interface any
ip classless
ip default-network 192.168.2.0

Router 5

r5#sh run
interface Loopback0
 ip address 192.168.5.5 255.255.255.0
!
interface Ethernet0/0
 ip address 172.16.136.5 255.255.255.192
 half-duplex
!
interface Serial0/0
 ip address 172.16.35.2 255.255.255.252
!
interface TokenRing0/0
 ip address 172.16.15.5 255.255.255.240
ring-speed 16
!
interface Serial0/1
   no ip address
   shutdown
!
interface ATM1/0
   no ip address
   shutdown
   no atm ilmi-keepalive
!
router eigrp 304
   passive-interface Loopback0
   network 172.16.15.0 0.0.0.15
   network 172.16.35.0 0.0.0.3
   network 172.16.136.0 0.0.0.63
   network 192.168.5.0
   no auto-summary
   no eigrp log-neighbor-changes

Router 6

r6#sh run
interface Loopback0
   ip address 192.168.6.6 255.255.255.0
   no ip directed-broadcast
!
interface FastEthernet0/0
   ip address 172.16.136 255.255.255.192
   no ip directed-broadcast
duplex auto
   speed auto
!
interface ATM1/0
   no ip address
   no ip directed-broadcast
   shutdown
   no atm ilmi-keepalive
!
interface Ethernet2/0
   ip address 10.2.6.6 255.255.254.0
   no ip directed-broadcast
!
router eigrp 304
   redistribute connected
passive-interface Ethernet2/0
network 10.2.6.0 0.0.1.255
network 172.16.136.0 0.0.0.63
no auto-summary
Lab Preparation Scenario: EIGRP

Topics Covered

- EIGRP over Frame-Relay
- Auto Summarization
- Manual Summarization
- Authentication
- EIGRP Metrics
- Administrative Distance

Difficulty Level: CCIE™

Average Completion Time: 2 Hours

Standard Topology

Standard TCP/IP Addressing and SPID Information

R1 (3620)
Loop0  192.168.1.1 /24  Loopback
E0/0   172.16.136.1 /26  Ethernet Segment to Catalyst 3/1
T0/0   172.16.15.1 /28  Token Ring Segment to 3920

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S1/1  172.16.31.1 /30 Serial to R3  
S1/0  unassigned Frame-relay

#### R2 (3620)
Loop0  192.168.1.1 /24 Loopback  
E0/0  172.16.136.1 /26 Ethernet Segment to Catalyst 3/1  
T0/0  172.16.15.1 /28 Token Ring Segment to 3920  
S1/1  172.16.31.1 /30 Serial to R3  
S1/0  unassigned Frame-relay

#### R2 (3620)
Loop0  192.168.2.2 /24 Loopback  
T0/0  172.16.2.2 /24 Token Ring Segment to 3920  
BRI0/0  172.16.230.2 /24 BRI to R3  
S1/1  172.16.32.2/24 Serial to R3  
S1/0  unassigned Frame-relay

#### R3 (2610)
Loop0  192.168.3.3 /24 Loopback  
E0/0  172.16.136.3 /26 Ethernet Segment to Catalyst 3/3  
BRI0/0  172.16.230.3 /24 ISDN to R2  
S1/3  172.16.35.1 /30 Serial to R5  
S1/2  172.16.32.3/24 Serial to R2  
S1/1  172.16.31.2/30 Serial to R1  
S1/0  unassigned Frame-relay

#### R4 (2610)
Loop0  192.168.4.4 /24 Loopback  
E0/0  10.1.4.4 /22 Ethernet Segment to BB1  
S0/0  unassigned Frame-relay

#### R5 (3620)
Loop0  192.168.5.5 /24 Loopback  
E0/0  172.16.136.5 /26 Ethernet Segment to Catalyst 3/5  
T0/0  172.16.15.5 /28 Token Ring Segment to 3920  
S0/0  172.16.35.2 /30 Serial link to R3  
A1/0  172.16.56.5 /30 ATM – R6

#### R6 (3640)
Loop0  192.168.6.6 /24 Loopback  
FAQ/0  172.16.136.6 /26 Ethernet segment – R2  
E2/0  10.2.6.6 /23 Ethernet segment – BB2  
A1/0  172.16.56.6 /30 ATM – R5

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ISDN Information
Switch Type Basic NI1

R2
SPID1: 42255501210101
SPID2: 42255501220101

R3
SPID1: 42255501310101
SPID2: 42255501320101

Lab Technical Tasks

A. Configure the frame-relay interfaces in AS 308.
   Using only physical interfaces and DLCI’s from the table above, make R3 the hub with R1, R2 and
   R4 as spokes.
   Do not configure or make use of any other DLCI’s.
   Assign IP addresses from the 172.16.123.0/27 subnet.
B. Using AS 305, enable EIGRP on all interfaces except ISDN and ATM.
   Classful routes should not appear in any routing table.
C. Configure R4 such that a route for 10.1.0.0/16 pointing to the null0 interface in its routing table.
   Do not use static routes and do not advertise this route to any other router including BB1.
D. Set R3’s bandwidth to 64KB on its frame-relay and three point-to-point interfaces.
   Configure R3 to prefer the point-to-point interface (serial 1/2) for 172.16.2.0/24 and
   192.168.2.0/24.
E. Configure your network such that R3 has two equal cost routes for 172.16.15.0/24 and three equal
   cost routes for 172.16.15.0/28.
F. If R3 redistributed routes from OSPF into EIGRP, ensure that R2 would have an administrative
   distance of 175 for these routes.
G. Enable authentication on subnet 172.16.15.0/28.

All subnets/interfaces that participate in EIGRP must be reachable from all routers.

Instructor’s Comments and Technical Tips

A. Eigrp follows the rules of split-horizon on multicast, packet-switched networks.
   If you disable split-horizon on one router, you should disable it for all routers.
   R3 needs to have split-horizon shut-off for EIGRP specifically.
   If not, R4 will not get routes.
   You also need to manually assign neighbors.
B. Eigrp summarizes at the classful boundary by default.
   You need to disable this.
C. Adding “ip summary-address eigrp”, on an interface will automatically create a route to the null0 interface. This route will have an administrative value of 5. By putting this statement on the loopback interface it will not be advertised to any peer. For this to work, the loopback cannot be passive under EIGRP.

D. By default eigrp uses bandwidth and delay to calculate its metric. The delay is a derivative of the bandwidth. You can however set the delay value independently.

E. You need to configure summary-address statements on the appropriate interfaces of R1 and R5.

F. Remember that eigrp has an administrative distance for internal routes (90) and for external routes (170). While it is still a good practice to filter, having separate AD values avoids some of the problems encountered when you have two routers performing mutual redistribution.

G. This requires interface statements and configuring the key chain.

Lab Technical Verification

Technical Verification For Task A

```
r1#sh fram map
Serial1/0(up): ip 172.16.123.2 dlci 133(0x85,0x2050), static, broadcast, CISCO, status defined, active
Serial1/0(up): ip 172.16.123.3 dlci 133(0x85,0x2050), static, broadcast, CISCO, status defined, active
```

```
r2#sh fram map
Serial1/0(up): ip 172.16.123.1 dlci 233(0xE9,0x3890), static broadcast, CISCO, status defined, active
Serial1/0(up): ip 172.16.123.3 dlci 233(0xE9,0x3890), static broadcast, CISCO, status defined, active
```

```
r3#sh fram map
Serial1/0(up): ip 172.16.123.1 dlci 331(0x148B,0x50B0), static, broadcast, CISCO, status defined, active
Serial1/0(up): ip 172.16.123.2 dlci 332(0x14C,0x50C0), static, broadcast, CISCO, status defined, active
Serial1/0(up): ip 172.16.123.4 dlci 334(0x14E,0x50E0), static, broadcast,
```

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CISCO, status defined, active

r4#sh fram map
Serial0/0 (up): ip 172.16.123.1 dlc1 433(0x1B1,0x6C10), static,
    broadcast,
    CISCO, status defined, active
Serial0/0 (up): ip 172.16.123.2 dlc1 433(0x1B1,0x6C10), static,
    broadcast,
    CISCO, status defined, active
Serial0/0 (up): ip 172.16.123.3 dlc1 433(0x1B1,0x6C10), static,
    broadcast,
    CISCO, status defined, active

r3#sh ip ei neighbors s1/0
IP-EIGRP neighbors for process 308
H Address Interface Hold Uptime SRTT RTO Q SEQ Type
  (sec) (ms) Cnt Num
1 172.16.123.2 Se1/0 158 00:29:35 1158 5000 0 109 S
2 172.16.123.4 Se1/0 144 00:43:05  13 2280 0   44 S
0 172.16.123.1 Se1/0 146 00:50:42  15 2280 0  214 S

Technical Verification For Task B

Verification for this task can be viewed in Task G.

Technical Verification For Task C

r4#sh ip ro 10.1.0.0
Routing entry for 10.1.0.0/16
    Known via "eigrp 308", distance 5, metric 281600, type internal
    Redistributing via eigrp 308
    Routing Descriptor Blocks:
    * directly connected, via Null0
        Route metric is 281600, traffic share count is 1
        Total delays is 1000 microseconds, minimum bandwidth is 1000 Kbit
        Reliability 255/255, minimum MTU 1500 bytes
        Loading 1/255, Hops 0
    Route metric is 281600, traffic share count is 1
    Total delay is 1000 microseconds, minimum bandwidth is 10000 Kbit
    Reliability 255/255, minimum MTU 1500 bytes
    Loading 1/255, Hops 0

r3#sh ip ro 10.1.0.0
% Subnet not in table
Technical Verification For Task D

r3#sh ip ei top 172.16.2.0 255.255.255.0

F. IP-EIGRP topology entry for 172.16.2.0/24
State is Passive, Query origin flag is 1, 1 Successor(s), FD is 40400128
Routing Descriptor Blocks:

172.16.32.2 (Serial1/2), from 172.16.32.2, Send flag is 0x0
Composite metric is (4040128/176128), Route is Internal
Vector metric:
  Minimum bandwidth is 64 Kbit
  **Total delay is 15630 microseconds**
  Reliability is 255/255
  Load is 1/255
  Minimum MTU is 1500
  Hop count is 1

172.16.123.2 (Serial1/0), from 172.16.123.2, Send flag is 0x0
Composite metric is (40528128/176128), Route is Internal
Vector metric:
  Minimum bandwidth is 64 Kbit
  **Total delay is 20630 microseconds**
  Reliability is 255/255
  Load is 1/255
  Minimum is 1/255
  Hop count is 1

172.16.123.1 (Serial1/0), from 172.16.123.1, Send flag is 0x0
Composite metric is (40937728/40425728), Route is Internal
Vector metric:
  **Total delay is 36630 microseconds**
  Reliability is 255/255
  Load is 1/255
  Minimum is 1/255
  Hop count is 3

172.16.31.1 (Serial1/1), from 172.16.31.1, Send flag is 0x0
Composite metric is (40937728/40425728), Route is Internal
Vector metric:
  Minimum bandwidth is 64 Kbit
  **Total delay is 36630 microseconds**
  Reliability is 255/255
  Load is 3/255
  Minimum MTU is 1500
  Hop count is 3

172.16.35.2 (Serial1/3), from 172.16.25.2, Send flag is 0x0
Composite metric is (40937728/40425728), Route is Internal
Vector metric:
Minimum bandwidth is 64 Kbit
**Total delay us 36630 microseconds**
Reliability is 255/255
Load is 3/255
Minimum MTU is 1500
Hop count is 3

Technical Verification For Task E

```
r3#sh ip ro 172.16.15.0 255.255.0 longer-prefixes
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
    i - IS-IS, 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

172.16.0.0/16 is variably subnetted, 8 subnets, 5 masks
D  172.16.15.0/24 [90/297728] via 172.16.136.1, 00:41:15, Ethernet0/0
    [90/297728] via 172.16.136.5, 00:41:15, Ethernet0/0
D  172.16.15.0/28 [90/40528128] via 172.16.123.1, 00:41:19, Serial1/0
    [90/40529128] via 172.16.35.2, 00:41:19, Serial1/3
    [90/40528128] via 172.16.31.1, 00:41:19, Serial1/1
```  

Technical Verification For Task F

```
r2#sh ip protocols
Routing Protocols is “eigrp 308”
Outgoing update filter list for all interfaces is
Incoming update filter list for all interfaces is
Default networks flagged in outgoing updates
Default networks accepted from incoming updates
EIGRP metric weight K1=1, K2=0, K3=1, K4=4, K5=0
EIGRP maximum hopcount 100
EIGRP maximum metric variance 1
Redistributing: eigrp 308
Automatic network summarization is not in effect
Routing for Networks:
    172.16.0.0
    192.168.2.0
Passive Interface(s):
Technical Verification For Task G
The routing tables of all routers are included here. The legend normally provided in router output has been deleted.

r1#sh ip eh n de to 0/0  The authentication can be viewed in the configuration
IP-EIGRP neighbors for process 308
H Address Interface Hold Uptime SRTT RTO Q Seq Type
     (sec)     (ms)      Cnt Num
3 172.16.15.5  To0/0  13 00:24:04  1486 5000  0  165

Router 1

r1#sh ip ro
172.16.0.0/16 is variably subnetted, 8 subnets, 5 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
D 172.16.32.0/24 [90/40409600] via 172.16.136.3, 00:15:08, Ethernet0/0
D 172.16.35.0/30 [90/40528128] via 172.16.15.5, 00:15:08, TokenRing0/0
C 172.16.31.0/30 is directly connected, Serial1/1
D 172.16.15.0/24 is a summary, 00:44:53, Null0
C 172.16.15.0/28 is directly connected, TokenRing0/0
D 172.16.2.0/24 [90/40425728] via 172.16.136.3, 00:15:08, Ethernet0/0
D 172.16.123.0/27 is directly connected, Serial1/0
D 192.168.4.0/24 [90/40665600] via 172.16.136.3, 00:15:09, Ethernet0/0
D 192.168.5.0/24 [90/40563200] via 172.16.136.3, 00:15:09, TokenRing0/0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D 10.2.6.0/23 [90/307200] via 172.16.136.3, 00:15:10, Ethernet0/0
D 10.1.4.0/22 [90/40563200] via 172.16.136.3, 00:15:09, Ethernet0/0
D 192.168.6.0/24 [90/409600] via 172.16.136.6, 00:15:10, Ethernet0/0
C 192.168.1.0/24 is directly connected, Loopback0
D 192.168.2.0/24 [90/40537600] via 172.16.136.3, 00:15:10, Ethernet0/0
D 192.168.3.0/24 [90/409600] via 172.16.136.3, 00:15:10, Ethernet0/0

Router 2

r2#sh ip ro
172.16.0.0/16 is variably subnetted, 8 subnets, 5 masks
D 172.16.136.0/26 [90/40537600] via 172.16.32.3, 00:40:59, Serial1/1
CCIE LAB

[90/40537600] via 172.16.123.3, 00:40:59, Serial1/0
C 172.16.32.0/24 is directly connected, Serial1/1
D 172.16.35.0/30 [90/41024000] via 172.16.32.3, 00:40:59, Serial1/1
[90/41024000] via 172.16.123.3, 00:40.49, Serial1/0
D 172.16.31.0/30 [90/41024000] via 172.16.32.3, 00:40:59, Serial1/1
[90/4102000] via 172.16.123.3, 00:41.00, Serial1/0
D 172.16.15.0/28 [90/41040128] via 172.16.32.3, 00:41:00, Serial1/1
[90/41040128] via 172.16.123.3, 00:41:00, Serial1/0
D 172.16.15.0/24 [90/40553728] via 172.16.32.3, 00:41:00, Serial1/1
[90/40553728] via 172.16.123.3, 00:41:00, Serial1/0
C 172.16.2.0/24 is directly connected, TokenRing0/0
C 172.16.123.0/27 is directly connected, Serial1/0
D 192.168.4.0/24 [90/41152000] via 172.16.32.3, 00:41, Serial1/1
[90/41152000] via 172.16.123.3, 00:41:01, Serial1/0
D 192.168.5.0/24 [90/40665600] via 172.16.32.3, 00:41:01, Serial1/1
[90/40665600] via 172.16.123.3, 00:41:01, Serial1/0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D 10.2.6.0/23 [90/40563200] via 172.16.32.3, 00:41:01, Serial1/1
[90/40563200] via 172.16.123.3, 00:41:01, Serial1/0
D 10.1.4.0/22 [90/41049600] via 172.16.32.3, 00:41:01, Serial1/1
[90/41049600] via 172.16.123.3, 00:41:01, Serial1/0
D 192.168.6.0/24 [90/40665600] via 172.16.32.3, 00:41:01, Serial1/1
[90/40665600] via 172.16.123.3, 00:41:01, Serial1/0
D 192.168.1.0/24 [90/40665600] via 172.16.32.3, 00:41:01, Serial1/1
[90/40665600] via 172.16.123.3, 00:41:01, Serial1/0
C 192.168.2.0/24 is directly connected, Loopback0
D 192.168.3.0/24 [90/40640000] via 172.16.123.3, 00:41:02, Serial1/0
[90/40640000] via 172.16.123.3, 00:41:02, Serial1/0

Router 3

r3#sh ip ro
172.16.0.0/16 is variably subnetted, 8 subnets, 5 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
C 172.16.32.0/24 is directly connected, Serial1/2
C 172.16.35.0/30 is directly connected, Serial1/3
C 172.16.31.0/30 is directly connected, Serial1/1
D 172.16.15.0/24 [90/297728] via 172.16.136.1, 00:45:03, Ethernet0/0
[90/297728] via 172.16.136.5, 00:45:03, Ethernet0/0
D 172.16.15.0/28 [90/40528128] via 172.16.136.1, 00:45:07, Serial1/0
[90/40528128] via 172.16.35.2, 00:45:08, Serial1/3
[90/40528128] via 172.16.31.1, 00:45:08, Serial1/1
D 172.16.2.0/24 [90/40400128] via 172.16.32.2, 00:41:07, Serial1/2
C 172.16.123.0/27 is directly connected, Serial1/0
Router 4

R4#sh ip ro

172.16.0.0/26 is variably subnetted, 8 subnets, 5 masks
D 172.16.136.0/26 [90/40537600] via 172.16.123.3, 00:50:06, Serial0/0
D 172.16.32.0/24 [90/40896000] via 172.16.123.3, 00:47:28, Serial0/0
D 172.16.35.0/30 [90/41040000] via 172.16.123.3, 00:50:12, Serial0/0
D 172.16.15.0/24 [90/40553728] via 172.16.123.3, 00:45:36, Serial0/0
D 172.16.15.0/28 [90/40912128] via 172.16.123.3, 00:42:16, Serial0/0
C 172.16.123.0/27 is directly connected, Serial0/0
C 172.16.123.0/27 is directly connected, Serial0/0
D 192.168.4.0/24 [90/40640000] via 172.16.123.4, 00:45:05, Serial1/0
D 192.168.5.0/24 [90/4096000] via 172.16.136.5, 00:15:25, Ethernet0/0
10.0.0.0/0 is variably subnetted, 2 subnets, 2 masks
D 10.2.6.0/23 [90/3072000] via 172.16.136.6, 00:45:06, Ethernet0/0
D 10.1.4.0/22 [90/40537600] via 172.16.123.4, 00:45:06, Ethernet0/0
D 192.168.6.0/24 [90/4096000] via 172.16.136.6, 00:45:06, Ethernet0/0
D 192.168.1.0/24 [90/4096000] via 172.16.136.1, 00:15:27, Ethernet0/0
D 192.168.2.0/24 [90/40512000] via 172.16.32.2, 00:41:08, Serial1/2
C 192.168.3.0/24 is directly connected, Loopback0

Router 5

R5#sh ip ro

172.16.0.0/16 is variably subnetted, 8 subnets, 5 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
D 172.16.32.0/24 [90/40409600] via 172.16.136.3, 00:50:13, Serial0/0
C 10.1.0.0/8 is variably subnetted, 3 subnets, 3 masks
D 10.1.0.0/16 is a summary, 00:50:13, Null0
D 10.2.6.0/23 [90/40563200] via 172.16.123.3, 00:50:07, Serial0/0
C 10.1.4.0/22 is directly connected, Ethernet0/0
D 192.168.6.0/24 [90/40656000] via 172.16.123.3, 00:50:07, Serial0/0
D 192.168.1.0/24 [90/40656000] via 172.16.123.3, 00:50:07, Serial0/0
D 192.168.2.0/24 [90/40124000] via 172.16.123.3, 00:50:07, Serial0/0
D 192.168.3.0/24 [90/40640000] via 172.16.123.3, 00:50:07, Serial0/0
C 172.16.15.0/28 is directly connected, Loopback0

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Router 6

**R6#sh ip ro**

172.16.0.0/16 is variably subnetted, 8 subnets, 5 masks  
C 172.16.136.0/26 is directly connected, FastEthernet0/0  
D 172.16.32.0/24  
  [90/40386560] via 172.16.136.3, 00:47:44, FastEthernet0/0  
D 172.16.35.0/30  
  [90/40514560] via 172.16.136.3, 00:15:47, FastEthernet0/0  
  [90/40514560] via 172.16.136.5, 00:15:47, FastEthernet0/0  
D 172.16.31.0/30  
  [90/40514560] via 172.16.136.3, 00:15:49, FastEthernet0/0  
  [90/40514560] via 172.16.136.1, 00:15:49, FastEthernet0/0  
D 172.16.15.0/24 [90/178688] via 172.16.136.1, 00:45:29, FastEthernet0/0  
  [90/178688 via 172.16.136.5, 00:45:29, FastEthernet0/0  
D 172.16.15.0/28 [90/40514560] via 172.16.136.1, 00:15:49, FastEthernet0/0  
D 172.16.2.0/24 [90/40402699] via 172.16.136.3, 00:42:31, FastEthernet0/0  
D 172.16.123.0/27 [90/40514560] via 172.16.136.3, 00:15:51, FastEthernet0/0  
  [90/40514560] via 172.16.136.1, 00:15:51, FastEthernet0/0  
D 192.168.4.0/24 [90/40642560] via 172.16.136.3, 00:51:43, FastEthernet0/0  
D 192.168.5.0/24 [90/156160] via 172.16.136.5, 00:15:49, FastEthernet0/0  
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks  
C 10.2.6.0/23 is directly connected, Ethernet2/0  
D 10.1.4.0/22 [90/40540160] via 172.16.136.3, 00:51:43, FastEthernet0/0  
C 192.168.6.0/24 is directly connected, Loopback0  
D 192.168.1.0/24 [90/156160] via 172.16.136.1, 00:15:51, FastEthernet0/0  
D 192.168.2.0/24 [90/40514560] via 172.16.136.3, 00:42:32, FastEthernet0/0  
D 192.168.3.0/24 [90/156160] via 172.16.136.3, 01:21:14, FastEthernet0/0

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Configuration Verification

Only relevant portions of the configuration have been included

```plaintext
r1#sh run
key chain testking
  key 1
    key-string get
    accept-lifetime 00:00:00 Mar 1 1993 infinite
    send-lifetime 00:00:00 Mar 1 1993 infinite
  call rsvp-sync
  
  interface Loopback0
    ip address 192.168.1.1 255.255.255.0
  
  interface Ethernet0/0
    ip address 172.16.136.1 255.255.255.192
    ip summary-address eigrp 308 172.16.15.0 255.255.255.0 5
    half-duplex
  
  interface TokenRing0/0
    ip address 172.16.15.1 255.255.255.240
    ip authentication mode eigrp 308 md5
    ip authentication key-chain eigrp 308 testking
    ring-speed 16
  
  interface Serial1/0
    bandwidth 64
    ip address 172.16.123.1 255.255.255.224
    encapsulation frame-relay
    ip split-horizon
    frame-relay map ip 172.16.123.2 133 broadcast
    frame-relay map ip 172.16.123.3 133 broadcast
    frame-relay map ip 172.16.123.4 133 broadcast
    no frame-relay inverse-arp
  
  interface Serial1/1
    bandwidth 64
    ip address 172.16.31.1 255.255.255.252
  
  router eigrp 308
    passive-interface Loopback0
    network 172.16.0.0
```

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Router 2

```
Router 2
r2#sh run
interface Loopback0
   ip address 192.168.2.2 255.255.255.0
!
interface BRI0/0
   no ip address
   shutdown
!
interface Ethernet0/0
   no ip address
   shutdown
   half-duplex
!
interface TokenRing0/0
   ip address 172.16.2.2 255.255.255.0
   ring-speed 16
!
interface Serial1/0
   bandwidth 64
   ip address 172.16.123.2 255.255.255.224
   encapsulation frame-relay
   ip split-horizon
   frame-relay map ip 172.16.123.1 233 broadcast
   frame-relay map ip 172.16.123.3 233 broadcast
   frame-relay map ip 172.16.123.4 233 broadcast
   no frame-relay inverse-arp
!
interface Serial1/1
   bandwidth 64
   ip address 172.16.32.2 255.255.255.0
!
router eigrp 308
   passive-interface TokenRing0/0
   passive-interface Loopback0
   network 172.16.0.0
   network 192.168.2.0
   neighbor 172.16.123.3 Serial1/0
```
distance eigrp 90 175
no auto-summary
no eigrp log-neighbor-changes

Router 3

r3#sh run
interface Loopback0
  ip address 192.168.3.3 255.255.255.0

interface Ethernet0/0
  ip address 172.16.136.3 255.255.255.192
tHalf-duplex

interface BRI0/0
  no ip address
  shutdown

interface Serial1/0
  bandwidth 64
  ip address 172.16.123.3 255.255.255.224
  encapsulation frame-relay
  no ip split-horizon eigrp 308
  ip split horizon
  frame-relay map ip 172.16.123.1 331 broadcast
  frame-relay map ip 172.16.123.2 332 broadcast
  frame-relay map ip 172.16.123.4 334 broadcast
  no frame-relay inverse-arp

interface Serial1/1
  bandwidth 64
  ip address 172.16.31.2 255.255.255.252
  clockrate 64000

interface Serial1/3
  bandwidth 64
  ip address 172.16.35.1 255.255.255.252
  clockrate 64000

router eigrp 308
  passive-interface Loopback0
  network 192.168.3.0
  neighbor 172.16.123.4 Serial1/0
  neighbor 172.16.123.2 Serial1/0
  neighbor 172.16.123.1 Serial1/0
no auto-summary
no eigrp log-neighbor-changes

Router 4

r4#sh run
interface Loopback0
  ip address 192.168.4.4 255.255.255.0
  ip summary-address eigrp 308 10.1.0.0 255.255.0.0 5

interface Ethernet0/0
  ip address 10.1.4.4 255.255.252.0
  half-duplex

interface Serial0/0
  bandwidth 64
  ip address 172.16.123.4 255.255.255.224
  encapsulation frame-relay
  ip split horizon
  frame-relay map ip 172.16.123.1 443 broadcast
  frame-relay map ip 172.16.123.2 433 broadcast
  frame-relay map ip 172.16.123.3 433 broadcast
  no frame-relay inverse-arp

interface Serial0/1
  no ip address
  shutdown

router eigrp 308
  passive-interface Ethernet0/0
  network 10.0.0.0
  network 172.16.123.0 0.0.0.31
  network 192.168.4.0
  neighbor 172.16.123.3 Serial0/0
  no auto-summary
  no eigrp log-neighbor-changes

Router 5

r5#sh run
key chain testking
  key 1
    key-string gett
    accept-lifetime 00:00:00: Mar 1 1993 infinite
    send-lifetime 00:00:00: Mar 1 1993 infinite
call rsvp sync
cns event-service server
!
!
!
!
!
!
!
!

interface Loopback0
  ip address 192.168.5.5 255.255.255.0
!
interface Ethernet0/0
  ip address 172.16.136.5 255.255.255.192
  ip summary-address eigrp 308 172.16.15.0 255.255.255.0 5
  half-duplex
!
interface Serial0/0
  bandwidth 64
  ip address 172.16.35.2 255.255.255.252
!
interface TokenRing0/0
  ip address 172.16.15.5 255.255.255.240
  ip authentication mode eigrp 308 md5
  ip authentication key-chain eigrp 308 testking
  ring-speed 16
!
interface Serial0/1
  no ip address
  shutdown
!
interface ATM1/0
  no ip address
  shutdown
  no atm ilmi-keepalive
!
router eigrp 308
  passive-interface Loopback0
  network 172.16.0.0
  network 192.168.5.0
  no auto-summary
  no eigrp lop-neighbor-changes
Router 6

```
r6#sh run
interface Loopback0
 ip address 192.168.6.6 255.255.255.0
 no ip directed-broadcast
!
interface FastEthernet0/0
 ip address 172.16.136.6 255.255.255.192
 no ip directed-broadcast
duplex auto
 speed auto
!
interface ATM1/0
 no ip address
 no ip directed-broadcast
 shutdown
 no atm ilmi-keepalive
!
interface Ethernet2/0
 ip address 10.2.6.6 255.255.254.0
 no ip directed-broadcast
!
router eigrp 308
 passive-interface Ethernet2/0
 passive-interface Loopback0
 network 10.0.0.0
 network 172.16.0.0
 network 192.168.6.0
 no auto-summary
```
Lab Preparation Scenario: IS-IS

Topics Covered
- IS-IS Over Frame-Relay
- IS-IS Timers
- IS-IS Authentication
- IS-IS/OSPF Redistribution
- OSPF Distance Calculation

Standard TCP/IP Addressing and SPID Information

R1 (3620)
Loop0 192.168.1.1/24  Loopback
E/0/0 172.16.136.1/26  Ethernet Segment to Catalyst 3/1
T0/0 172.16.15.1/28  Token Ring Segment to 3920
S1/1 172.16.31.1/30  Serial to R3
S1/0  unassigned  Frame-relay
<table>
<thead>
<tr>
<th>Device</th>
<th>Interface</th>
<th>IP Address/Netmask</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>R2</strong>  (3620)</td>
<td>Loop0</td>
<td>192.16.202/24</td>
<td>Loopback</td>
</tr>
<tr>
<td></td>
<td>T0/0</td>
<td>172.16.2.2/24</td>
<td>Token Ring Segment to 3920</td>
</tr>
<tr>
<td></td>
<td>BRI0/0</td>
<td>172.16.230.2/24</td>
<td>BRI to R3</td>
</tr>
<tr>
<td></td>
<td>S1/1</td>
<td>172.16.32.2/24</td>
<td>Serial to R3</td>
</tr>
<tr>
<td></td>
<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
<tr>
<td><strong>R3</strong>  (2610)</td>
<td>Loop0</td>
<td>192.168.3.3.2/24</td>
<td>Loopback</td>
</tr>
<tr>
<td></td>
<td>E0/0</td>
<td>172.16.136.3/26</td>
<td>Ethernet Segment to Catalyst 3/3</td>
</tr>
<tr>
<td></td>
<td>BRI0/0</td>
<td>172.16.230.3/24</td>
<td>ISDN to R2</td>
</tr>
<tr>
<td></td>
<td>S1/3</td>
<td>172.16.35.1/30</td>
<td>Serial to R5</td>
</tr>
<tr>
<td></td>
<td>S1/2</td>
<td>172.16.35.3/24</td>
<td>Serial to R2</td>
</tr>
<tr>
<td></td>
<td>S1/1</td>
<td>172.16.31.2/30</td>
<td>Serial to R1</td>
</tr>
<tr>
<td></td>
<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
<tr>
<td><strong>R4</strong>  (2610)</td>
<td>Loop0</td>
<td>192.168.4.4/24</td>
<td>Loopback</td>
</tr>
<tr>
<td></td>
<td>E0/0</td>
<td>10.1.1.4/22</td>
<td>Ethernet Segment to BB1</td>
</tr>
<tr>
<td></td>
<td>S0/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
<tr>
<td><strong>R5</strong>  (3620)</td>
<td>Loop0</td>
<td>192.168.5.5/24</td>
<td>Loopback</td>
</tr>
<tr>
<td></td>
<td>E0/0</td>
<td>172.16.136.5/26</td>
<td>Ethernet Segment to Catalyst 3/5</td>
</tr>
<tr>
<td></td>
<td>T0/0</td>
<td>172.16.15.5/28</td>
<td>Token ring segment to 3920</td>
</tr>
<tr>
<td></td>
<td>S0/0</td>
<td>172.16.35.2/30</td>
<td>Serial link to 3920</td>
</tr>
<tr>
<td></td>
<td>A1/0</td>
<td>172.16.58.5/30</td>
<td>ATM-R6</td>
</tr>
<tr>
<td><strong>R6</strong>  (3640)</td>
<td>Loop0</td>
<td>192.168.6.6/24</td>
<td>Loopback</td>
</tr>
<tr>
<td></td>
<td>FA0/0</td>
<td>172.16.136.6/26</td>
<td>Ethernet segnet-R2</td>
</tr>
<tr>
<td></td>
<td>E2/0</td>
<td>10.26.6/23</td>
<td>Ethernet segment-BB2</td>
</tr>
<tr>
<td></td>
<td>A1/0</td>
<td>172.16.56.6/30</td>
<td>ATM-R5</td>
</tr>
</tbody>
</table>

**ISDN Information**

**Switch Type Basic-NI1**

**R2**
- SPID1: 42255601210101
- SPID2: 42255601220101

**R3**
- SPID1: 42255501310101
- SPID2: 42255501320101

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Lab Technical Tasks

A. Configure a hub and spoke Frame Relay Network on R1, R2 < R3 and R4 with R3 as the hub.
   You should use point-to-point sub-interfaces on R1, R2, and R4, R3 should use a multipoint sub-interface.
   Configure the 172.16.100.0/29 subnet on the Frame relay network. Enable OSPF on R1, R2, R3, and R4
   and place the Frame Relay network and loopback 0 interfaces into area 0.
   Also configure subnets 172.16.2.0/24, 172.16.32.0/24, 172.16.31.0/30 and 10.1.4.0/22 into area 0.

B. Configure IS-IS on the 172.16.136.0/26 and the 172.16.35.0/30 subnets.
   All the subnets should belong to area 0002.
   The system ID of each router should be the loopback address.
   All routers should be level 1/2 routers, except for R1 which should be a level 1 only router.

C. On R5 and R6, add the loopback 0 interface into the IS-IS process.
   Make sure that the advertisements of loopbacks do not waste CPU cycles by trying to form unnecessary
   adjacencies

D. Secure the Level 1 area 0002 with authentication.
   The password should be "testking".

E. Create 2 static routes on R3 (10.10.100.0/24 and 10.10.101.0/24, both to null 0). Redistribute these
   static routes into IS-IS as a summary route.

F. Ensure that all IS-IS enable routers send newer style TLVs and accept both older and newer style
   TLVs.

G. Configure mutual redistribution between OSPF and IS-IS on R3.
   You should have full IP connectivity at the end of this lab.
   Keep in mind that the level1 routers act as stub routers and that a default route will be injected by
   the Level2 router.

All subnets/interfaces that participates in routers must reachable from all routers.

Instructor's Comments and technical tips

A. Ensure that the OSPF network types are consisted across all OSPF interfaces.
B. The standard format for the network Entity Title(NET) is in the form of an NSAP address. The
   format can be follows:
   • 47.0001.aaaa.bbbb.cccc.00
     Area:47.0001, System ID:aaaa.bbbb.cccc.NSel:00
   • 39.0f01.0002.0000.0c00.1111.00
     Area:39.0f01.0002.System ID:0000.0c00.1111.NSel:00
   • 49.0002.0000.0000.00012.00
     Area 39.0f01.0002.System ID:0000.0c00.1111.Nsel:00

C. Remember to use passive interfaces if you would like an address advertised by IS-IS, but want to
   alleviate the routers from needless CPU processing form typing to form an unnecessary adjacency.

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D. IS-IS has 3 levels of authentication: domain wide, area wide, and interface. The domain wide authentication must be enabled on every routers within the IS-IS area. Interface authentication must be enable on both sides of the adjacency.
E. To redistribute into IS-IS, you must use the ip keyword.
F. There are 2 types of metric-types that are associated with IS-IS narrow and wide. Wide metrics must be used for MPLS traffic engineering (TLV type 22 and TLV type 135).
G. A subnets keyword must be used when redistributing into OSPF, otherwise only classful networks will be redistributed.

Technical Verification

Technical Verification for Task A

```
---
r1#sh fram map
Serial 1/0.1(up): Point-to-point dlci,dlci 113(0*71.0*1C10),broadcast
       status defined, active
r1#sho ip ospf neigh
Neighbor ID Pri State  Dead Time Address  Interface
192.168.3.3   1  FULL/-  00:00:31   172.16.31.2 Serial1/1
192.168.3.3   1  FULL/-  00:01:31   172.16.100.3 Serial1/0.1
---
r2#sh frame map
Serial1/0.1(up): point-to-point dlci 223(0*DF,0*34F0),broadcast
       Status defined,active
r2#shop ip ospf neigh
Neighbor ID Pri State  Dead Time Address  Interface
192.168.3.3   1  FULL/-  00:00:31   172.16.32.3 Serial1/1
192.168.3.3   1  FULL/-  00:01:48   172.16.100.3 Serial1/0.1
---
r3#sho frame map
Serial1/0.1(up): ip 172.16.100.1 dlci311(0*137,0*4C70), dynamic, broadcast,,status defined,active
Serial1/0.1(up): ip 172.16.100.2 dlci 322(0*147,0*5020),dynamic, broadcast,,status defined,active
Serial1/0.1(up):
ip 172.16.100.4 dlci 334(0*158,0*5480),dynamic, broadcast,,status defined active
r3#sho ip ospf neigh
Neighbor ID Pri State  Dead Time Address  Interface
192.168.2.2   1  FULL/-  00:00:36   172.16.32.2 Serial1/2
192.168.1.1   1  FULL/-  00:00:35   172.16.31.1 Serial1/1
---
```
r4#sh fram map
Serial0/0.1(up): point-to-point dlci,dlci 443(0*1BB,0*6CB0),broadcast
Status defined,active

r4#sho ip ospf neigh
 Neighbor ID Pri State Dead Time Address Interface
192.168.3.3 1 FULL/- 00:01:36 172.16.100.3 Serial0/0.1

Technical Verification For Task B

r1#sho clns neigh

System ID Interface SNPA State Holdtime Type Protocol
r6 Et0/0 0002.fd69.9e00 Up 9 L1 IS-IS
r5 Et0/0 0002.b934.6421 Up 25 L1 IS-IS
r3 Et0/0 0002.b92a.c920 Up 23 L1 IS-IS

r3>sho clns neigh

System ID Interface SNPA State Holdtime Type Protocol
r6 Et0/0 0002.fd69.9e00 Up 8 L1 IS-IS
r5 Se0/0 *HDLC* UP 26 L1 IS-IS
r5 Et0/0 0002.b934.6421 Up 26 L1 IS-IS
r1 Et0/0 0002.1651.eb61 UP 29 L1 IS-IS

r5#sh clns neigh

System ID Interface SNPA State Holdtime Type Protocol
r6 Et/0/0 0002.fd69.9e00 UP 8 L1 IS-IS
r3 Se0/0 *HDLC* UP 22 L1 IS-IS
r3 Et0/0 0002.b92a.c920 Up 26 L1 IS-IS
r1 Et0/0 0002.1651.eb61 UP 28 L1 IS-IS

r6#sh clns neigh

System ID Interface SNPA State Holdtime Type Protocol
Tenchnical Verification For Task C

r3#sho ip route 192.168.5.0
Routing entry for 192.168.5.0/24
Known via "isis", distance 115, metric 20, type level-1
Redistributing via isis
Last update from 172.16.136.5 on Ethernet0/0, 00:00:29 ago
Routing Descriptor Blocks:
* 172.16.35.2, from 192.168.5.5, via Serial1/3
  Route metric is 20, traffic share count is 1
  172.16.136.5, from 192.168.5.5, via Ethernet0/0
  Route metric is 20, traffic share count is 1

r3#sho ip route 192.168.6.0
Routing entry for 192.168.6.0/24
Known via "isis", distance 115, metric 10, type level-1
Redistributing via isis
Last update from 172.16.136.6 on Ethernet0/0, 00:01:37 ago
Routing Descriptor Blocks:
* 172.16.136.6, from 192.168.6.6, via Ethernet0/0
  Route metric is 10, traffic share counts is 1

Technical Verification For Task D

r3#sho clns neigh

<table>
<thead>
<tr>
<th>System ID</th>
<th>Interface</th>
<th>SNPA</th>
<th>State</th>
<th>Holdtime</th>
<th>Type</th>
<th>Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>r6</td>
<td>Et0/0</td>
<td>0002.fd69.9e00</td>
<td>UP</td>
<td>7</td>
<td>L1</td>
<td>IS-IS</td>
</tr>
<tr>
<td>r5</td>
<td>Se1/3</td>
<td><em>HDLC</em></td>
<td>UP</td>
<td>27</td>
<td>L1</td>
<td>IS-IS</td>
</tr>
<tr>
<td>r5</td>
<td>Et0/0</td>
<td>0002.b934.6421</td>
<td>UP</td>
<td>23</td>
<td>L1</td>
<td>IS-IS</td>
</tr>
<tr>
<td>r1</td>
<td>Et0/0</td>
<td>0002.1651.eb61</td>
<td>UP</td>
<td>26</td>
<td>L1</td>
<td>IS-IS</td>
</tr>
</tbody>
</table>

Technical Verification For Task E

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r1#sho ip route isis
  172.16.0.0/16 is variably subnetted, 10 subnets, 6 masks
  i L1 172.16.35.0/30[115/20] via 172.16.136.3, Ethernet0/0
  [115/20] via 172.16.136.5, Ethernet0/0
  i L1 192.168.5.0/24[115/20] via 172.16.136.5, Ethernet0/0
  i L1 192.168.6.3/24[115/10] via 172.16.136.6, Ethernet0/0

r3#sho ip route isis
  172.16.0.0/16 is variably subnetted, 10 subnets, 6 masks
  i L1 172.16.15.0/28[115/20] via 172.16.136.1, Ethernet0/0
  [115/20] via 172.16.35.2, Serial1/3
  [115/20] via 172.16.136.5, Ethernet0/0
  i L1 192.168.5.0/24[115/20] via 172.16.35.2, Serial1/3
  [115/20] via 172.16.136.5, Ethernet0/0
  10.0.0.0/8 is variably subnetted, 4 subnets, 3 masks
  i su 10.10.100.0/23[115/0] via 0.0.0.0, Null0
  i L1 192.168.6.0/24[115/0] via 172.16.136.6, Ethernet0/0

r5#sho ip route isis
  10.0.0.0/23 is subnetted, 1 subnets
  i L1 10.10.100.0[115/10] via 172.16.35.1, Serial0/0
  [115/10] via 172.16.136.3, Ethernet0/0
  i L1 192.168.6.0/24[115/10] via 172.16.136.6, Ethernet0/0

r6#sho ip route isis
  172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
  i L1 172.16.35.0/30[115/20] via 172.16.136.3, FastEthernet0/0
  [115/20] via 172.16.136.5, FastEthernet0/0
  i L1 172.16.15.0/28[115/20] via 172.16.136.1, FastEthernet0/0
  [115/20] via 172.16.136.5, FastEthernet0/0
  i L1 192.168.5.0/24[115/20] via 172.16.136.5, FastEthernet0/0
  10.0.0.0/23 is subnetted, 2 subnets
  i L2 10.10.100.0[115/10] via 172.16.136.3, FastEthernet0/0

Technical Verification For Task F

r1#sho clns protocol
  IS-IS Router: <Null Tag>
  System id: 1921.6800.1001.00 IS-Type: level-1
  Manual area address(es):

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Interfaces supported by IS-IS:

TokenRing0/0-ip
Ethernet0/0-IP

Redistribute:
Static(on by default)
Distance for L2 CLNS routes: 110
RRR level: none
Generate narrow metrics:none
Accept narrow metrics:level-1-2

r3#sho clns protocol

IS-IS routers::<Null Tag>
System id: 19221.6800.3003.00 IS-Type:level-1-2
Manual area address(es):

49.0002

Interfaces supported by IS-IS:

49.0002

Interfaces supported by IS-IS:
Serial 1/3-IP
Ethernet0/0-IP

Redistribute:
Static(on by default)
Distance for L2 clns Routes: 110
RRR level: none
Generate narrow metrics: none
Accept narrow metrics: level-1-2
Generate wide metrics: level-1-2
Accept wide metrics: level-1-2
Generate wide metrics: level-1-2
Accept wide metrics: level-1-2

Technical Verification For Tasks G

The routing of all routers are inclined here. The legend normally provided in router output has been deleted.

r1#sho ip route
172.16.0.0/16 is variably subnetted, 10 subnets, 6 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
O 172.16.32.0/24 [110/829] via 172.16.31.2, 00:02:51, Serial1/1
    [110/829] via 172.16.100.3, 00:02:51, Serial 1/0.1
i L1 172.16.35.0/30 [115/20] via 172.16.136.3, Ethernet0/0
C 172.16.31.0/30 is directly connected, Serial1/1
C 172.16.15..0/28 is directly connected, TokenRing0/0
O 172.16.100.0/29 is directly connected, Serial1/1
O 172.16.2.0/24 [110/829] via 172.16.100.3, 00:02:52, Serial1/0.1
O 172.16.100.2/32 [110/829] via 172.16.100.3, 00:02:53, Serial1/1
C 172.16.100.3/32 [110/829] via 172.16.100.3, 00:02:53, Serial1/1
192.168.4.0/32 is subnetted, 1 subnets
O 192.168.4.4 [110/830] via 172.16.100.3, 00:02:53, Serial1/1
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O 10.1.4.0/22 [110/839] via 172.16.100.3, 00:02:53, Serial1/0.1
O E2 10.10.100.0/23 [110/10] via 172.16.31.2, 00:02:54, Serial1/1
    [110/10] via 172.16.31.2, 00:02:54, Serial1/1
O E2 192.168.6.0/24 [110/10] via 172.16.100.3, 00:02:54, Serial1/1
    [110/10] via 172.16.100.3, 00:02:54, Serial1/1
C 192.168.1.0/24 is directly connected, Loopback0
192.168.2.0/32 is subnetted, 1 subnets
O 192.168.3.3 [110/49] via 172.16.100.3, 00:02:54, Serial1/0.1
192.168.3.0/32 is subnetted, 1 subnets
O 192.168.3.3 [110/49] via 172.16.100.3, 00:02:54, serial 1/0.1
    [110/49] via 172.16.31.2, 00:02:54, serial1/1
r2#sho ip route
172.16.0.0/16 is variably subnetted, 8 subnets, 5 masks
C 172.16.32.0/24 is directly connected, Serial 1/1
O 172.16.31.0/30 [110/829] via 172.16.32.3, 00:05:43, Serial1/1
    [110/829] via 172.16.100.3, 00:05:43, Serial 1/0.1
O E2 172.16.15.0/28 [110/10] via 172.16.32.3, 00:05:43, Serial1/1
    [110/10] via 172.16.100.3, 00:05:43, Serial1/0.1

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C 172.16.2.0/24 is directly connected, TokenRing0/0
C 172.16.100.0/29 is directly connected, Serial 1/0.1
O 172.16.100.1/32[110/829] via 172.16.100.3, 00:05:44, Serial1/0.1
    [110/829] via 172.16.32.3, 00:05:44, Serial1/1
O 172.16.100.3/32[110/48] via 172.16.100.3, 00:10:0.3, Serial1/0.1
    [100/48] via 172.16.32.3, 00:05:44, Serial1/1
O 172.16.100.4/32[110/829] via 172.16.100.3, Serial1/0.1
    [110/829] via 172.16.32.3, 00:05:44, Serial 1/1
192.168.4.0/32 is subnetted, 1 subnets
O 192.168.4.4[110/830] via 172.16.100.3, 00:05:44, Serial1/1
O E2 192.168.5.0/24[110/10] via 172.16.32.3, 00:05:44, Serial1/1
    [110/10] via 172.16.100.3, 00:05:44, Serial1/0.1
    10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O 10.1.4.0/22[110/839] via 172.16.100.3, 00:05:44, Serial1/0.1
    [110/839] via 172.16.32.3, 00:05:44, Serial1/1
O E2 10.10.100.0/23[110/10] via 172.16.32.3, 00:05:44, Serial 1/1
    [110/10] via 172.16.32.3, 00:05:44, Serial1/0.1
O E2 192.168.6.0/24[110/10] via 172.16.32.3, 00:05:44, Serial1/0.1
    [110/10] via 172.16.100.3, 00:05:44, Serial1/0.1
192.168.1.0/32 is subnetted, 1 subnets
O 192.168.1.1[110/830] via 172.16.100.3, 00:05:46, Serial1/1
    [110/830] via 172.16.32.3, Serial1/1
C 192.168.2.0/24 is directly connected, Loopback0
192.168.3.0/32 is subnetted, 1 subnets
O 192.168.3.3[110/49] via 172.16.100.3, 00:05:46, Serial 1/0.1
    [110/49] via 172.16.32.3, 00:05:46, Serial1/1

r3#sho ip route
    192.16.0.0/16 is variably subnetted, 10 subnets, 6 Masks
C 192.16.136.0/26 is directly connected, Ethernet0/0
C 192.16.32.0/24 is directly connected, Serial1/2
C 192.16.35.0/30 is directly connected, Serial1/3
C 192.16.31.0/30 is directly connected, Serial1/1
i L1 172.16.15.0/28[115/20] via 172.16.35.2, Serial1/3
    [115/20] via 172.16.136.5, Ethernet0/0
    [115/20] via 172.16.136.1, Ethernet0/0
O 172.16.2.0/24[110/787] via 172.16.100.2, Serial1/0.1
    [110/787] via 172.16.32.2, 00:06:29, Serial 1/2
C 172.16.100.0/29 is directly connected, Serial1/0.1
O 172.16.100.1/32[110/781] via 172.16.100.1, 00:06:29, Serial1/0.1
    [110/781] via 172.16.31.1, 00:06:29, Serial1/1
O 172.16.100.2/32[110/781] via 172.16.100.2, 00:06:32, Serial1/0.1
    [110/781] via 172.16.32.2, 00:06:32, Serial 1/2

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O 172.16.100.4/32 [110/781] via 172.16.100.4, 00:06:32, Serial1/0
  192.168.4.0/32 is subnetted, 1 subnets
O 192.168.4.4 [110/782] via 172.16.100.4, 00:06:32, Serial1/0
iL1 192.168.5.0/24 [115/20] via 172.16.35.2, Serial1/3
  [115/20] via 172.16.136.5, Ethernet0/0
  10.0.0.0/8 is variably subnetted, 4 subnets, 3 masks
O 10.1.4.0/22 [110/791] via 172.16.100.4, 00:05:32, Serial1/0
i su 10.10.100.0/23 [115/0] via 0.0.0.0, Null0
S 10.10.101.0/24 is directly connected, Null0
S 10.10.101.0/24 is directly connected, Null0
iL1 192.168.6.0/24 [115/10] via 172.16.136.6, Ethernet0/0
  192.168.1.0/32 is subnetted, 1 subnets
O 192.168.1.1 [110/782] via 172.16.100.1, 00:06:32, Serial1/0
  [110/782] via 172.16.31.1, 00:06:32, Serial1/1
O 192.168.2.0/32 [110/782] via 172.16.100.2, 00:06:33, Serial1/0
  [110/782] via 172.16.32.2, 00:06:33, Serial1/2
S 192.168.3.0/24 is directly connected, Loopback0

r4#sho ip route

172.16.0.0/16 is variably, 8 subnets, 5 masks
O 172.16.32.0/24 [110/845] via 172.16.100.3, 00:07:09, Serial0/0
O 172.16.31.0/30 [110/845] via 172.16.100.3, 00:07:09, Serial0/0
O E2 172.16.31.0/30 [110/845] via 172.16.100.3, 00:07:09, Serial0/0
O 172.16.2.0/24 [110/851] via 172.16.100.3, 00:06:09, Serial0/0
O 172.16.100.0/29 is directly connected, Serial0/0
O 172.16.100.1/32 [110/845] via 172.16.100.3, 00:07:09, Serial0/0
O 172.16.100.2/32 [110/845] via 172.16.100.3, 00:07:10, Serial0/0
O 172.16.100.3/32 [110/845] via 172.16.100.3, 00:07:11, Serial0/0
O E2 192.168.5.0/24 [110/10] via 172.16.100.3, 00:07:10, Serial0/0
  10.0.0.0/8 is variably subnetted, Ethernet0/0
C 10.1.4.0/22 is directly connected, Ethernet0/0
O E2 10.10.100.0/23 [110/10] via 172.16.100.3, 00:07:11, Serial0/0
O E2 192.168.6.0/24 [110/10] via 172.16.100.3, 00:07:11, Serial0/0
  192.168.1.0/32 is subnetted, 1 subnets
O 192.168.1.1 [110/846] via 172.16.100.3, 00:07:11, Serial0/0
O 192.168.2.0/32 [110/846] via 172.16.100.3, 00:07:11, Serial0/0
O 192.168.3.0/32 [110/65] via 172.16.100.3, 00:07:11, serial0/0

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r5#sho ip route
172.16.0.0/16 is variably subnetted, 10 subnets, 6 masks
C 172.16.100.0/24 is correctly connected, Ethernet0/0
i L2 172.16.32.0/24[115/20] via 172.16.35.1, Serial0/0
[115/20] via 172.16.136.3, Ethernet0/0
C 172.16.35.0/30 is directly connected, Serial0/0
i L2 172.16.31.0/30[115/20] via 172.16.35.1, Serial0/0
[115/20] via 172.16.136.3, Ethernet0/0
C 172.16.255.0/24 is correctly connected, FastEthernet0/0
i L2 172.16.32.0/24[115/20] via 172.16.35.1, Serial0/0
[115/20] via 172.16.136.3, Ethernet0/0
C 192.168.4.0/32 is subnetted, 1 Serial0/0
i L2 192.168.4.4[115/20] via 172.16.35.1, Serial0/0
[115/20] via 172.16.136.3, Ethernet0/0
C 192.168.5.0/24 is directly connected, Loopback0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
i L2 10.1.4.0/22[115/20] via 172.16.35.1, Serial0/0
[115/20] via 172.16.136.3, Ethernet0/0
i L2 10.10.100.0/23[115/10] via 172.16.35.1, Serial0/0
[115/10] via 172.16.136.3, Ethernet0/0
i L1 192.168.6.0/24[115/10] via 172.16.136.6, Ethernet0/0
192.168.1.0/32 is subnetted, 1 subnets
i L2 192.168.1.1[115/20] via 172.16.35.1, Serial0/0
[115/20] via 172.16.136.3, Ethernet0/0
192.168.2.0/32 is subnetted, 1 subnets, 1 subnets
i L2 192.168.2.2[115/20] via 172.16.35.1, Serial0/0
[115/20] via 172.16.136.3, Ethernet0/0

r6#sho ip route
172.16.0.0/16 is variably subnetted, 10 subnets, 6 masks
C 172.16.135.0/26 is correctly connected, FastEthernet0/0
i L2 172.16.32.0/24[115/20] via 172.16.136.3, FastEthernet0/0
[115/20] via 172.16.136.3, FastEthernet0/0

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i L2 172.16.31.0/30[115/20] via 172.16.136.3, FastEthernet0/0
i L1 172.16.15.0/28[115/20] via 172.16.136.5, FastEthernet0/0
    [115/20] via 172.16.136.1, FastEthernet0/0
i L2 172.16.2.0/24[115/20] via 172.16.136.3, FastEthernet0/0
i L2 172.16.100.0/29[115/20] via 172.16.136.3, FastEthernet0/0
i L2 172.16.100..0/29[115/20] via 172.16.136.3, FastEthernet0/0
i L2 172.16.100.0/29[115/20] via 172.16.136.3, FastEthernet0/0
i L2 172.16.100.2/32[115/20] via 172.16.136.3, FastEthernet0/0
i L2 172.16.100.4/32[115/20] via 172.16.136.3, FastEthernet0/0
192.168.4.0/32 is subnetted, 1 subnets
i L2 192.168.4.4[115/20] via 172.16.136.3, FastEthernet0/0
i L1 192.168.5.0/24[115/20] via 172.16.136.5, FastEthernet0/0
10.0.0.0/8 is Variably subnetted, 3 subnets, Ethernet2/0
C 10.2.6.0/23 is directly connected, Ethernet2/0
i L2 10.1.4.0/22[115/20] via 172.16.136.3, FastEthernet0/0
i L2 10.10.100.0/23[115/20] via 172.16.136.3, FastEthernet0/0
C 192.168.60/24 is directly connected, Loopback0
192.168.1.0/32 is subnetted, 1 subnets
i L2 192.168.1.1[115/20] via 172.16.1363, FastEthernet0/0
192.168.2.0/32 is subnetted, 1 subnets
i L2 192.168.2.2[115/20] via 172.16.136.3, FastEthernet0/0

**Configuration Verification**

_only relevant portions of the configuration have been included._

**routers 1**

```
rl#sh run
host name r1
!
interface Loopback0
    ip address 192.168.1.1 225.255.0
!
interface Ethernet0/0
ip address 172.16.136.1 225.255.255.192
ip routers isis
half-duplex
!
interface Token Ring0/0
ip address 172.16.15.1 225.255.255.240
```
ring-speed 16
!
interface Serial1/0
no ip address
encapsulation frame-relay
!
interface Serial 1/0.1 point-to-point
ip address 172.16.100.1 225.255.255.248
ip ospf network point-to-point
frame-relay interface-dlci 113
!
interface Serial1/1
ip address 172.16.31.1 255.255.255.252
!
router ospf 1
log-adjacency-changes
network 172.16.31.1 225.255.255.252
!
router ospf 1
log-adjacency-changes
network 172.16.31.0.0.0.0.3 area 0
network 172.16.100.0.0.0.0.7 area 0
network 192.168.1.0.0.0.0.255 area 0
!
router isis
net 49.0002.1921.6800.1001.00
is-type-level-1
area-Password testking
metric-style wide transition

Router 2

r2#sh run
hostname r2
!
interface Loopback0
ip address 192.168.2.2 225.255.255.0
!
interface BRI0/0
no ip address
shutdown
half-duplex
!
interface Ethernet0/0
no ip address
shutdown
half-duplex
interface TokenRing0/0
ip address 172.16.2.2 225.225.225.0
ring-speed 16

interface Serial 1/0.1 point-to-point
ip address 172.16.100.2 225.225.248
ip ospf network point-to-point
ip address 172.16.100.2 225.225.225.248
frame-relay interface-dlci 223

interface Serial 1/1
ip address 172.16.32.2 225.225.255.0

router ospf 1
log-adjacency-changes
network 172.16.2.0.0.0.0.225 area 0
network 172.16.32.0.0.0.0.3 area 0
network 172.16.100.0.0.0.0.7 area 0
network 192.1682.0.0.0.0.225 area 0

Router 3
r3#sh run
hostname r3
interface Loopback0
ip address 192.168.3.3 255.255.255.192
ip router isis
half-duplex

interface BRI0/0
no ip address
shutdown

interface Serial1/0
no ip address
encapasulation frame-relay

interface Serial 1/1
ip address 172.16.31.2 255.255.255.248
clockrate 64000

interface Serial1/2
ip address 172.16.32.2 255.255.255.0
clockrate 64000

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router ospf 1
log-adjacency-changes
redistribute isis level-2 metric 10 subnets
network 172.16.31.0.0.0.0.3 area 0
network 172.16.32.0.0.0.0.3 area 0
network 172.16.100.0.0.0.0.7 area 0
network 192.168.3.0.0.0.0.255 area 0
!
router isis
summary-address 10.10.100.0 255.255.254.0 level-1-2
redistribution static ip
redistribution ospf 1 metric 10 match internal external 1 external 2
    net 49.0002.1921.6800.3003.00
area-password testking
metric-style wide transition
!
ip route 10.10.100.0 255.255.255.0 Null0
ip route 10.10.101.0 255.255.255.0 Null

**Router 4**

r4#sh run
hostname r4
interface loopback0
ip address 192.168.4.4 255.255.0
!
interface Ethernet0/0
ip address 10.1.4.4 255.255.255.0
half-duplex
!
interface Serial0/0
no ip address
encapsulation frame-relay
!
interface Serial0/0.1 point-to-point
ip address 172.16.100.4 255.255.255.248
ip ospf network point-to-multipoint
frame-relay interface-dlci 443
!
interface Serial 0/1
no ip address
shutdown
! router ospf 1
log-adjacency-changes
network 10.1.4.0.0.0.3.255 area 0
network 172.16.100.0 0.0.0.7 area 0
network 192.168.4.0 0.0.0.255 area 0

**Router 5**

```
r5#sh run
hostname r5
interface Loopback0
ip address 192.168.5.5 255.255.255.0
ip router isis
!
interface Ethernet0/0
ip address 172.16.136.5 255.255.255.192
ip router isis
half-duplex
!
interface Serial0/0
ip address 172.16.35.2 255.255.255.252
ip router isis
!
interface Serial0/1
no ip address
shutdown
!
inertface ATM1/0
no ip address
shutdown
no atm ilmi-keepalive
!
router isis
net 49.0002.1921.6800.5005.00
area-password testking
metric-style wide
```
interface ATM1/0
no ip address
no ip directed-broadcast
shutdown
no atm ilmi-keepalive

interface Ethernet2/0
ip address 10.2.6.6 255.255.
no ip directed-broadcast

router isis
passive-interface Loopback0
net 49.0002.1921.6800.6006.00
area-password testking
metric-style wide transition
Lab Preparation Scenario: RIP

Topics Covered

- RIPv1/v2
- Split-Horizon
- Authentication
- Unicast updates
- Update Validation
- Auto-Summarization
- Route Filtering
- Route Metrics

Difficulty Level: CCIE TM

Average Completion Time: 2 Hours

Standard Topology
Standard TCP/IP Addressing and SPID Information

**R1 (3620)**
- Loop0 192.168.1.1 /24  Loopback
- E0/0 172.16.136.1 /26  Ethernet Segment to Catalyst 3/1
- T0/0 172.16.15.1 /28  Token Ring Segment to 3920
- S1/1 172.16.31.1 /30  Serial to R3
- S1/0 unassigned  Frame-relay

**R2 (3620)**
- Loop0 192.168.2.2 /24  Loopback
- T0/0 172.16.2.2 /24  Token Ring Segment to 3920
- BRI0/0 172.16.230.2 /24  BRI to R3
- S1/1 172.16.32.2/24  Serial to R3
- S1/0 unassigned  Frame-relay

**R3 (2610)**
- Loop0 192.168.3.3 /24  Loopback
- E0/0 172.16.136.3 /26  Ethernet Segment to Catalyst 3/3
- BRI0/0 172.16.230.3 /24  ISDN to R2
- S1/3 172.16.35.1 /30  Serial to R5
- S1/2 172.16.32.3/24  Serial to R2

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S1/1  172.16.31.2/30  Serial to R1
S1/0  unassigned  Frame-relay

R4 (2610)
Loop0  192.168.4.4  /24  Loopback
E0/0  10.1.4.4  /22  Ethernet Segment to BB1
S0/0  unassigned  Frame-Relay

R5 (3620)
Loop0  192.168.5.5  /24  Loopback
E0/0  172.16.136.5  /26  Ethernet Segment to Catalyst3/5
T0/0  172.16.15  /28  Token Ring Segment to 3920
S0/0  172.16.35.2  /30  Serial link to R3
A1/0  172.16.56.5  /30  ATM – R6

R6 (3640)
Loop0  192.168.6.6  /24  Loopback
FA0/O  172.16.136.6  /26  Ethernet segment – R2
E2/0  10.2.6.6  /23  Ethernet segment – BB2
A1/0  172.16.56.6  /30  ATM – R5

ISDN Information
Switch Type  Basic-NI1

R2
SPID1:  42255501210101
SPID2:  42255501220101

R3
SPID1:  42255501310101
SPID2:  42255501320101

Technical Tasks

A. Using only physical interfaces, configure the frame-relay interfaces such that R2 is the hub with
   R1, R3, and R4 as spokes.
   Use only the DLCI’s necessary to make R2 the hub.
   Do not make use of any other DLCI’s.
   All interfaces should be part of 172.16.100.0/24.
B. Shutdown subnets 172.16.15.0/28 and 172.16.35.0/30.
   All other interfaces except ATM and ISDN will be used in this lab.
   Enable RIP on the 172.16.100.0/24 subnet.
C. Enable RIP in the p-t-p interface between R2 and R3.

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This link should use the strongest possible authentication for routing updates.

D. Using RIPv1 on the p-t-p interface between R3 and R1, configure the routers to send updates using unicast addresses.

E. Configure RIP on R5 and R6.
   Do not use the “network” for the loopback of R5.
   192.168.5.0/24 must be in the routing table of R1, R3, and R6 with a hop-count of 5.

F. Configure R4 to disregard the source address of updates received from R2.
   All other subnets, including loopbacks must be in the routing tables of all routers.

All subnets/interfaces that participate in RIP must be reachable from all routers.

Instructor’s Comments and Technical Tips

A. To avoid using other DLCI’s you need to disable inverse-arp.
   Without inverse-arp you should use map statements.

B. Use RIPv2 to make life easier later.
   If not you will end up with discontiguous addressing for network 10.0.0.0.
   RIPv2 will auto-summarize at classful boundaries.
   You should disable this feature.

   Enabling RIP on this subnet may sound simple but watch for problems with routing loops and split-horizon.
   If you disable split-horizon on R1, R3, and R4, by design you should disable it on R3 also.
   This would prevent routes from being advertised to the spokes.
   You can work around this by configuring neighbors and making the interfaces passive.
   To test this shutdown other point-to-point links and work with just the loopbacks and the 172.16.100.0/24 subnet.

C. RIPv1 does not support authentication, you need to use v2.
   This requires interface commands and global key chain commands.

D. You should have made RIPv2 the default version under the routing process.
   You can force v1 updates at the interface level.
   This will have the undesirable effect of having R3 send a classful update for 10.0.0.0/9 to R1,
   which will in turn propagate the route out other interfaces.
   You should prevent R1 from propagating this route.
   I hope you ran into this problem before reading this tip.
   If you did and corrected the problem, two points for you!

   RIP sends updates to 255.255.255.255.
   Using the “neighbor” command under RIP will force RIP to use unicast packets for routing updates.
   You should also make the interfaces passive.

E. R6 must be configured to send and receive RIPv1 and v2.

F. By default the router will validate the source address of all incoming routing updates.
   You can disable this feature under the routing process.
Use the “no” form of the command.

Technical Verification

Technical Verification For Task A

r1#sh fram map
Serial1/0(up): ip 172.16.100.2 dlci 122(0x7A,0x1CA0), static, broadcast, CISCO, status defined, active
Serial1/0(up): ip 172.16.100.3 dlci 122(0x7A,0x1CA0), static, broadcast, CISCO, status defined, active
Serial1/0(up): ip 172.16.100.4 dlci 122(0x7A,0x1CA0), static, broadcast, CISCO, status defined, active

r2#sh fram map
Serial1/0(up): ip 172.16.100.1 dlci 221(0xDD,0x34D0), static, broadcast, CISCO, status defined, active
Serial1/0(up): ip 172.16.100.3 dlci 223(0xDF,0x34F0), static, broadcast, CISCO, status defined, active
Serial1/0(up): ip 172.16.100.4 dlci 224(0xE0,0x3800), static, broadcast, CISCO, status defined, active

r3#sh fram map
Serial1/0(up): ip 172.16.100.1 dlci 322(0x142,0x5020), static, broadcast, CISCO, status defined, active
Serial1/0(up): ip 172.16.100.2 dlci 322(0x142,0x5020), static, broadcast, CISCO, status defined, active
Serial1/0(up): ip 172.16.100.4 dlci 322(0x142,0x5020), static, broadcast, CISCO, status defined, active

r4#sh fram map
serial0/0(up): ip 172.16.100.1 dlci 422(0x1A6,0x6860), static, broadcast, CISCO, status defined, active
Serial0/0(up): ip 172.16.100.2 dlci 422(0x1A6,0x6860), static,
Technical Verification For Task B

```
r2#sh ip protocols
Routing Protocol is "rip"
   Sending updates every 30 seconds, next due in 16 seconds
   Invalid after 180 seconds, hold down 180, flushed after 240
   Outgoing update filter list for all interfaces is
   Incoming update filter list for all interfaces is
   Redistributing: rip
Neighbor(s):
   172.16.100.1
   172.16.100.3
   172.16.100.4
Default version control: send version 2, receive version 2
   Interface       Send    Revc   Triggered RIP Key-chain
   Serial1/1       2       2          testking
Automatic network summarization is not in effect
Routing for Networks:
   172.16.0.0
   192.168.2.0
Passive Interface(s):
   TokenRing0/0
   Serial1/0
   Loopback0
Routing Information Sources:
   Gateway     Distance  Last Update
   Gateway     Distance  Last Update
   172.16.32.3  120      00:00:03
   172.16.100.1 120      00:00:13
   172.16.100.3 120      00:00:03
   172.16.100.4 120      00:00:04
```

Technical Verification For Task C

```
r2#deb ip rip
RIP protocol debugging is on
r2#clear ip ro *
r2#
```
07:02:53: RIP: sending request on Serial1/1 to 224.0.0.9
07:02:53: RIP: received packet with MD5 authentication
07:02:53: RIP: received v2 update from 172.16.32.3 on Serial1/1
07:02:53: 10.2.6.0/23 via 0.0.0.0 in 2 hops
07:02:53: 172.16.31.0/30 via 0.0.0.0 in 1 hops
07:02:53: 172.16.100.0/24 via 0.0.0.0 in 1 hops
07:02:53: 172.16.136.0/24 via 0.0.0.0 in 1 hops
07:02:53: 172.16.136.0/26 via 0.0.0.0 in 1 hops
07:02:53: 172.16.136.0/26 via 0.0.0.0 in 1 hops
07:02:53: 172.16.136.0/26 via 0.0.0.0 in 1 hops
07:02:53: 192.168.1.0/24 via 0.0.0.0 in 2 hops
07:02:53: 192.168.1.0/24 via 0.0.0.0 in 2 hops
07:02:53: 192.168.5.0/24 via 0.0.0.0 in 6 hops
07:02:53: 192.168.6.0/24 via 0.0.0.0 in 2 hops

Technical Verification For Task D

r1#deb ip rip
RIP protocol debugging is on
r1#clear ip ro
----output omitted----
02:26:10 RIP: sending v1 update to 172.16.31.2 via Serial1/1 (172.16.31.1)

Technical Verification For Task E

r6#sh ip ro 192.168.5.0
Routing entry for 192.168.5.0/24
Known via “rip”, distance 120, metric 5
Redistributing via rip
   Last update from 172.16.136.5 on FastEthernet0/0, 00:00:09 ago
Routing Descriptor Blocks:
* 172.16.136.5, from 172.16.136.5, 00:00:09 ago, via FastEthernet0/0
   Route metric is 5, traffic share count is 1

Technical Verification For Task E

Routing tables of all routers are included here. The legend normally provided in router output has been deleted.

Router 1

r1#sh ip ro
172.16.0.0/16 is variably subnetted, 5 subnets, 3 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
R 172.16.32.0/24 [120/1] via 172.16.3, 00:00:19, Ethernet0/0
   [120/1] via 172.16.100.2, 00:00:09, Serial1/0

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C  172.16.31.0/30 is directly connected, Serial1/1
R  172.16.2.0/24 [120/1] via 172.16.100.2, 00:00:09, Serial1/0
C  172.16.100.0/24 is directly connected, Serial1/0
R  192.168.5.0/24 [120/5] via 172.16.136.5, 00:00:12, Ethernet0/0
10.0.0.0/8 is variably subnetted, 3 subnets, 3 masks
R  10.0.0.0/8 [120/2] via 172.16.31.1, 00:00:20, Serial1/1
R  10.2.6.0/23 [120/1] via 172.16.136.6, 00:00:03, Ethernet0/0
R  10.1.4.0/22 [120/2] via 172.16.100.4, 00:00:10, Serial1/0
R  192.168.6.0/24 [120/1] via 172.16.136.6, 00:00:03, Ethernet0/0
C  192.168.1.0/24 is directly connected, Loopback0
R  192.168.2.0/24 [120/1] via 172.16.100.2, 00:00:11, Serial1/0
R  192.168.3.0/24 [120/1] via 172.16.136.3, 00:00:21, Ethernet0/0
  [120/1] via 172.16.31.2, 00:00:21, Serial1/1

Router 2

r2#sh ip ro
172.16.0.0/16 is variably subnetted, 5 subnets, 3 masks
R  172.16.136.0/26 [120/1] via 172.16.32.3, 00:00:09, Serial1/1
  [120/1] via 172.16.100.3, 00:00:09, Serial1/0
  [120/1] via 172.16.100.1, 00:00:19, Serial1/0
C  172.16.32.0/24 is directly connected, Serial1/1
R  172.16.31.0/30 [120/1] via 172.16.32.3, 00:00:09, Serial1/1
  [120/1] via 172.16.100.3, 00:00:09, Serial1/0
  [120/1] via 172.16.100.1, 00:00:19, Serial1/0
C  172.16.2.0/24 is directly connected, TokenRing0/0
C  172.16.100.0/24 is directly connected, Serial1/0
R  192.168.4.0/24 [120/1] via 172.16.100.4, 00:00:09, Serial1/0
R  192.168.5.0/24 [120/6] via 172.16.32.3, 00:00:10, Serial1/1
  [120/6] via 172.16.100.3, 00:00:10, Serial1/0
  [120/6] via 172.16.100.1, 00:00:20, Serial1/0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
R  10.2.6.0/23 [120/2] via 172.16.32.3, 00:00:10, Serial1/1
  [120/2] via 172.16.100.3, 00:00:10, Serial1/0
  [120/2] via 172.16.100.1, 00:00:20, Serial1/0
R  10.1.4.0/22 [120/1] via 172.16.100.4, 00:00:09, Serial1/0
R  192.168.6.0/24 [120/2] via 172.16.100.4, 00:00:10, Serial1/1
  [120/2] via 172.16.100.3, 00:00:10, Serial1/0
  [120/2] via 172.16.100.1, 00:00:20, Serial1/0
R  192.168.1.0/24 [120/1] via 172.16.100.1, 00:00:20, Serial1/1
C  192.168.2.0/24 is directly connected, Loopback0
R  192.168.3.0/24 [120/1] via 172.16.32.3, 00:00:10, Serial1/1
  [120/1] via 172.16.100.3, 00:00:12, Serial1/0

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Router 3

r3#sh ip ro

172.16.0.0/16 is variably subnetted, 5 subnets, 3 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
C 172.16.32.0/24 is directly connected, Serial1/2
C 172.16.31.0/30 is directly connected, Serial1/1
R 172.16.2.0/24 [120/1] via 172.16.100.2, 00:00:21, Serial1/0
  [120/1] via 172.16.32.2, 00:00:21, Serial1/2
C 172.16.100.0/24 is directly connected, Serial1/0
R 192.168.4.0/24 [120/2] via 172.16.100.4, 00:00:21, Serial1/0
  [120/2] via 172.16.32.2, 00:00:22, Serial1/2
R 10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
R 10.2.6.0/23 [120/1] via 172.16.136.6, 00:00:12, Ethernet0/0
R 10.1.4.0/22 [120/2] via 172.16.100.4, 00:00:22, Serial1/0
  [120/2] via 172.16.32.2, 00:00:22, Serial1/2
R 192.168.6.0/24 [120/1] via 172.16.136.6, 00:00:12, Ethernet0/0
R 192.168.1.0/24 [120/1] via 172.16.136.1, 00:00:16, Ethernet0/0
  [120/1] via 172.16.31.1, 00:00:16, Serial1/1
R 192.168.2.0/24 [120/1] via 172.16.32.2, 00:00:22, Serial1/2
  [120/1] via 172.16.100.2, 00:00:22, Serial1/0
C 192.168.3.0/24 is directly connected, Loopback0

Router 4

G. R4#sh ip ro

172.16.0.0/16 is variably subnetted, 5 subnets, 3 masks
R 172.16.136.0/26 [120/2] via 172.16.100.3, 00:05:02, Serial1/0
  [120/2] via 172.16.100.1, 00:00:00, Serial1/0
R 172.16.32.0/24 [120/1] via 172.16.10.2, 00:00:00, Serial1/0
R 172.16.31.0/30 [120/2] via 172.16.100.3, 00:05:02, Serial1/0
  [120/2] via 172.16.100.1, 00:00:00, Serial1/0
R 172.16.2.0/24 [120/1] via 172.16.100.2, 00:00:00, Serial1/0
C 172.16.10.0/24 is directly connected, Serial1/0
C 192.168.4.0/24 is directly connected, Loopback0
R 192.168.5.0/24 [120/7] via 172.16.100.3, 00:05:03, Serial1/0
  [120/7] via 172.16.100.1, 00:00:01, Serial1/0
R 10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
R 10.2.6.0/23 [120/3] via 172.16.100.3, 00:05:03, Serial1/0
  [120/3] via 172.16.100.1, 00:00:01, Serial1/0
C 10.1.4.0/22 is directly connected, Ethernet0/0
R 192.168.6.0/24 [120/3] via 172.16.100.3, 00:05:03, Serial1/0
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[120/3] via 172.16.100.1, 00:00:01, Serial0/0
R 192.168.1.0/24 [120/2] via 172.16.100.1, 00:00:01, Serial0/0
R 192.168.2.0/24 [120/1] via 172.16.100.2, 00:00:01, Serial0/0
R 192.168.3.0/24 [120/2] via 172.16.100.3, 00:00:01, Serial0/0

Router 5

H. R5#sh ip ro
172.16.0.0/16 is variably subnetted, 5 subnets, 3 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
R 172.16.32.0/24 [120/1] via 172.16.136.3, 00:00:16, Ethernet0/0
R 172.16.31.0/30 [120/1] via 172.16.136.3, 00:00:16, Ethernet0/0
R 172.16.2.0/24 [120/2] via 172.16.136.1, 00:00:02, Ethernet0/0
R 172.16.100.0/24 [120/1] via 172.16.136.3, 00:00:17, Ethernet0/0
R 172.16.100.0/24 [120/1] via 172.16.136.3, 00:00:17, Ethernet0/0
R 172.16.2.0/24 [120/2] via 172.16.136.1, 00:00:02, Ethernet0/0
R 172.16.100.0/24 [120/1] via 172.16.136.3, 00:00:17, Ethernet0/0
R 192.158.4.0/24 [120/3] via 172.16.136.1, 00:00:04, Ethernet0/0
R 192.158.4.0/24 [120/3] via 172.16.136.3, 00:00:17, Ethernet0/0
C 192.168.5.0/24 is directly connected, Loopback0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
R 10.2.6.0/23 [120/1] via 172.16.136.6, 00:00:00, Ethernet0/0
R 10.1.4.0/22 [120/3] via 172.16.136.1, 00:00:04, Ethernet0/0
R 192.168.6.0/24 [120/1] via 172.16.136.6, 00:00:00, Ethernet0/0
R 192.168.6.0/24 [120/1] via 172.16.136.6, 00:00:00, Ethernet0/0
R 192.168.2.0/24 [120/2] via 172.16.136.3, 00:00:17, Ethernet0/0
R 192.168.2.0/24 [120/2] via 172.16.136.3, 00:00:17, Ethernet0/0
R 192.168.3.0/24 [120/1] via 172.16.136.3, 00:00:17, Ethernet0/0

Router 6

R6#sh ip ro
172.16.0.0/16 is variably subnetted, 5 subnets, 3 masks
C 172.16.136.0/26 is directly connected, FastEthernet0/0
R 172.16.32.0/24 [120/1] via 172.16.136.3, 00:00:23, FastEthernet0/0
R 172.16.31.0/30 [120/1] via 172.16.136.3, 00:00:23, FastEthernet0/0
[120/1] via 172.16.136.1, 00:00:10, FastEthernet0/0
R 172.16.2.0/24 [120/2] via 172.16.136.1, 00:00:10, FastEthernet0/0
R 172.16.100.0/24 [120/1] via 172.16.136.1, 00:00:24, FastEthernet0/0
R 172.16.100.0/24 [120/1] via 172.16.136.1, 00:00:24, FastEthernet0/0
R 192.168.4.0/24 [120/3] via 172.16.136.1, 00:00:10, FastEthernet0/0
[120/3] via 172.16.136.3, 00:00:24, FastEthernet0/0
Configuration Verification

Only relevant portions of the configuration have been included

Router 1

r1#sh run
interface Loopback0
   ip address 192.168.1.1 255.255.255.0
!
interface Ethernet0/0
   ip address 172.16.136.1 255.255.255.192
   half-duplex
!
interface TokenRing0/0
   ip address 172.16.15.1 255.255.255.240
   shutdown
   ring-speed 16
!
interface Serial1/0
   ip address 172.16.100.1 255.255.255.0
   encapsulation frame-relay
   frame-relay map ip 172.16.100.2 122 broadcast
   frame-relay map ip 172.16.100.3 122 broadcast
   frame-relay map ip 172.16.100.4 122 broadcast
   no frame-relay inverse-arp
!
interface Serial1/1
   ip address 172.16.31.1 255.255.255.252
   ip rip send version 1
   ip rip receive version 1
!
router rip
version 2
passive-interface Serial1/0
passive-interface Serial1/1
passive-interface Loopback0
network 172.16.0.0
network 192.168.1.0
neighbor 172.16.100.2
neighbor 172.16.31.2
distribute-list 1 out
no auto-summary
!
ip kerberos source-interface any
ip classless
no ip http server
!
access-list 1 deny 10.0.0.0
access-list 1 permit any

Router 2

r2#sh run
key chain testking
  key 1
  key-string ccie
  accept-lifetime 00:00:00 Mar 1 1993 infinite
  send-lifetime 00:00:00:00 Mar 1 1993 infinite
  call rsvp-sync
cns event-service server
!
interface Loopback0
  ip address 192.168.2.2 255.255.255.0
!
interface BRI0/0
  no ip address
  shutdown
!
interface Ethernet0/0
  no ip address
  shutdown
  half-duplex
!
interface TokenRing0/0
  ip address 172.16.2.2 255.255.255.0
  ring-speed 16
! interface Serial1/0
  ip address 172.16.100.2 255.255.255.0
  encapsulation frame-relay
  frame-relay map ip 172.16.100.1 221 broadcast
  frame-relay map ip 172.16.100.3 233 broadcast
  frame-relay map ip 172.16.100.4 224 broadcast
  no frame-relay inverse-arp
!
interface Serial1/1
  ip address 172.16.32.2 255.255.255.0
  ip rip authentication mode md5
  ip rip authentication key-chain testking
!
routing rip
  version 2
  passive-interface TokenRing0/0
  passive-interface Serial1/0
  passive-interface Loopback0
  network 172.16.0.0
  network 192.168.2.0
  neighbor 172.16.100.1
  neighbor 172.16.100.3
  neighbor 172.16.100.4
  no auto-summary

Router 3

r3#sh run
key chain testking
  key 1
  key-string ccie
  accept-lifetime 00:00:00 Mar 1 1993 infinite
  send-lifetime 00:00:00 Mar 1 1993 infinite
  call rsvp-sync
  cns event-service server
!
interface Loopback0
  ip address 192.168.3.3 255.255.255.0
!
interface Ethernet0/0
  ip address 172.16.136.3 255.255.255.192
  half-duplex

interface BRI0/0  
  no ip address  
  shutdown  
!
interface Serial1/0  
  ip address 172.16.100.3 255.255.255.0  
  encapsulation frame-relay  
  frame-relay map ip 172.16.100.1 322 broadcast  
  frame-relay map ip 172.16.100.2 322 broadcast  
  frame-relay map ip 172.16.100.4 322 broadcast  
  no-frame-relay inverse-arp  
!
interface Serial1/1  
  ip address 172.16.31.2 255.255.255.252  
  ip rip send version 1  
  ip rip receive version 1  
  clockrate 64000  
!
interface Serial1/2  
  ip address 172.16.32.3 255.255.255.0  
  ip rip authentication mode md5  
  ip rip authentication key-chain testking  
  clockrate 64000  
!
interface Serial1/3  
  ip address 172.16.35.1 255.255.255.252  
  shutdown  
  clockrate 64000  
!
router rip  
  version 2  
  passive-interface Serial1/0  
  passive-interface Serial1/1  
  passive-interface Loopback0  
  network 172.16.0.0  
  network 192.168.2.0  
  network 192.168.3.0  
  neighbor 172.16.100.2  
  neighbor 172.16.31.1  
  no auto-summary  

Router 4

r4#sh run

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interface Loopback0
  ip address 192.168.4.4 255.255.255.0
!
interface Ethernet0/0
  ip address 10.1.5.5 255.255.252.0
  half-duplex
!
interface Serial0/0
  ip address 172.165.100.4 255.255.255.0
  encapsulation frame-relay
  frame-relay map ip 172.16.100.1 422 broadcast
  frame-relay map ip 172.16.100.2 422 broadcast
  frame-relay map ip 172.16.100.3 422 broadcast
  no frame-relay inverse-arp
!
interface Serial0/1
  no ip address
  shutdown
!
routerr rip
  version 2
  no validate-update-source
  passive-interface Ethernet0/0
  passive-interface Serial0/0
  passive-interface Loopback0
  network 10.0.0.0
  network 172.16.0.0
  network 192.168.4.0
  neighbor 172.16.100.2
  no auto-summary

Router 5

r5#sh run
interface Loopback0
  ip address 192.168.5.5 255.255.255.0
!
interface Ethernet0/0
  ip address 172.16.136.5 255.255.255.192
  half-duplex
!
interface Serial0/0
  ip address 172.16.35.2 255.255.255.252
  shutdown
interface TokenRing0/0
  ip address 172.16.15.5 255.255.255.240
  shutdown
  ring-speed 16
!
interface Serial0/1
  no ip address
  shutdown
!
interface ATM1/0
  no ip address
  shutdown
  no atm ilmi-keepalive
!
routing rip
  version 2
  redistribute connected
  passive-interface Loopback+
  offset-list 1 out 4
  network 172.16.0.0
  no auto-summary

Router 6

r6#sh run
interface Loopback0
  ip address 192.168.6.6 255.255.255.0
  no ip directed-broadcast
!
interface FastEthernet0/0
  ip address 172.16.136.6 255.255.255.192
  no ip directed-broadcast
duplex auto
speed auto
!
interface ATM1/0
  no ip address
  no ip directed-broadcast
  shutdown
  no atm ilmi-keepalive
!
interface Ethernet2/0
  ip address 10.2.6.6 255.255.254.0
no ip directed-broadcast
!
router rip
  version 2
  passive-interface Ethernet2/0
  passive-interface Loopback0
  network 10.0.0.0
  network 172.16.0.0
  network 192.168.6.0
  no auto-summary
Lab Preparation Scenario: BGP

Topics Covered

- Internal BGP Peers
- External BGP Peers
- BGP Route Advertisement
- Route Aggregation
- AS Path Filtering
- Synchronization
- BGP Next-Hop

Difficulty Level: CCIE™

Average Completion Time: 2 to 4 Hours

Standard Topology

Standard TCP/IP Addressing and SPID Information

R1 (3620)
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Loop0  192.168.1.1 /24  Loopback
E0/0  172.16.136.1 /26  Ethernet Segment to Catalyst 3/1
T0/0  172.16.15.1 /28  Token Ring Segment to 3920
S1/1  172.16.31.1 /30  Serial to R3
S1/10 unassigned  Frame-relay

R2 (3620)
Loop0  192.168.2.2 /24  Loopback
T0/0  172.16.2.2 /24  Token Ring Segment to 3920
BRI0/0  172.16.230.2 /24  BRI to R3
S1/1  172.16.32.2 /24  Serial to R3
S1/0 unassigned  Frame-relay

R3 (2610)
Loop0  192.168.3.3 /24  Loopback
E0/0  172.16.136.3 /26  Ethernet Segment to Catalyst 3/3
BRI0/0  172.16.230.3 /24  ISDN to R2
S1/3  172.16.35.1 /30  Serial to R5
S1/2  172.16.32.3 /24  Serial to R2
S1/1  172.16.31.2 /30  Serial to R1
S1/0 unassigned  Frame-relay

R4 (2610)
Loop0  192.168.4.4 /24  Loopback
E0/0  10.1.4.4 /22  Ethernet Segment to BB1
S0/0 unassigned  Frame-relay

R5 (3620)
Loop0  192.168.5.5 /24  Loopback
E0/0  172.16.136.5 /26  Ethernet Segment to Catalyst 3/5
T0/0  172.16.15.5 /28  Token Ring Segment to 3920
S0/0  172.16.35.2 /30  Serial link to R3
A1/0  172.16.56.5 /30  ATM – R6

R6 (3640)
Loop0  192.168.6.6 /24  Loopback
FA0/0  172.16.136.6 /26  Ethernet segment – R2
E2/0  10.2.6.6 /23  Ethernet segment – BB2
A1/0  172.16.56.6 /30  ATM – R5

ISDN Information
Switch type  Basic NI1

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R2
SPID1: 42255501210101
SPID2: 42255501220101

R3
SPID1: 42255501310101
SPID2: 42255501320101

Technical Tasks

A. Configure the frame-relay interfaces with R2 as the hub, R1, R3, and R4 as spokes.
   Configure all routers in subnet 172.16.100.0/29.
   Do not use any sub-interfaces.
   Do not use any DLCIs other than those necessary to make R2 with the hub.
   Shutdown subnet 172.16.35.0/30.
B. Configure R4 in AS and have it peer to R2 in AS 123.
   Configure R1 and R3 in AS 123.
   Configure R5 in AS 56
   Configure R3 to peer to R6 while R1 peers to R5.
   Configure your peering as robust as possible.
   Do not enable any IGP.
C. Configure R6 to advertise 192.168.6.0/24 and 10.2.0.0/20.
D. Configure R5 to advertise 192.168.5.0/24.
   Do not use the network command.
E. Configure R2 to advertise 172.16.2.0/24.
F. All four routes should be in the BGP tables of R4.
   R4 should see the 192.168.5.0/24 network as having traversed AS 321.
   The four routes must also be in the routing table of R4.

Instructor’s Comments and Technical Tips

A. This task presents some layer two issues.
   You cannot rely on inverse-arp, so you will need to configure map statements on R1, R3, and R4.
   You may choose to map on R2 also just to maintain consistency across the routes.
B. Although not spelled out in the task, you need to fully-mesh R1, R2, and R3 in AS 123.
   When peering from R2 to R3 there are two paths, subnets 172.16.100.0/29 and 171.16.32.0/24.
   To make this as robust as possible you should use both interfaces between R2 and R3.
   The same issue is raised between R3 and R1 (three paths) and R1 to R5 (two paths).
   When this step is complete R3 should have five internal peers.
   If we are running an IGP you would peer to the loopback address only and allow the IGP to find a
   path to the loopback.
   Sounds like something you might see in a later lab.

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C. There are three ways to advertise routes in BGP, the network command, redistribution from EGP, and redistribution from an IGP. The last one includes redistribution from “connected”. For this task you can use the network command. BGP summarizes at classful boundaries by default, you need to shut this off and do an aggregate for 10.2.0.0/20. On your aggregate statement if you do not include the keyword “only”, the aggregate and the longer prefix will both be advertised.

D. As mentioned above, you can redistribute connected. You will need to filter (route-map) to avoid advertising additional subnets.

E. You can use the network command or redistribute. It would be easier to use the network command.

F. There are two issues involved with getting the R5 and R6 routes up to R2. The first is next-hop. By default all routers in an AS have the same next-hop to reach a route. In this case R2 does not know how to reach the subnets between R1 and R5 therefore the next-hop is invalid. To overcome this you can modify the next-hop information by adding an additional statement at R1.

To get the routes from R2 to R4 (and routes from AS 123 to AS 56) you need to overcome the rule of synchronization. The rule of sync is “Do not use and do not advertise to an external peer, any route learned from in internal peer until a matching route has been learned via an underlying IGP”. Sounds like it was written by a lawyer but you can find this (I paraphrased) in RFC 1771. The first three words, Do not use, means do not put the route into your own routing table. So until you disable sync R2 will not have the routes from R5 and R6 in its routing table. The rule of sync exist to avoid creating blackholes. There are two cases where it is safe to disable sync, all routers in your AS speak BGP (like an ISP) or you are a non-transit AS. If you are a non-transit AS you should filter to protect your AS. Sounds like something else you might see in a later lab.

Lastly, you need to make R4 believe that one of the routes has traversed AS 321. This will require you to prepend AS 321 to outgoing updates from R2. You need to be careful to prepend the AS only to the 192.168.5.0/24 network. This could also be configured on R4 by prepending incoming updates.

Technical Verification

Technical Verification For Task A

```
 r1#sh fram map
 Serial1/0(up): ip 172.16.100.2 dlci 122(0x7A,0x1CA0), static,
```

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broadcast,
CISCO, status defined, active
Serial1/0(up): ip 172.16.100.3 dlci 122 (0x7A,0x1CA0), static
broadcast,
CISCO, status defined, active
Serial1/0(up): ip 172.16.100.4 dlci 122 (0x7A,0x1CA0), static
broadcast
CISCO, status defined, active

r2#sh fram map
Serial1/0(up): ip 172.16.100.1 dlci 221 (0xDD,0x34D0), static,
broadcast,
CISCO, status defined, active
Serial1/0(up): ip 172.16.100.3 dlci 223 (0xDF,0x34F0), static,
broadcast,
CISCO, status defined, active
Serial1/0(up): ip 172.16.100.4 dlci 223 (0xE0,0x3800), static,
broadcast
CISCO, status defined, active

r3#sh fram map
Serial1/0(up): ip 172.16.100.1 dlci 322 (0x142,0x5020), static,
broadcast,
CISCO, status defined, active
Serial1/0(up): ip 172.16.100.2 dlci 322 (0x1A6,0x6860), static,
broadcast
CISCO, status defined, active
Serial1/0(up): ip 172.16.100.4 dlci 322 (0x142,0x5020), static
broadcast,
CISCO, status defined, active

r4#sh fram map
Serial0/0(up): ip 172.16.100.1 dlci 422 (0x1A6,0x6860), static
broadcast,
CISCO, status defined, active
Serial0/0(up): ip 172.16.100.2 dlci 422 (0x1A6,0x6860), static
broadcast
CISCO, status defined active
Serial0/0(up): ip 172.16.100.3 dlci 422 (0x1A6,0x6860), static
broadcast,
CISCO, status defined, active

Technical Verification For Task B
Technical Verification For Task C

r6# sh ip bgp sum
Neighbor  V  AS MsgRcvd MsgSent  TblVer  InQ OutQ Up/Down  State/PfxRcd
172.16.15.1  4  123  97  97  19  0  0 01:29:16  3
172.16.31.2  4  123  162  167  19  0  0 01:48:39  3
172.16.168.2  4  123  149  164  19  0  0 01:39:21  1
172.16.100.3  4  123  162  167  19  0  0 01:48:39  3
172.16.136.3  4  123  162  167  19  0  0 01:48:39  3
172.16.136.5  4  56  157  158  19  0  0 01:51:03  3

r2# sh ip bgp sum
Neighbor  V  AS MsgRcvd MsgSent  TblVer  InQ OutQ Up/Down  State/PfxRcd
172.16.32.3  4  123  163  151  0  0  0 01:39:31  3
172.16.100.1  4  123  164  149  8  0  0 01:39:31  3
172.16.100.3  4  123  163  151  8  0  0 01:39:21  3
172.16.100.4  4  4  145  157  8  0  0 01:39:20  0

r3# sh ip bgp sum
Neighbor  V  AS MsgRcvd MsgSent  TblVer  InQ OutQ Up/Down  State/PfxRcd
172.16.31.1  4  123  167  162  13  0  0 01:48:55  3
172.16.32.2  4  123  151  163  13  0  0 01:39:33  1
172.16.100.1  4  123  167  162  13  0  0 01:48:55  1
172.16.100.2  4  123  151  163  13  0  0 01:48:35  3
172.16.136.1  4  123  167  162  13  0  0 01:48:55  3
172.16.136.6  4  56  150  157  13  0  0 01:48:42  3

r4# sh ip bgp sum
Neighbor  V  AS MsgRcvd MsgSent  TblVer  InQ OutQ Up/Down  State/PfxRcd
172.16.100.2  4  123  157  145  17  0  0 01:39:33  4

r5# sh ip bgp sum
Neighbor  V  AS MsgRcvd MsgSent  TblVer  InQ OutQ Up/Down  State/PfxRcd
172.16.15.1  4  123  97  97  10  0  0 01:29:46  1
172.16.136.1  4  123  158  157  10  0  0 01:51:34  1
172.16.136.6  4  56  154  149  10  0  0 01:58:33  3

r6# sh ip bgp
BGP table version is 21, local router ID is 192.168.6.6
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal
Origin codes: i - IGP, e - EGP, ? - incomplete

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.2.0.0/16</td>
<td>0.0.0.0</td>
<td>32768 i</td>
<td></td>
<td></td>
<td>(the 0.0.0.0 next hop identifies directly connected)</td>
</tr>
<tr>
<td>10.2.6.0/23</td>
<td>0.0.0.0</td>
<td>32768 i</td>
<td></td>
<td></td>
<td>(route is being suppressed)</td>
</tr>
<tr>
<td>192.168.6.0</td>
<td>0.0.0.0</td>
<td>32768 i</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Technical Verification For Task D

r5#sh ip bgp
BGP table version is 10, local router ID is 192.168.5.5
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal
Origin codes: i - IGP, e - EGP, ? - incomplete

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
</table>
| > 192.168.5.0 | 0.0.0.0    | 0      |        | 32768   | ? 

Technical Verification For Task E

r2#sh ip bgp
BGP table version is 8, local router ID is 192.168.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal
Origin codes: i - IGP, e - EGP, ? - incomplete

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 172.16.2.0/24</td>
<td>0.0.0.0</td>
<td>0</td>
<td></td>
<td>32768 i</td>
<td></td>
</tr>
</tbody>
</table>

Technical Verification For Task F

BGP table of R4 is provided below. The routing tables are also included. The legend normally provided in router output has been deleted.

r4#sh ip bgp
BGP table version is 17, local router ID is 192.168.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal
Origin codes: i - IGP, e - EGP, ? - incomplete

Router 1

rl#sh ip ro
172.16.0.0/16 is variably subnetted, 5 subnets, 5 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
C 172.16.31.0/30 is directly connected, Serial1/1
C 172.16.15.0/28 is directly connected, TokenRing0/0
B 172.16.2.0/24 [200/0] via 172.16.100.2, 02:01:42
C 172.16.100.0/29 is directly connected, Serial1/0
B 192.168.5.0/24 [20/10] via 172.16.15.5, 01:51:37
10.0.0.0/16 is subnetted, 1 subnets
B 10.2.0.0 [20/0] via 172.16.15.5, 01:51:37
B 192.168.6.0/24 [20/0] via 172.16.15.5, 01:51:38
C 192.168.1.0/24 is directly connected, Loopback0

Router 2

r2#sh ip ro
172.16.0.0/16 is variably subnetted, 3 subnets, 2 masks

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C  172.16.32.0/24 is directly connected, Serial1/1
C  172.16.2.0/24 is directly connected, TokenRing0/0
C  172.16.100.0/29 is directly connected, Serial1/0
B  192.168.5.0/24 [200/0] via 172.16.100.1, 02:02:23
    10.0.0.0/16 is subnetted, 1 subnets
B  10.2.0.0 [200/0] via 172.16.100.1, 02:02:23
B  192.168.6.0/24 [200/0] VIA 172.16.100.1, 02:02:23
C  192.168.2.0/24 is directly connected, Loopback0

Router 3

r3#sh ip ro
172.16.0.0/16 is variably subnetted, 5 subnets, 4 masks
C  172.16.136.0/26 is directly connected, Ethernet0/0
C  172.16.32.0/24 is directly connected, Serial1/2
C  172.16.31.0/30 is directly connected, Serial1/1
B  172.16.2.0/24 [200/0] via 172.16.32.2, 02:02:43
C  172.16.100.0/29 is directly connected, Serial1/0
B  192.168.5.0/24 [20/0] via 172.16.136.5, 02:11:47
    10.0.0.0/16 is subnetted, 1 subnets
B  10.2.0.0 [20/0] VIA 172.16.136.6, 02:11:47
B  192.168.6.0/24 [20/0] via 172.16.136.6, 02:11:48
C  192.168.3.0/24 is directly connected, Loopback0

Router 4

R4#sh ip ro
172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
B  172.16.2.0/24 [20/0] via 172.16.100.2, 02:04:58
C  172.16.100.0/29 is directly connected, Serial0/0
C  192.168.4.0/24 is directly connected, Loopback0
B  192.168.5.0/24 [20/0] via 172.16.100.1, 02:04:58
    10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
B  10.2.0.0/16 [20/0] via 172.16.100.1, 02:04:58
C  10.1.4.0/22 is directly connected, Ethernet0/0
B  192.168.6.0/24 [20/0] via 172.16.100.1, 02:04:58

Router 5

R5#sh ip ro
172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
C  172.16.136.0/26 is directly connected, Ethernet0/0

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C 172.16.15.0/28 is directly connected, TokenRing0/0
B 172.16.2.0/24 [20/0] via 172.16.15.1, 01:55:30
C 192.168.5.0/24 is directly connected, Loopback0

10.0.0.0/16 is subnetted, 1 subnets
B 10.2.0.0 [200/0] via 172.16.136.6, 02:24:16
B 192.168.6.0/24 [200/0] via 172.16.136, 02:24:16

Router 6

R6#sh ip ro
172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C 172.16.136.0/26 is directly connected, FastEthernet0/0
B 172.16.2.0/24 [20/0] via 172.16.136.3, 02:06:01
B 192.168.5.0/24 [200/0] via 172.16.136.5, 02:24:45
10.0.0.0/0 is variably subnetted, 2 subnets, 2 masks
B 10.2.0.0/16 is directly connected, Ethernet2/0
C 192.168.6.0/24 is directly connected, Loopback0

Configuration Verification

Only relevant portions of the configuration have been included

Router 1

r1#sh run
interface Serial1/0
   ip address 172.16.100.1 255.255.255.248
   encapsulation frame-relay
   frame-relay map ip 172.16.100.2 122 broadcast
   frame-relay map ip 172.16.100.3 122 broadcast
   frame-relay map ip 172.16.100.4 122 broadcast
   no frame-relay inverse-arp
!
routing bgp 123
   no synchronization
   bgp log-neighbor-changes
   neighbor 172.16.15.5 remote-as 56
   neighbor 172.16.15.5 next-hop-self
   neighbor 172.16.31.2 remote-as 123
   neighbor 172.16.31.2 next-hop-self
   neighbor 172.16.100.2 remote-as 123
   neighbor 172.16.100.2 next-hop-self
   neighbor 172.16.100.3 remote-as 123
neighbor 172.16.100.3 next-hop-self
neighbor 172.16.136.3 remote-as 123
neighbor 172.16.136.3 next-hop-self
neighbor 172.16.136.5 remote-as 56
neighbor 172.16.136.5 next-hop-self

Router 2

r2#sh run
interface Serial1/0
  ip address 172.16.100.2 255.255.255.248
  encapsulation frame-relay
  frame-relay map ip 172.16.100.1 221 broadcast
  frame-relay map ip 172.16.100.3 223 broadcast
  frame-relay map ip 172.16.100.4 224 broadcast
  no frame-relay inverse-arp

router bgp 123
  no synchronization
  bgp log-neighbor-changes
  network 172.16.2.0 mask 255.255.255.0
  neighbor 172.16.32.3 remote-as 123
  neighbor 172.16.100.1 remote-as 123
  neighbor 172.16.100.3 remote-as 123
  neighbor 172.16.100.4 remote-as 4
  neighbor 172.16.100.4 route-map mock321 out
  no auto-summary

access-list 1 permit 192.168.5.0
route-map mock321 permit 10
  match ip address 1
  set as-path prepend 321

route-map mock321 permit 20

Router 3

r3#sh run
interface Serial1/0
  ip address 172.16.100.3 255.255.255.248
  encapsulation frame-relay
  frame-relay map ip 172.16.100.1 322 broadcast
  frame-relay map ip 172.16.100.2 322 broadcast
frame-relay map ip 172.16.100.4 322 broadcast
no frame-relay inverse-arp
!
router bgp 123
  no synchronization
  bgp log-neighbor-changes
  neighbor 172.16.31.1 remote-as 123
  neighbor 172.16.31.1 next-hop-self
  neighbor 172.16.32.2 remote-as 123
  neighbor 172.16.32.2 next-hop-self
  neighbor 172.16.100.1 remote-as 123
  neighbor 172.16.100.2 remote-as 123
  neighbor 172.16.100.2 next-hop-self
  neighbor 172.16.136.1 remote-as 123
  neighbor 172.16.136.1 next-hop-self
  neighbor 172.16.136.6 remote-as 56
  neighbor 172.16.136.6 next-hop-self

Router 4

dl4sh run
interface Serial0/0
  ip address 172.16.100.4 255.255.255.248
  encapsulation frame-relay
  frame-relay map ip 172.16.100.1 422 broadcast
  frame-relay map ip 172.16.100.2 422 broadcast
  frame-relay map ip 172.16.100.3 422 broadcast
  no frame-relay inverse-arp
!
router bgp 4
  bgp log-neighbor-changes
  neighbor 172.16.100.2 remote-as 123

Router 5

dl5#sh run
router bgp 56
  no synchronization
  bgp log-neighbor-changes
  redistribute connected route-map loop
  neighbor 172.16.15.1 remote-as 123
  neighbor 172.16.136.1 remote-as 123
  neighbor 172.16.136.6 remote-as 56
!
access-list 1 permit 192.168.5.0
route-map loop permit 10
  match ip address 1

Router 6

r6#sh run
router bgp 56
  no synchronization
  network 10.2.6.0 mask 255.255.254.0
  network 192.168.6.0
  aggregate-address 10.2.0.0 255.255.0.0 summary-only
  neighbor 172.16.136.3 remote-as 123
  neighbor 172.16.136.5 remote-as 56
  no auto-summary
Lab Preparation Scenario: IGP Redistribution

Topics Covered

- Classless to Classful routing
- Split-horizon
- Route Summarization
- Route Redistribution
- OSPF over Frame-Relay

Difficulty Level: CCIE TM

Average Completion Time: 2 to 3 Hours

Standard Topology

Standard TCP/IP Addressing and SPID Information

R1 (3620)
Loop0 192.168.1.1 /24  Loopback

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E0/0  172.16.136.1 /26  Ethernet Segment to Catalyst 3/1
T0/0  172.16.15.1 /28  Token Ring Segment to 3920
S1/1  172.16.31.1 /30  Serial to R3
S1/0  unassigned        Frame-relay

R2 (3620)
Loop0  192.168.2.2 /24  Loopback
T0/0   172.16.2.2 /24  Token Ring Segment to 3920
BRI0/= 172.16.230.2 /24  BRI to R3
S1/1   172.16.32.2/24  Serial to R3
S1/0   unassigned        Frame-relay

R3 (2610)
Loop0  192.168.3.3 /24  Loopback
E0/0   172.16.136.3 /26  Ethernet Segment to Catalyst 3/3
BRI0/0 172.16.230.3 /24  ISDN to R2
S1/3   172.16.35.1 /30  Serial to R5
S1/2   172.16.32.3/24  Serial to R2
S1/1   172.16.31.2/30  Serial to R1
S1/0   unassigned        Frame-relay

R4 (2610)
Loop0  192.168.4.4 /24  Loopback
E0/0   10.1.4.4 /22  Ethernet Segment to BB1
S0/0   unassigned        Frame-relay

R5 (3620)
Loop0  192.168.5.5 /24  Loopback
E0/0   172.16.136.5 /26  Ethernet Segment to Catalyst 3/5
T0/0   172.16.15.5 /28  Token Ring Segment to 3920
S0/0   172.16.35.2 /30  Serial link to R3
A1/0   172.16.56.5 /30  ATM – R6

R6 (3640)
Loop0  192.168.6.6 /24  Loopback
FA0/0  172.16.136.6 /26  Ethernet segment – R2
E2/0   10.2.6.6 /23  Ethernet segment – BB2
A1/0   172.16.56.6 /30  ATM – R5

ISDN Information
Switch type  Basic NI1

R2
SPID1: 42255501210101
SPID2: 42255501220101

R3
SPID1: 42255501310101
SPID2: 42255501320101

Technical Tasks

A. Configure the frame-relay cloud with R2 as the hub and R1, R3, and R4 as spokes.
   Only R2 may use sub-interfaces.
   Configure R2 – R4 in subnet 172.16.24.0/24.
   Configure R1, R2, and R3 in subnet 172.16.123.0/29.
   Do not use any CLCI’s other than those necessary to make R2 the hub.
B. On R4 enable IGRP for the ethernet, loopback, and frame-relay interfaces.
C. Configure subnets 172.16.2.0/24 and 172.16.123.0/29 in the OSPF backbone.
   Use the default OSPF network type on R1.
D. Configure subnets 172.16.136.0/26, 172.16.31.0/30, 172.16.32.0/24, and 172.16.35.0/30 in OSPF
   area 1.
   All possible routers should participate.
E. Enable EIGRP on R1 and R5 for subnet 172.16.15.0/28.
F. Subnet 10.2.6.0/23 as well as the ATM and ISDN interfaces will not be used in this lab.
   Every interface that is used should only have one routing protocol active.
   Loopback interfaces for R1, R2, R3, and R6 may be advertised as you see fit.
   Loopbacks should not appear as host routes.
   Do not use any static or default routes.

All subnets/interfaces that participate in routing must be reachable from all routers.

Instructor’s Comments and Technical Tips

A. The R2 – R4 connection should be point-to-point.
   R2, R1, and R3 should be multipoint.
   Since you cannot use any other DLCI’s you will need to use map statements.
   You should also disable inverse-arp.
B. It is not explicitly called for but you will need to enable IGRP on R2 also.
C. The default OSPF network type on a frame-relay physical interface is NBMA.
   If one of the routers is NBMA, the others will need to be NBMA.
   To make this work you need to ensure that R2 is the DR.
   You need to manually configure neighbors on R2.
   You should also set the OSPF priority to 0 for R1 and R3.
You could make R2 the DR by raising R2’s OSPF priority and leaving R1 and R3 at the default value of 1, however since you do not a full-mesh this would create the situation where R1 and R3 both think they are the BDR.

D. N/A  
E. N/A  
F. You may need to use passive-interface statements to avoid having multiple routing protocols going out a single interface. 
   To get routes to R4 you need to summarize them into /24 advertisements. 
   For OSPF routes you should use the “area X range” on the ABR’s. 
   For the EIGRP route you need to use the “summary-address” command on the ASBR’s. 
   An alternative would be to use the “ip summary-address eigrp” command at the interface level. 
   Be mindful of split-horizon on R4. 
   Setting the encapsulation to frame-relay disables split-horizon. 
   If you leave it disabled, R4 will echo routes back to R2. 
   Because of the lower administrative distance, R2 will believe R4 is the next-hop for routes that are in the OSPF/EIGRP domains. 
   When redistributing routes into IGRP you must assign a default-metric, if not the routers will be advertised to R4 with an “unreachable” metric and R4 will not put the routes into its routing table.

Technical Verification

Technical Verification For Task A

r1#sh fram map  
Serial1/0(up): ip 172.16.123.2 dlc 122(0x7A,0x1CA0), static, broadcast, CISCO, status defined, active  
Serial1/0(up): ip 172.16.123.3 dlc 122(0x7A,0x1CA0), static broadcast, CISCO, status defined, active

r2#sh fram map  
Serial1/0.123(up): ip 172.16.123.1 dlc 221(0xDD,0X34D0), static, broadcast, CISCO, status defined, active  
Serial1/0.123(up): ip 172.16.123.3 dlc 223(0xDF,0x34F0), static, broadcast, CISCO, status defined, active  
Serial1/0.24(up): point-to-point dlc, dlc 24(0xE0,0X3800), broadcast status defined active

r3#sh frame map  
Serial1/0(up): ip 172.16.123.1 dlc 322(0x142,0x5020), static,
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broadcast,
CISCO, status defined, active
Serial1/0(up): ip 172.16.123.2 dlci 322(0x142,0x5020, static,
broadcast,
CISCO, status defined, active

r4#sh frame map
Serial0/0(up): ip 172.16.24.2 dlci 422(0x1A6,0x6869), static,
broadcast,
CISCO, status defined, active

Technical Verification For Task B

R4#sh ip protocols
Routing Protocols is “igrp 24”
Sending updates every 90 seconds, next due in 8 seconds
Invalid after 270 seconds, hold down 280, flushed after 630
Outgoing update filter list for all interfaces is
Incoming update filter list for all interfaces is
Default networks flagged in outgoing updates
Default networks accepted from incoming updates
IGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
IGRP maximum hopcount 100
IGRP maximum metric variance 1
Redistributing: igrp 24
Routing for Networks:
  10.0.0.0
  172.16.0.0
  192.168.4.0
Passive Interface(s):
  Ethernet0/0
  Loopback0
Routing Information Sources:
  Gateway         Distance     Last Update
  172.16.24.2        100        00:01:18
Distance: (default is 100)

Technical Verification For Task C

r1#sh ip o int s1/0
Serial1/0 is up, line protocol is up
  Internet Address 172.16.123.1/29, Area 0
  Process ID 1, Router ID 192.168.1.1, Network Type NON_BROADCAST, Cost: 48
Transmit Delay is 1 sec, State DROTHER, Priority 0
Designated Router (ID) 192.168.2.2, Interface address 172.16.123.2
No backup designated router on this network
Timer intervals configured, Hello 30, Dead 120, Wait 120, Retransmit 5
Hello die in 00:00:07
Index 1/1, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 6
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 192.168.2.2 (Designated Router)
Suppress hello for 0 neighbor(s)

r2#sh ip o int to 0/0
TokenRing0/0 is up, line protocol is up
Internet Address 172.16.2.2/24, Area 0
Process ID 1, Router ID 192.168.2.2, Network Type BROADCAST, Cost: 6
Transmit Delay is 1 sec, State DR, Priority 1
Designated Router (ID) 192.168.2.2, Interface address 172.16.2.2
No backup designated router on this network
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
  No Hellos (Passive interface)
Index 1/1, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 0 maximum is 0
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 0, Adjacent neighbor count is 0
Suppress hello for 0 neighbor(s)

r2#sh ip o int s1/0.123
Serial1/0.123 is up, line protocol is up
Internet Address 172.16.123.2/29, Area 0
Process ID 1, Router ID 192.168.2.2, Network Type NON_BROADCAST, Cost: 48
Transmit Delay is 1 sec, State DR, Priority 1
Designated Router (ID) 192.168.2.2, Interface address 172.16.123.2
No backup designated router on this network
Timer intervals configured, Hello 30, Dead 120, Wait 120, Retransmit 5
  Hello due in 00:00:09
Index 3/3, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 2, maximum is 8
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 2, Adjacent neighbor count is 2
  Adjacent with neighbor 192.168.3.3
  Adjacent with neighbor 192.168.1.1
Suppress hello 0 for neighbor(s)
r3#sh ip os int s1/0
Serial1/0 is up, line protocol is up
    Internet Address 172.16.123.3/29, Area 0
    Process ID 1, Router ID 192.168.3.3, Network Type NON_BROADCAST, Cost: 781
    Transmit Delay is 1 sec, State DROTHER, priority 0
    Designated Router (ID) 192.168.2.2, Interface address 172.16.123.2
    No backup designated router on this network
    Timer intervals configured, Hello 30, Dead 120, Wait 120, Retransmit 5
        Hello due in 00:00:01
    Index 3/3, flood queue length 0
    Next 0x0(0)/0x0(0)
    Last flood scan length is 1, maximum is 7
    Last flood scan time is 0 msec, maximum is 4 msec
    Neighbor Count is 1, Adjacent neighbor count is 1
        Adjacent with neighbor 192.168.2.2 (Designated Router)
    Suppress hello for 0 neighbor(s)

Technical Verification For Task D

R3 is connected to every interface in this task

r3# sh ip ospf neighbor

<table>
<thead>
<tr>
<th>Neighbor ID</th>
<th>Pri</th>
<th>State</th>
<th>Dead Time</th>
<th>Address</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>192.168.2.2</td>
<td>1</td>
<td>FULL/DR</td>
<td>00:01:55</td>
<td>172.16.123.2</td>
<td>Serial1/0</td>
</tr>
<tr>
<td>192.168.1.1</td>
<td>1</td>
<td>FULL</td>
<td>00:00:34</td>
<td>172.16.31.1</td>
<td>Serial1/1</td>
</tr>
<tr>
<td>192.168.2.2</td>
<td>1</td>
<td>FULL</td>
<td>00:00:33</td>
<td>172.16.32.2</td>
<td>Serial1/2</td>
</tr>
<tr>
<td>192.168.5.5</td>
<td>1</td>
<td>FULL</td>
<td>00:00:39</td>
<td>172.16.35.2</td>
<td>Serial1/3</td>
</tr>
<tr>
<td>192.168.6.6</td>
<td>1</td>
<td>FULL/DR</td>
<td>00:00:33</td>
<td>172.16.136.6</td>
<td>Ethernet0/0</td>
</tr>
<tr>
<td>192.168.1.1</td>
<td>1</td>
<td>FULL/DROTHER</td>
<td>00:00:32</td>
<td>172.16.136.1</td>
<td>Ethernet0/0</td>
</tr>
<tr>
<td>192.168.5.5</td>
<td>1</td>
<td>FULL/DROTHER</td>
<td>00:00:39</td>
<td>172.16.136.5</td>
<td>Ethernet0/0</td>
</tr>
</tbody>
</table>

Technical verification For Task E

r1#sh ip ei neighbors
IP-EIGRP neighbors for process 15
H Address Interface Hold Uptime SPTT RTO Q Seq Type
   (sec)     (ms) Cnt Num
0    To0/0     14 01:09:37 1360 500 0 1

Technical Verification For Task F

The routing tables of all routers are included here. The legend normally provided in router output has been deleted.

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Router 1

```
rl#sh ip ro

172.16.0.0/16 is variably subnetted, 13 subnets, 5 masks
O  172.16.136.0/24 is a summary, 00:13:49, Null0
C  172.16.136.0/26 is directly connected, Ethernet0/0
O  172.16.32.0/24 [110/791] via 172.16.36.3, 00:13:49, Ethernet0/0
O IA  172.16.35.0/24 [110/106] via 172.16.123.3 00:13:29, Serial1/0
O  172.16.35.0/30 [110/58] via 172.16.136.5, 00:13:49, Ethernet0/0
O  172.16.31.0/25 is a summary, 00:13:49, Null0
C  172.16.31.0/30 is directly connected, Ethernet0/0
O E2 172.16.24.0/24 [110/20] via 172.16.123.2, 00:13:30, Serial1/0
O  172.16.15.0/24 is a summary, 00:15:27, Null0
C  172.16.15.0/28 is directly connected, TokenRing0/0
O  172.16.2.0/24 [110/54] via 172.16.123.2, 00:13:50, Serial1/0
O  172.16.123.0/24 is a summary, 00:13:50, Null0
C  172.16.123.0/29 is directly connected, Serial1/0
O E2 192.168.4.0/24 [110/20] via 172.16.123.2, 00:13:31, Serial1/0
O  192.168.5.0/24 [110/11] via 172.16.123.5, 00:13:51, Ethernet0/0
O E2 10.0.0.0/8 [110/20] via 172.16.123.2, 00:13:31, Serial1/0
O  192.168.6.0/24 [110/11] via 172.16.123.6, 00:13:51, Ethernet0/0
C  192.168.1.0/24 is directly connected, Loopback0
O  192.168.2.0/24 [110/54] via 172.16.123.2, 00:13:51, Serial1/0
O  192.168.3.0/24 [110/49] via 172.16.123.3, 00:13:51, Serial1/0
```

Router 2

```
r2#sh ip ro

172.16.0.0/16 is variably subnetted, 12 subnets, 4 masks
O IA  172.16.136.0/24 [110/58] via 172.16.123.1 00:13:46, Serial1/0.123
O  172.16.136.0/26 [110/58] via 172.16.136.3 00:13:46, Serial1/0.123
O  172.16.32.0/24 is directly connected, Serial1/0
O IA  172.16.35.0/24 [110/106] via 172.16.123.3 00:13:46, Serial1/0.123
O  172.16.35.0/30 [110/106] via 172.16.123.3 00:13:46, Serial1/0.123
O  172.16.31.0/24 [110/96] via 172.16.123.1, 00:13:47, Serial1/0.123
O  172.16.31.0/30 [110/96] via 172.16.123.1, 00:13:47, Serial1/0.123
O  172.16.24.0/24 is directly connected, Serial1/0.24
O E2 172.16.15.0/24 [110/20] via 172.16.123.1, 00:13:47, Serial1/0.123
C  172.16.2.0/24 is directly connected, TokenRing0/0
O  172.16.123.0/24 is a summary, 00:13:57, Null0
```
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C  172.16.123.0/29 is directly connected, Serial1/0.123  
I  192.168.4.0/24 [100/7382] via 172.16.24.4, 00:00:56, Serial1/0.24  
O  192.168.5.0/24 [110/59] via 172.16.32.3, 00:14:05, Serial1/1  
I  10.0.0.0/8 [100/6982] via 172.16.24.4, 00:00:56, Serial1/0.24  
O  192.168.6.0/24 [110/59] via 172.16.32.3, 00:14:05, Serial1/1  
O  192.168.1.0/24 [110/49] via 172.16.123.1, 00:14:05, Serial1/0.123  
C  192.168.2.0/24 is directly connected, Loopback0  
O  192.168.3.0/24 [110/49] via 172.16.123.3, 00:14:05, Serial1/0.123  

**Router 3**

r3#sh ip ro

172.16.0.0/16 is variably subnetted, 12 subnets, 4 masks  
O  172.16.136.0/24 is a summary, 00:14:10, Null0  
C  172.16.136.0/26 is directly connected, Ethernet0/0  
C  172.16.32.0/24 is directly connected, Serial1/2  
O  172.16.35.0/24 is a summary, 00:14:10, Null0  
C  172.16.35.0/30 is directly connected, Serial1/3  
O  172.16.31.0/24 is a summary, 00:14:10, Null0  
C  172.16.31.0/30 is directly connected, Serial1/1  
[110/20] via 172.16.32.2, 00:13:51, Serial1/2  
O E2  172.16.15.0/24 [110/20] via 172.16.136.1, 00:13:51, Ethernet0/0  
[110/20] via 172.16.136.5, 00:13:51, Ethernet0/0  
O  172.16.2.0/24 [110/87] VIA 172.16.123.2, 00:14:11, Serial1/0  
O  172.16.123.0/24 is a summary, 00:14:13, Null0  
C  172.16.123.0/24 is directly connected, Serial1/0  
O E2  192.168.4.0/24 [110/20] via 172.16.123.2, 00:13:52, Serial1/0  
[110/20] via 172.16.32.2, 00:13:53, Serial1/2  
O  192.168.5.0/24 [110/11] via 172.16.136.5, 00:14:13, Ethernet0/0  
O E2  10.0.0.0/8 [110/20] via 172.16.136.5, 00:14:13, Ethernet0/0  
[110/20] via 172.16.32.2, 00:13:53, Serial1/2  
O  192.168.6.0/24 [110/11] via 172.16.136.6, 00:15:13, Ethernet0/0  
O  192.168.1.0/24 [110/782] via 172.16.123.1, 00:14:13, Serial1/0  
O  192.168.2.0/24 [110/782] via 172.16.123.2, 00:14:13, Serial1/0  
C  192.168.3.0/24 is directly connected, Loopback0  

**Router 4**

R4#sh ip ro

172.16.0.0/24 is subnetted, 8 subnets  
I  172.16.136.0 [100/181571] via 172.16.24.2, 00:01:03, Serial1/0  
I  172.16.32.0 [100/10476] via 172.16.24.2, 00:01:03, Serial1/0

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- 121 -
I 172.16.35.0 [100/181571] via 172.16.24.2, 00:01:03, Serial0/0
I 172.16.31.0 [100/181571] via 172.16.24.2, 00:01:03, Serial0/0
C 172.16.24.0 is directly connected, Serial0/0
I 172.16.15.0 [100/181571] via 172.16.24.2, 00:01:03, Serial0/0
I 172.16.2.0 [100/8539] via 172.16.24.2, 00:01:03, Serial0/0
I 172.16.123.0 [100/181571] via 172.16.24.2, 00:01:04, Serial0/0
C 192.168.4.0/24 is directly connected, Loopback0
I 192.168.5.0/24 [100/181571] via 172.16.24.2, 00:01:04, Serial0/0
10.0.0.0/22 is subnetted, 1 subnets
C 10.1.4.0 is directly connected, Ethernet0/0
I 192.168.6.0/24 [100/181571] via 172.16.24.2, 00:01:05, Serial0/0
I 192.168.1.0/24 [100/181571] via 172.16.24.2, 00:01:05, Serial0/0
I 192.168.2.0/24 [100/8976] via 172.16.24.2, 00:01:05, Serial0/0
I 192.168.2.0/24 [100/8976] via 172.16.24.2, 00:01:05, Serial0/0

Router 5

R5#sh ip ro

172.16.0.0/16 is variably subnetted, 12 subnets, 4 masks
O IA 172.16.136.0/24 [110/849] via 172.16.136.3, 00:14:04, Ethernet0/0
C 172.16.136.0/26 is directly connected, Ethernet0/0
O 172.16.32.0/24 [110/791] via 172.16.136.3, 00:14:24, Ethernet0/0
O IA 172.16.35.0/24 [110/116] via 172.16.136.1, 00:14:04, Ethernet0/0
C 172.16.35.0/30 is directly connected, Serial0/0
O IA 172.16.31.0/24 [110/887] via 172.16.136.3, 00:14:04, Ethernet0/0
O 172.16.31.0/30 [110/58] via 172.16.136.1, 00:14:25, Ethernet0/0
O E2 172.16.24.0/24 [110/20] via 172.16.136.3, 00:15:05, Ethernet0/0
O 172.16.15.0/24 is a summary, 00:15:49, Null10
C 172.16.15.0/28 is directly connected, TokenRing0/0
O IA 172.16.2.0/24 [110/64] via 172.16.136.1, 00:14:05, Ethernet0/0
O IA 172.16.123.0/24 [110/58] via 172.16.136.1, 00:14:05, Ethernet0/0
O E2 192.168.4.0/24 [110/20] via 172.16.136.3, 00:14:06, Ethernet0/0
192.168.5.0/24 is directly connected, Loopback0
O E2 10.0.0.0/0 [110/20] via 172.16.136.3, 00:14:06, Ethernet0/0
192.168.1.0/24 [110/11] via 172.16.136.6, 00:14:26, Ethernet0/0
O IA 192.168.1.0/24 [110/11] via 172.16.136.1, 00:14:06, Ethernet0/0
O IA 192.168.2.0/24 [110/59] via 172.16.136.1, 00:14:06, Ethernet0/0
O IA 192.168.3.0/24 [110/11] via 172.16.136.3, 00:14:06, Ethernet0/0

Router 6

R6#sh ip ro
172.16.0.0/16 is variably subnetted, 11 subnets, 3 masks
O IA 172.16.0.24 [110/840] via 172.16.136.3, 00:14:13, FastEthernet0/0
C 172.16.136.0/26 is directly connected, FastEthernet0/0
O 172.16.32.0/24 [110/782] via 172.16.136.3, 00:14:33, FastEthernet0/0
O IA 172.16.35.0/24 [110/107] via 172.16.136.1, 00:14:13 FastEthernet0/0
O 172.16.35.0/30 [110/49] via 172.16.136.5, 00:14:33, FastEthernet0/0
I IA 172.16.31.0/24 [110/878] via 172.16.136.3, 00:14:13, FastEthernet0/0
O 172.16.31.0/30 [110/49] via 172.16.136.1, 00:14:14, FastEthernet0/0
O E2 172.16.24.0/24 [110/20] via 172.16.136.3, 00:14:14, FastEthernet0/0
O E2 172.16.15.0/24 [110/20] via 172.16.136.1, 00:14:14, FastEthernet0/0
O IA 172.16.2.0/24 [110/55] via 172.16.136.1, 00:14:14, FastEthernet0/0
O IA 172.16.123.0/24 [110/49] via 172.16.136.3, 00:14:14, FastEthernet0/0
O E2 192.168.4.0/24 [110/20] via 172.16.136.3, 00:14:15, FastEthernet0/0
O 192.168.5.0/24 [110/2] via 172.16.136.5, 00:14:35, FastEthernet0/0
O E2 10.0.0.0/8 [110/20 via 172.16.136.3, 00:14:15, FastEthernet0/0
C 192.168.6.0/24 is directly connected, Loopback0
O IA 192.168.1.0/24 [110/2] via 172.16.136.1, 00:14:15, FastEthernet0/0
O IA 192.168.2.0/24 [110/50] via 172.16.136.1, 00:14:15, FastEthernet0/0
O IA 192.168.3.0/24 [110/2] via 172.16.136.3, 00:14:15, FastEthernet0/0

Configuration Verification

Only relevant portions of the configuration have been included.

Router 1

```plaintext
r1#sh run
interface Serial1/0
  ip address 172.16.123.1 255.255.255.248
  encapsulation frame-relay
  ip ospf priority 0
  frame-relay map ip 172.16.123.2 122 broadcast
  frame-relay map ip 172.16.123.3 122 broadcast
  no frame-relay inverse-arp
!
router eigrp 15
  network 172.16.15.0 0.0.0.15
  no auto-summary
  no eigrp log-neighbor-changes
!
router ospf 1
  log-adjacency-changes
  area 0 range 172.16.123.0 255.255.255.0
```

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area 1 range 172.16.31.0 255.255.255.0
area 1 range 172.16.136.0 255.255.255.0
summary-address 172.15.0 255.255.255.0
redistribute eigrp 15 subnets
passive-interface Loopback0
network 172.16.31.0 0.0.0.3 area 1
network 172.16.123.0 0.0.0.7 area 0
network 172.16.136.0 0.0.0.63 area 1
network 192.168.1.0 0.0.0.255 area 0

Router 2

r2#sh run
interface Serial1/0
  no ip address
  encapsulation frame-relay
  no frame-relay inverse-arp
!
interface Serial1/0.24 point-to-point
  ip address 172.16.24.2 255.255.255.0
  frame-relay interface-dlci 224
!
interface Serial1/0.123 multipoint
  ip address 172.16.123.2 255.255.255.248
  ip ospf network non-broadcast
  frame-relay map ip 172.16.123.1 221 broadcast
  frame-relay map ip 172.16.123.3 233 broadcast
!
router ospf 1
  log-adjacency-changes
  area 0 range 172.16.123.0 255.255.255.0
  redistribute igrp 24 subnets
  passive-interface TokenRing0/0
  passive-interface Loopback0
  network 172.16.2.0 0.0.0.255 area 0
  network 172.16.32.0 0.0.0.255 area 1
  network 172.16.123.0 0.0.0.7 area 0
  network 192.168.2.0 0.0.0.255 area 0
  neighbor 172.16.123.3
  neighbor 172.16.123.1
!
router igrp 24
  redistribute ospf 1
  passive-interface TokenRing0/0

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passive-interface Serial1/0.123
passive-interface Serial1/1
network 172.16.0.0
default-metric 56 1000 255 2 1500

Router 3

r3#sh run
interface Serial1/0
  ip address 172.16.123.3 255.255.255.248
  encapsulation frame-relay
  ip ospf priority 0
  frame-relay map ip 172.16.123.1 322 broadcast
  frame-relay map ip 172.16.123.2 322 broadcast
  no frame-relay inverse-arp
!
router ospf 1
  log-adjacency-changes
  area 0 range 172.16.123.0 255.255.255.0
  area 1 range 172.16.31.0 255.255.255.0
  area 1 range 172.16.35.0 255.255.255.0
  area 1 range 172.16.136.0 255.255.255.0
  passive-interface Loopback0
  network 172.16.31.0 0.0.0.3 area 1
  network 172.16.32.0 0.0.0.255 area 1
  network 172.16.35.0 0.0.0.3 area 1
  network 172.16.123.0 0.0.0.7 area 0
  network 172.16.136.0 0.0.0.63 area 1
  network 192.168.3.0 0.0.0.255 area 0

Router 4

r4#sh run
interface Serial0/0
  ip address 172.16.24.4 255.255.255.0
  encapsulation frame-relay
  ip split-horizon
  frame-relay map ip 172.16.24.2 422 broadcast
  no frame-relay inverse-arp
!
router igrp 24
  passive-interface Ethernet0/0
  passive-interface Loopback0
  network 10.0.0.0
  network 172.16.0.0
network 192.168.4.0

Router 5

r5#sh run
router eigrp 15
    network 172.16.15.0 0.0.0.15
    no auto-summary
    no eigrp log-neighbor-changes

router ospf 1
    log-adjacency-changes
    area 1 range 172.16.35.0 255.255.255.0
    summary-address 172.16.15.0 255.255.255.0
    redistribute eigrp 15 subnets
    passive-interface Loopback0
    network 172.16.35.0 0.0.0.3 area 1
    network 172.16.136.0 0.0.0.63 area 1
    network 192.168.5.0 0.0.0.255 area 1

Router 6

r6#sh run
interface Ethernet2/0
    ip address 10.2.6.6 255.255.254.0
    no ip directed-broadcast
    shutdown

router ospf 1
    passive-interface Loopback0
    network 172.16.136.0 0.0.0.63 area 1
    network 192.168.0 0.0.0.255 area 1
Lab Preparation Scenario: Catalyst TM Switch Configuration

Topics Covered

- System Information (IP addressing, Gateway, System Name, Prompt, etc)
- CDP (Cisco Discovery Protocol)
- STP (Spanning Tree Protocol)
- Auto Negotiation
- VTP
- VLAN’s
- VTP Pruning
- ISL
- UDLD (Unidirectional Link Detection)
- System Logging

Difficulty Level: CCIE TM

Average Completion Time: 2 Hours

Standard Topology
Standard TCP/IP Addressing and SPID Information

**R1 (3620)**

- **Loop0**: 192.168.1.1 /24, Loopback
- **E0/0**: 172.16.136.1 /26, Ethernet Segment to Catalyst 3/1
- **T0/0**: 172.16.15.1 /28, Token Ring Segment to 3920
- **S1/1**: 172.16.31.1 /30, Serial to R3
- **S1/0**: unassigned, Frame-relay

**R2 (3620)**

- **Loop0**: 192.168.2.2 /24, Loopback
- **T0/0**: 172.16.2.2 /24, Token Ring Segment to 3920
- **BRI0/0**: 172.16.230.2 /24, BRI to R3
- **S1/1**: 172.16.32.2/24, Serial to R3
- **S1/0**: unassigned, Frame-relay

**R3 (2610)**

- **Loop0**: 192.168.3.3 /24, Loopback
- **E0/0**: 172.16.136.3 /26, Ethernet Segment to Catalyst 3/3
- **BRI0/0**: 172.16.230.3 /24, ISDN to R2
- **S1/3**: 172.16.35.1 /30, Serial to R5
**Technical Tasks**

**Note:** In this lab we will only be using the catalyst and the routers directly attached to it.

**A. Configure the Catalyst switch with the following information:**

- **System Name:** CAT5K
- **System Prompt:** CAT5K==>
- **System Location:** Testking, INC
- **System Contact:** Future Testking
B. Set the Date and Time.
   Set the Catalyst to Eastern Timezone.
C. Configure The Switch IP Address: 172.16.136.15/24 and default Gateway: 172.16.136.6
D. CDP
   Disable CDP on the Entire Switch
   Enable CDP only on switch port 3/3 connected to router R3
E. Using one command to enable Portfast and turn off trunk and channel modes on port 3/1.
F. To protect against someone inadvertently plugging a switch into port 3/1 make sure the port will
go into Errdisable state should it receive BPDU’s.
G. Turn port auto negotiation off of port 3/5 and match the configuration to Router 5.
H. Prepare for another switch to enter your network by setting up VTP information
   Configure VTP Domain: TESTKING
   Configure Cat5k to be a VTP Server
   Configure a VTP Password of Testking
   Configure switch to Use VTP version 2
I. Create a new VLANs 2-6.
J. Turn Pruning on then using one command remove VLAN’s 3-5 from being Prune eligible.
K. Using one command make VLAN 4 eligible to be pruned.
L. Create an ISL trunk connection between R6 and Cat5k
   Create ISL interfaces on R6 as follows:
   VLAN1: IP Address 172.16.136.6/24
   VLAN2: IP Address 172.16.62.6/24
   VLAN3: IP Address 172.16.63.6/24
   VLAN4: IP Address 172.16.64.6/24
   VLAN5: IP Address 172.16.65.6/24
   VLAN6: IP Address 172.16.66.6/24
M. In the future another switch will be added to port 3/12.
   Configure the Cat5k to monitor the physical connection for port 3/12 for
   Unidirectional links.
N. Enable logging as follows:
   Server: 172.16.65.77

   Facility: Local5

   Severity Level: Notifications

Instructor’s Comments and Technical Tips

A. Use the Set System command(s).
B. Use the Set time and set timezone commands.
C. Use the Set Interface and set IP route Commands, if you need to remove a gateway you can use the Clear IP route command.

D. Use the set CDP command.
   CDP is on by default.
   CDP is a very useful tools in determining what Cisco devices are connected where.
   Remember the default interval for CDP message is 60 seconds.

E. Use the Set Port host command.
   When configuring a port for portfast it should also have PagP and trunking negotiation turned off.
   In Version 5.2 of the 4000 and 5000 the new command set port host was introduced.
   This command actually issues three commands; set spantree portfast 3/1 enable, set port channel 3/?? Off, and set trunk ?? Off.

F. When a port is set for SpanTree Portfast there is a possibility for a loop to be created should a switch be plugged into the port.
   By enabling the portfast BPDU guard feature on the catalyst switch the switch will shut down any port with portfast enabled when it receives any BPDU packets.

G. Use the Set port command Auto negotiation should be on or off both ends of the connection.
   It should never be on one end of the connection and off of the other.

H. Use the Set VTP command.
   Configuring VTP in a network allows Vlans to be created on one switch and propagated to all the other switches participating in the VTP Domain.

I. Use the Set VLAN command.
   When Creating a vlan most of the default values are acceptable.

J. Use the Set and Clear VTP commands.
   Vlans 2-1000 are Prune eligible by default.
   Making VLANs pruning-eligible or pruning-ineligible on a switch affects pruning-eligibility for those VLANs on that device (not on all switches in the VTP domain).

K. Use the Set VTP command.

L. Use the Set trunk command or the cat5k and configure sub interfaces on the Fast Ethernet on R6.
   This will allow a one-arm router scenario where one connection to a router serves many vlans.

M. Use the Set UDLD command.
   The functionality of the UDLD protocol can be very useful in determining Physical layer 2 problems.
   Used in conjunction with auto-negotiation both layer 1 and layer 2 malfunctions can be detected.

N. Use the Set logging command.
   A log server is highly recommended in any network.

Technical Verification

Technical Verification For Task A
Technical Verification For Task B

```
CAT5K===> (enable) sho time
Sun Jan 27 2002, 08:39:31 EST
```

Technical Verification For Task C

```
CAT5K===> (enable) sho interface
s10: flags=51<UP,POINTOPOINT,RUNNING>
    slip 0.0.0.0 dest 0.0.0.0
sc0: flags=63<UP,BROADCAST,RUNNING>
    vlan 1 inet 172.136.138.15 netmask 255.255.255.0 broadcast 172.16.136.255
```

Technical Verification For Task D

```
CAT5K===> (enable) sho cdp port 3
Port    CDP Status Message-Interval
-------- ----------- -----------
3/1     disabled 60
```
3/2  disabled  60
3/3  enabled  60
3/4  disabled  60
3/5  disabled  60
3/6  disabled  60
3/7  disabled  60
3/8  disabled  60
3/9  disabled  60
3/10  disabled  60
3/11  disabled  60
3/12  disabled  60

CAT5K==> (enable)

CAT5K==> (enable) sho cdp nei
Capability Codes: R - Router, T - Trans Bridge, B - Source Route Bridge
                S - Switch, H - Host, I - IGMP, r - Repeater

+-------------+-----------------+-----------------+---------------------------+--------------------------+------------------------+------------------------+
<table>
<thead>
<tr>
<th>Port</th>
<th>Device-ID</th>
<th>Port-ID</th>
<th>Platform</th>
<th>Capability</th>
</tr>
</thead>
</table>
+-------------+-----------------+-----------------+---------------------------+--------------------------+------------------------+------------------------+
| 3/3 | 3/3 r3 Ethernet0/0 cisco 2610 | R |
+-------------+-----------------+-----------------+---------------------------+--------------------------+------------------------+------------------------+

Technical Verification For Task E

CAT5K==> (enable) sho spantree

VLAN 1
Spanning tree enabled
Spanning tree type   ieee

Designated Root  00-04-dd-ae-7d-41
Designated Root Priority  32768
Designated Root Cost  38
Designated Root Port  1/1
Root Max Age  20 sec Hello Time  2 sec Forward Delay  15 sec

Bridge ID MAC ADDR  00-90-2b-a3-bc-00
Bridge ID Priority  32768
Bridge Max Age  20 sec Hello Time  2 sec Forward Delay  15 sec

+---------------+-------------+----------+---------------+---------------+------------------+
<table>
<thead>
<tr>
<th>Port</th>
<th>Vlan</th>
<th>Port-State</th>
<th>Cost</th>
<th>Prio</th>
<th>Portfast</th>
<th>Channel_id</th>
</tr>
</thead>
</table>
+---------------+-------------+----------+---------------+---------------+------------------+
| 1/1 | 1 | forwarding | 19  | 32 | disabled | 0 |
| 1/2 | 1 | not-connected | 100  | 32 | disabled | 0 |
| 3/1 | 1 | forwarding | 100  | 32 | enabled | 0 |
+---------------+-------------+----------+---------------+---------------+------------------+
3/2  1 forwarding  100  32 disabled  0
3/3  1 forwarding  100  32 disabled  0
3/4  1 no-connected  100  32 disabled  0
3/5  1 forwarding  100  32 disabled  0
3/6  1 forwarding  19  32 disabled  0
3/7  1 not-connected  100  32 disabled  0
3/8  1 not-connected  100  32 disabled  0
3/9  1 not-connected  100  32 disabled  0
3/10  1 not-connected  100  32 disabled  0
3/11  1 not-connected  100  32 disabled  0
3/12  1 not-connected  100  32 disabled  0

CAT5K==> (enable)

Technical Verification For Task F

CAT5K==> (enable) sho spantree summary

Mac address reduction: disabled
Root switch for vlans: 2-6.
BPDU skewing detection disabled for the bridge
BPDU skewed for vlans: none.
Portfast bpdu-guard enabled for bridge.
Portfast bpdu-filter disabled for bridge.
Uplinkfast disabled for bridge.
Backbonefast disabled for bridge.

Summary of connected spanning tree ports by vlan.
Vlan Blocking Listening Learning Forwarding STP Active
---- ---- ---- ----- ------- ----- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- 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 Technical Verification For Task G

sho port 3/5

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Port Name | Status | Vlan | Level | Duplex | Speed | Type
--- | ------- | ---- | ------ | ------ | ----- | ----
3/5 | connected | 1 | normal | half | 10/100BaseTX

Port Security Secure-Src-Addr Last-Src-Addr Shutdown Trap IfIndex
--- | ----------- | --------------- | ------ | ------ | ------- | ------
3/5 | disabled | No | disabled | 14

Port Broadcast-Limit Broadcast-Drop
--- | ----------- | ------
3/5 | 0

Port Align-Err FCS-Err Xmit-Err Rcv-Err UnderSize
--- | ----------- | ------ | ------ | ------ | ------
3/5 | 0 | 0 | 0 | 0 | 0

Port Single-Col Multi-Col Late-Col Excess-Col Carri-Sen Runts Giants
--- | ----------- | ------ | ------ | ------ | ------ | ------
3/5 | 0 | 0 | 0 | 0 | 0 | 0

Last-Time-Cleared
-------------------
Mon Jan 28 2002, 01:24:25

Technical Verification For Task H

**CAT5K==> (enable) sho vtp domain**

**Domain Name** | **Domain Index** | **Vtp Version** | **Local Mode** | **Password**
--- | --- | ------ | ------- | ------
**TESTKING** | 1 | 2 | server | configured

Vlan-count Max-vlan-storage Config Revision Notifications
--- | ------- | ------ | ------ | ------
5 | 1023 | 1 | disabled

Last Updater V2 Mode Pruning PruneEligible on Vlans
--- | ------ | ------ | ------ | ------
172.16.136.15 | enabled | disabled | 2-1000

Technical Verification For Task I

**CAT5K==> (enable) sho vlan**

**VLAN Name** | **Status** | **Ifindex** | **Mod/Ports, Vlans**
--- | ------- | --- | -------
1 | default | active | 5 | 1/1-2 | 3/1-12

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2 VLAN0002 active 278
3 VLAN0003 active 279
4 VLAN0004 active 280
5 VLAN0005 active 281
6 VLAN0006 active 282
1002 fddi-default active 6
1003 trcrf-default active 9
1004 fddinet-default active 7
1005 trbrf-default active 8

VLAN Type   SAID   MTU     Parent RingNo BrdgNo Stp   BrdgMode Trans1 Trans2
--- ----------- --- -------- ----------- -------- ----------- ---------
 1 enet 100001  1500  - - - - - -  0  0
 2 enet 100002  1500  - - - - - -  0  0
 3 enet 100003  1500  - - - - - -  0  0
 4 enet 100004  1500  - - - - - -  0  0
 5 enet 100005  1500  - - - - - -  0  0
 6 enet 100006  1500  - - - - - -  0  0
--More--  ... ... ... ... ... ... ... ... ... ... 1002 fddi 101002 1500 - - - -  0  0
1003 trcrf 101003  4472  1005 0xccc - - sb 0  0
1004 fddnet 101004  1500  - - 0x0  ieee -  0  0
1005 trbrf 101005  4472 - - 0xf ibm -  0  0

Technical Verification For Task J

CAT5K==> (enable) sho vtp domain
Domain NAME  Domain Index  VTP Version  Local Mode  Password
------------------- ----------- ----------- ------- -------
TESTKING       1 2    server    configured

Vlan-count  Max-vlan-storage  Config  Revision  Notifications
----------  --------------  -------  ---------  ----------
 10  1023 7  disabled

Last Updater  V2 Mode  Pruning  PruneEligible on Vlans
----------  -----  -------  ----------------------
172.16.136.15 enabled enabled 2,6-1000

CAT5K==> (enable)

Technical Verification For Task K

CAT5K==> (enable) sho vtp domain
Domain Name  Domain Index  VTP Version  Local Mode  Password
------------------- ----------- ----------- ------- -------
TESTKING  1  2  server configured

Vlan-count  Max-vlan-storage  Config  Revision  Notifications
-------  -------  -------------  --------
10      1023    7    disabled

Last Updater  V2 Mode  Pruning  PruneEligible on Vlans
----------  -----  -------  --------------
172.16.136.15 enabled  enabled  2,4,6-1000

CAT5K==> (enable)

Technical Verification For Task L

CAT5K==> sho trunk

<table>
<thead>
<tr>
<th>Port</th>
<th>Mode</th>
<th>Encapsulation</th>
<th>Status</th>
<th>Native vlan</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/6</td>
<td>on</td>
<td>isl trunking</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>5/1</td>
<td>on</td>
<td>lane trunking</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Port  Vlans allowed on trunk
------  -----------------------------------
3/6  1-1005
5/1  1-1005

Port  Vlans allowed and active in management domain
------  -----------------------------------------------
3/6  1-6, 1003, 1005
5/1   

Port  Vlans in spanning tree forwarding state and not pruned
------  -----------------------------------------------
3/6  1-6, 1003, 1005
5/1   

CAT5K==> (enable) sho spantree 3/6

<table>
<thead>
<tr>
<th>Port</th>
<th>Vlan</th>
<th>Port-State</th>
<th>Cost</th>
<th>Priority</th>
<th>Fast-Start</th>
<th>Group-Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/5</td>
<td>1</td>
<td>forwarding</td>
<td>19</td>
<td>32</td>
<td>disabled</td>
<td></td>
</tr>
<tr>
<td>3/6</td>
<td>2</td>
<td>forwarding</td>
<td>19</td>
<td>32</td>
<td>disabled</td>
<td></td>
</tr>
<tr>
<td>3/6</td>
<td>3</td>
<td>forwarding</td>
<td>19</td>
<td>32</td>
<td>disabled</td>
<td></td>
</tr>
<tr>
<td>3/6</td>
<td>4</td>
<td>forwarding</td>
<td>19</td>
<td>32</td>
<td>disabled</td>
<td></td>
</tr>
<tr>
<td>3/6</td>
<td>5</td>
<td>forwarding</td>
<td>19</td>
<td>32</td>
<td>disabled</td>
<td></td>
</tr>
<tr>
<td>3/6</td>
<td>6</td>
<td>forwarding</td>
<td>19</td>
<td>32</td>
<td>disabled</td>
<td></td>
</tr>
<tr>
<td>3/6</td>
<td>1003</td>
<td>forwarding</td>
<td>19</td>
<td>32</td>
<td>disabled</td>
<td></td>
</tr>
</tbody>
</table>
CCIE LAB

R6# sh interface type ethernet
FastEthernet0/0 is up, line protocol is up
   Hardware is AmdFE, address is 0002.fd69.9e00 (bia 0002.fd69.9e00)
   MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
      reliability 255/255, txload 1/255, rxload 1/255
   Encapsulation ARPA, loopback not set
   Keepalive set (10 sec)
   Full-duplex, 100Mb/s, 100BaseTX/FX
   ARP type: ARPA, ARP Timeout 04:00:00
   Last input 00:00:01, output 00:00:03, output hang never
   Last clearing of "show interface" counters never
   Queuing strategy: fifo
   Output queue 0/40, 0 drops; input queue 0/75, 0 drops
   5 minute input rate 1000 bits/sec, 3 packets/sec
   5 minute output rate 0 bits/sec, 0 packets/sec
   1882 packets input, 136496 bytes
   Received 1523 broadcast, 0 runts, 0 giants, 0 throttles
   0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
   0 watchdog, 0 multicast
   0 input packets with dribble condition detected
   1036 packets output, 117248 bytes, 0 underruns
   0 output errors, 0 collisions, 0 deferred
   0 lost carrier, 0 no carrier
   0 output buffer failures, 0 output buffers swapped out
FastEthernet0/0.1 is up, line protocol is up
   Hardware is AmdFE, address is 0002.fd69.9e00 (bia 0002.fd69.9e00)
   Internet address is 172.16.136.6/24
   MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
      reliability 255/255, txload 1/255, rxload 1/255
   Encapsulation ISL Virtual LAN, Color 1.
   ARP type: ARPA, ARP Timeout 04:00:00
FastEthernet0/0.2 is up, line protocol is up
   Hardware is AmdFE, address is 0002.fd69.9e00 (bia 0002.fd69.9e00)
   Internet address is 172.16.62.6/24
   MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
      reliability 255/255, txload 1/255, rxload 1/255
   Encapsulation ISL Virtual LAN, Color 2.
   ARP type: ARPA, ARP Timeout 04:00:00
FastEthernet0/0.3 is up, line protocol is up
   Hardware is AmdFE, address is 0002.fd69.9e00 (bia 0002.fd69.9e00)
   Internet address is 172.16.63.6/24
   MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
reliability 255/255m, txload 1/255, rxload 1/255
Encapsulation ISL Virtual LAN. Color 3.
ARP type: ARPA, ARP Timeout 04:00:00
FastEthernet0/0.4 is up, line protocol is up
  Hardware is AmdFE, address is 0002.fd69.9e00 (bia 0002.fd69.9e00)
  Internet address is 172.16.64.6/24
  MTU 1500 bytes, BW 10000 Kbit, DLY 100 usec
  reliability 255/255, txload 1/255, rxload 1/255
Encapsulation ISL Virtual LAN, Color 4.
ARP type: ARPA, ARP Timeout 04:00:00
FastEthernet0/0.5 is up, line protocol is up
  Hardware is AmdFE, address is 0002.fd69.9e00 (bia0002.fd69.9e00)
  Internet address is 172.16.65.6/24
  MTU 1500 bytes, BW 10000 Kbit, DLY 100 usec,
  reliability 255/255, txload 1/255, rxload 1/255
Encapsulation ISL Virtual LAN, Color 5.
ARP type: ARPA, ARP Timeout 04:00:00
FastEthernet0/0.6 is up, line protocol is up
  Hardware is AmdFE, address is 0001.fd69.9e00 (bia 0002.fd69.9e00)
  Internet address is 172.16.66.6/24
  MTU 1500 bytes, BW 10000 Kbit, DLY 100 usec,
  reliability 255/255, txload 1/255, rxload 1/255
Encapsulation ISL Virtual LAN, Color 6.
ARP type: ARPA, ARP Timeout 04:00:00

Technical Verification For Task M

CAT5K==> (enable) sho udlf port 3/12
UDLD     :enabled
Message Interval : 15 seconds
Port  Admin Status Aggressive Mode Link State
      ----------- ----------- ---------
3/12 enabled disabled undetermined

Technical Verification For Task N

CAT5K==> sho logging

Logging buffer size: 500
  timestamp option: enabled
Logging history size: 1
Logging console enabled
Logging server: disabled
{172.16.65.77}
server facility: LOCAL5
server severity: notification(5)

Configuration Verification

Only relevant portions of the configuration have been included

Router 6

R6#sh run
interface FastEthernet0/0
  no ip address
  no ip directed-broadcast
duplex auto
  speed auto
!
interface FastEthernet0/0.1
  encapsulation isl 1
  ip address 172.16.136.6 255.255.255.0
  no ip redirects
  no ip directed-broadcast
!
interface FastEthernet0/0.2
  encapsulation isl 2
  ip address 172.16.62.6 255.255.255.0
  no ip redirects
  no ip directed-broadcast
!
interface FastEthernet0/0.3
  encapsulation isl 3
  ip address 172.16.63.6 255.255.255.0
  no ip redirects
  no ip directed-broadcast
!
interface FastEthernet0/0.4
  encapsulation isl 4
  ip address 172.16.64.6 255.255.255.0
  no ip redirects
  no ip directed-broadcast
!
interface FastEthernet0/0.5
  encapsulation isl 5
  ip address 172.16.65.6 255.255.255.0
  no ip redirects
no ip directed-broadcast

interface FastEthernet0/0.6
encapsulation isl 6
  ip address 172.16.66.6 255.255.255.0
  no ip redirects
  no ip directed-broadcast

CAT5K

CAT5K===>(enable) sho config
This command shows non-default configurations only.
Use ‘show config all’ to show both default and non-default configurations.

begin

#***** NON-DEFAULT CONFIGURATION *****
!
#time: Mon Feb 4 2002, 09:14:13
!
#version 6.3(4)
!
set option fddi-user-pri enabled
set prompt CAT5K===>
set banner moth ^CC^C
!
#system
set system name CAT5K
set system location Testking, INC
set system contact Future Testking
!
#frame distribution method
set port channel all distribution mac both
!
#vto
set vtp domain TESTKING
set vtp passwd Testking
clear vtp pruneeligible 3,5,1001-1005
set vlan 1 name default type ethernet mtu 1500 said 100001 state active

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set vlan 1002 name fddi-default type fddi mtu 1500 said 101002 state active
set vlan 1004 name fddinet-default type fddinet mtu 1500 said 101004 state active stp ieee
set vlan 1005 name trnet-default type trbrp mtu 1500 said 101005 state active stp ibm
set vlan 2-6
set vlan 1003 name token-ring-default type trcrp mtu 1500 said 101003 state active srb aremaxhop 7 stemaxhop 7 backupcrf off
!
#ip
set interface sc0 1 172.16.136.15/255.255.255.0 172.16.136.255
set ip route 0.0.0.0/0.0.0.0 172.16.136.6
!
#spantree
#portfast
set spantree portfast bpdu-guard enable
!
#syslog
set logging server 172.16.65.77
set logging level cdp 2 default
set logging server facility LOCAL5
set logging server severity 5
!
#set boot command
set boot config-register 0x101
set boot system flash bootflash:
set boot system flash bootflash:cat5000-sup3.6-3-4.bin
!
#udld
set udld enable
!
#default port status is enable
!
!
#module 1 : 2-port 10/100BaseTX Supervisor
!
#module 2 empty
# module 3: 12-port 10/100BaseTX Ethernet
set port speed 3/5 10
set udld enable 3/12
set trunk 3/1 off isl 1-1005
set trunk 3/6 on isl 1-1005
set spantree portfast 3/1 enable
!
#module 4 empty
!
module 5: 1-port MM OC-3 ATM
end
CAT5K==> (enable)
Lab Preparation Scenario: Advanced Routing

Topics Covered

- Classless to Classful routing
- Split-Horizon
- Route Summarization
- Route Redistribution
- HSRP
- OSPF over Frame-Relay

Difficulty Level: CCIE™

Average Completion Time: 2 to 3 Hours

Standard Topology

Standard TCP/IP Addressing and SPID Information

**R1 (3620)**
Loop0  192.168.1.1 /24  Loopback

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### CCIE LAB

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E0/0</td>
<td>172.16.136.1 /26</td>
<td>Ethernet Segment to Catalyst 3/1</td>
</tr>
<tr>
<td>T0/0</td>
<td>172.16.15.1 /28</td>
<td>Token Ring Segment to 3920</td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.31.1 /30</td>
<td>Serial to R3</td>
</tr>
<tr>
<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

**R2 (3620)**

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.2.2 /24</td>
<td>Loopback</td>
</tr>
<tr>
<td>T0/0</td>
<td>172.16.2.2 /24</td>
<td>Token Ring Segment to 3920</td>
</tr>
<tr>
<td>BRI0/0</td>
<td>172.16.230.2 /24</td>
<td>Serial to R3</td>
</tr>
<tr>
<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

**R3 (2610)**

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.3.3 /24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E0/0</td>
<td>172.16.136.3 /26</td>
<td>Ethernet Segment to Catalyst 3/3</td>
</tr>
<tr>
<td>BRI0/0</td>
<td>172.16.230.3 /24</td>
<td>ISDN to R2</td>
</tr>
<tr>
<td>S1/3</td>
<td>172.16.35.1 /30</td>
<td>Serial to R5</td>
</tr>
<tr>
<td>S1/2</td>
<td>172.16.32.1 /30</td>
<td>Serial to R2</td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.31.2/30</td>
<td>Serial to R1</td>
</tr>
<tr>
<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

**R4 (2610)**

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.4.4 /24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E0/0</td>
<td>10.1.4.4 /22</td>
<td>Ethernet Segment to BB1</td>
</tr>
<tr>
<td>S0/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

**R5 (3620)**

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.5.5 /24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E0/0</td>
<td>172.16.136.5 /26</td>
<td>Ethernet Segment to Catalyst 3/5</td>
</tr>
<tr>
<td>T0/0</td>
<td>172.16.15.4 /28</td>
<td>Token Ring Segment to 3920</td>
</tr>
<tr>
<td>S0/0</td>
<td>172.16.35.2 /30</td>
<td>Serial link to R3</td>
</tr>
<tr>
<td>A1/0</td>
<td>172.16.56.5 /30</td>
<td>ATM - R6</td>
</tr>
</tbody>
</table>

**R6 (3640)**

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.6.6 /24</td>
<td>Loopback</td>
</tr>
<tr>
<td>FA0/0</td>
<td>172.16.1.136.6 /26</td>
<td>Ethernet segment - R2</td>
</tr>
<tr>
<td>E2/0</td>
<td>10.2.6.6 /23</td>
<td>Ethernet segment - BB2</td>
</tr>
<tr>
<td>A1/0</td>
<td>172.16.56.6 /30</td>
<td>ARM - R5</td>
</tr>
</tbody>
</table>

**ISDN Information**

Switch type: Basic-NI1

**R2**

SPID1: 42255501210101

SPID2: 42255501220101
Technical Tasks

A. Configure the frame-relay cloud with R2 as the hub and R1, R3, and R4 as spokes.
   Only R2 may use sub-interfaces.
   Configure R2 – R4 in subnet 172.16.24.0/24.
   Configure R1, R2, and R3 in subnet 172.16.123.0/29.
   Do not use any DLCI’s other than those necessary to make R2 the hub.
B. On R4 enable IGRP for the ethernet, loopback, and frame-relay interfaces.
C. Configure the following subnets in the OSPF backbone:
   172.16.123.0/29, 172.16.2.0/24, and 172.16.32.0/24.
   Use the default OSPF network type for R1.
D. Configure subnets 172.16.136.0/26, 172.16.31.0/30, and 172.16.35.0/30 in OSPF area 1.
E. Enable EIGRP on R1 and R5 for subnet 172.16.15.0/28.
   Users on this subnet will have their default-gateway set to 172.16.15.14.
   Configure the routers such that R1 normally forwards traffic originating from users on the subnet
   but if R1’s frame-relay connection fails then R5 will handle the traffic.
   If the frame-relay connection recovers, R1 should again handle the traffic.
F. Enable EIGRP on R6 for the loopback interface and subnet 10.2.6.0/23.
   Add two additional addresses to the e2/0 interface of R6 (192.168.16.6/24 and 192.168.26.6/24).
   The two additional subnets must be in the routing tables of all routers.
   On R6 do not use the “redistribute connected” command under OSPF.
G. The ATM and ISDN interfaces will not be used in this lab.
   Other loopback interfaces may be advertised as appropriate.
   If you use the “redistribute connected” command on any router ensure that only the necessary
   subnets are included.
   Only one routing protocol can be active on any interface.
   The routing tables should not contain any host routes (32-bit mask).
   You are allowed once static entry on one router in your network, this cannot be configured on R4.
   Wherever you place your static entry do not manually configure redistribution of static routes into
   any routing protocol.
   The 10.2.6.0/23 subnet does not need to be in the routing table of R4, however R4 must be able to
   ping this subnet.

All subnets/interfaces that participate in routing must be reachable from all routers.

Instructor’s Comments and Technical Tips

A. The R2 – R4 connection should be point-to-point.
R2, R1, and R3 should be multipoint. Since you cannot use any other DLCI’s you will need to use map statements. You should also disable inverse-arp.

B. N/A

C. The default OSPF network type on a frame-relay physical interface is NBMA. If one of the routers is NBMA, the others will need to be NBMA. To make this work you need to ensure that R2 is the DR. You need to manually configure neighbors on R2. You should also set the OSPF priority to 0 for R1 and R3. You could make R2 the DR by raising R2’s OSPF priority and leaving R1 and R3 at the default value of 1, however since you do not a full-mesh this would create the situation where R1 and R3 both think they are the BDR.

D. N/A

E. Configure HSRP on R1 and R5 with R1 having a higher priority, 100 is the default. You also need to configure R1 to track the frame-relay interface. If this interface fails it should decrement the priority be a value great enough to cause R5 to become active. Configure both routers for “preempt”, this will allow either to become active when its priority is greater.

F. Given that you are not allowed to redistribute connected into OSPF, you need to get the new subnets into EIGRP and then redistribute EIGRP into OSPF. You can also summarize the subnets to 24-bit mask in EIGRP.

G. You may need to use passive-interface statements to avoid having multiple routing protocols going out a single interface. To get routes to R4 you need to summarize them into /24 advertisements. For OSPF routes you should use the “area X range” on the ABR’s. For the EIGRP route you need to use the “summary-address” command on the ASBR’s. An alternative would be to use the “ip-summary-address eigrp” command at the interface level. Be mindful of split-horizon on R4. Setting the encapsulation to frame-relay disabled split-horizon. If you leave it disabled, R4 will echo routes back to R2. Because of the lower administrative distance, R2 will believe R4 is the next-hop for routes that are in the OSPF/EIGRP domains. When redistributing connected interfaces into a protocol you may need to use a route-map to limit which interfaces are included.

R4 will need a default route to reach the 10.1.6.0/23 subnet. Given the parameters, this must be advertised from R2. IGRP does not understand the all zeros route, so you need to use a default-network. Configure this on R2 and it will automatically (no manual configuration) be redistributed into IGRP. Default-networks work best if you point to a classful network.
Technical Verification

Technical Verification For Task A

r1#sh fram map
Serial1/0(up): ip 172.16.123.2 dlci 122(0x7A,0x1CA0), static, broadcast,
    CISCO, status defined, active
Serial1/0(up): ip 172.16.123.3 dlci 122(0x7A,0x1CA0); static, broadcast,
    CISCO, status defined, active

r2#sh fram map
Serial1/0.123(up): ip 172.16.123.1 dlci 221(0xDD,0x34D0), static, broadcast,
    CISCO, status defined, active
Serial1/0.123(up): ip 172.16.123.3 dlci 223(0xDF,0x34F0), static, broadcast,
    CISCO, status defined, active
Serial1/0.24(up): point-to-point dlci, dlci 224(0xE0,0x3800), broadcast status defined, active

r3#sh fram map
Serial1/0(up): ip 172.16.123.1 dlci 322(0x142,0x5020), static, broadcast,
    CISCO, status defined, active
Serial1/0(up): ip 172.16.123.2 dlci 322(0x142,0x5020), static, broadcast,
    CISCO, status defined, active

r4#sh fram map
Serial0/0(up): ip 172.16.24.2 dlci 422(0x1A6,0x6860), static, broadcast,
    CISCO, status defined, active

Technical Verification For Task B

r4#sh ip protocols
Routing Protocol is “eigrp 24”
Sending updates every 90 seconds, next due in 32 seconds
Invalid after 270 seconds, hold down 280, flushed after 630
Outgoing update filter list for all interfaces is
Incoming update filter list for all interfaces is
Default networks flagged in outgoing updates
Default networks accepted from incoming updates  
IGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0  
IGRP maximum hopcount 100  
IGRP maximum metric variance 1  
Redistributing: igrp 24  
**Routing for Networks:**  
  10.0.0.0  
  172.16.0.0  
  192.158.4.0  
**Passive Interface(s):**  
  Ethernet0/0  
  Loopback0  
**Routing Information Sources:**  
<table>
<thead>
<tr>
<th>Gateway</th>
<th>Distance</th>
<th>Last Update</th>
</tr>
</thead>
<tbody>
<tr>
<td>172.16.24.2</td>
<td>100</td>
<td>00:01:08</td>
</tr>
</tbody>
</table>

Distance: (default is 100)

**Technical Verification For Task C**

```
r2#sh ip on

<table>
<thead>
<tr>
<th>Neighbor ID</th>
<th>Pri</th>
<th>State</th>
<th>Dead Time</th>
<th>Address</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>192.168.3.3</td>
<td>1</td>
<td>FULL/-</td>
<td>00:00:33</td>
<td>172.16.32.3</td>
<td>Serial1/1</td>
</tr>
<tr>
<td>192.168.3.3</td>
<td>0</td>
<td>FULL/DROther</td>
<td>00:01:53</td>
<td>172.16.123.3</td>
<td>Serial1/0.123</td>
</tr>
<tr>
<td>192.168.1.1</td>
<td>0</td>
<td>FULL/DROther</td>
<td>00:01:55</td>
<td>172.16.123.1</td>
<td>Serial1/0.123</td>
</tr>
</tbody>
</table>
```

```
r2#sh ip o int s1/0.123

Serial1/0.123 is up, line protocol is up  
Internet Address 172.16.123.2/29, Area 0

  Process ID 1, Router ID 192.168.2.2, Network Type NON_BROADCAST, Cost: 48  
  Transmit Delay is 1 sec, State DR, Priority 1  
  Designated Router (ID) 192.168.2.2, Interface address 172.16.123.2  
  No backup designated router on this network  
  Timer intervals configured, Hello 30, Dead 120, Wait 120, Retransmit 5  
  Hello due in 00:00:10  
  Index 1/1, flood queue length 0  
  Next 0x0(0)0x0(0)  
  Last flood scan length is 1, maximum is 5  
  Last flood scan time is 0 msec, maximum is 4 msec  
  Neighbor Count is 2, Adjacent neighbor count is 2  
  Adjacent with neighbor 192.168.3.3  
  Adjacent with neighbor 192.168.1.1  
  Suppress hello for 0 neighbor(s)
```

```
r2#sh ip o int s1/1
```

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Serial1/1 is up, line protocol is up
Internet Address 172.16.32.2/24, Area 0
Process ID 1, Router ID 192.168.2.2, Network Type POINT_TO_POINT, Cost: 48
Transmit Delay is 1 sec, State POINT_TO_POINT,
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:00
Index 3/3, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 5
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
Adjacent with neighbor 192.168.3.3

Suppress hello for 0 neighbor(s)

t2#sh ip o int to0/0
TokenRing0/0 is up, line protocol is up
Internet Address 172.16.2.2/24, Area 0
Process ID 1, Router ID 192.168.2.2, Network Type BROADCAST, Cost: 6
Transmit Delay is 1 sec, State DR, Priority 1
Designated Router (ID) 192.168.2.2, Interface address 172.16.2.2
No backup designated router on this network
Time intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:06
Index 2/2, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 0, maximum is 0
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 0, Adjacent neighbor counts is 0
Suppress hello for 0 neighbor(s)

Technical Verification For Task D

t3#sh ip o int s1/1
Serial1/1 is up, line protocol is up
Internet Address 172.16.31.2/30, Area 1
Process ID 1, Router ID 192.168.3.3, Network Type POINT_TO_POINT, Cost: 781
Transmit Delay is 1 sec, State POINT_TO_POINT,
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:03
Index 3/2, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 3, maximum is 5
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
Adjacent with neighbor 192.168.1.1
Suppress hello for 0 neighbor(s)

r3#sh ip ro int s1/3
Serial 1/3 is up, line protocol is up
Internet Address 172.16.35.1/30, Area 1
Process ID 1, Router ID 192.168.3.3, Network Type POINT_TO_POINT, Cost: 781
Transmit Delay is 1 sec, State POINT_TO_POINT,
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:06
Index 1/3, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 3, maximum is 5
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
Adjacent with neighbor 192.168.5.5
Suppress hello for 0 neighbor(s)

r3# sh ip o int e0/0
Ethernet0/0 is up, line protocol is up
Internet Address 172.16.136.3/26, Area 1
Process ID 1, Router ID 192.168.3.3, Network Type BROADCAST, Cost: 10,
Transmit Delay is 1 sec, State DR, Priority 1
Designated Router (ID) 192.168.3.3, Interface address 172.16.136.3
Backup Designated router (ID( 192.168.1.12, Interface address 172.16.136.1
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:05
Index 2/4 flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 3, maximum is 5
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 3, Adjacent neighbor count is 3
Adjacent with neighbor 192.168.6.6
Adjacent with neighbor 192.168.5.5
Adjacent with neighbor 192.168.1.1 (Backup Designated Router)
Suppress hello for 0 neighbor(s)

Technical Verification For Task E

r1#sh ip ei n
IP-EIGRP neighbors for process 15

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Distance: internal 90 external 170

Technical Verification For Task G

The routing tables of all routers are included here. The legend normally provided in router output has been deleted.

Router 1

```
Router 1
r1#sh ip ro

172.16.0.0/16 is variably subnetted, 13 subnets, 5 masks
  O  172.16.136.0/24 is a summary, 00:37:16, Null0
  C  172.16.136.0/26 is directly connected, Ethernet0/0
  O  172.16.32.0/24 [110/96] via 172.16.123.2, 00:37:16, Serial1/0
O IA  172.16.35.0/24 [110/106] via 172.16.123.3, 00:37:16, Serial1/0
  O  172.16.35.0/30 [110/58] via 172.16.136.5, 00:37:16, Ethernet0/0
  O  172.16.31.0/24 [110/96] via 172.16.123.6, 00:37:16, Serial1/0
  O  172.16.31.0/30 is directly connected, Serial1/1
  O E2  172.16.24.0/24 [110/20] via 172.16.123.2, 00:37:17, Serial1/0
D  172.16.15.0/24 is a summary, 00:53:35, Null0
  C  172.16.15.0/28 is directly connected, TokenRing0/0
  O  172.16.2.0/24 [110/54] via 172.16.123.2, 00:37:17, Serial1/0
  O  172.16.123.0/24 is a summary, 00:37:17, Null0
  C  172.16.123.0/29 is directly connected, Serial1/0
  O E2  192.168.4.0/24 [110/20] via 172.16.123.2, 00:37:17, Serial1/0
  O  192.168.5.0/24 [110/20] via 172.16.123.2, 00:37:17, Serial1/0
  O  192.168.5.0/24 is variably subnetted, 2 subnets, 2 masks
    O E2 192.168.0.0/8 [110/20] via 172.16.123.2, 00:37:17, Ethernet0/0
  O E2  10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
    O E2 10.0.0.0/8 [110/20] via 172.16.123.2, 00:37:17, Ethernet0/0
    O E2  10.2.6.0/23 [110/20] via 172.16.123.2, 00:37:17, Ethernet0/0
  O E2  192.168.6.0/24 [110/20] via 172.16.123.2, 00:37:17, Ethernet0/0
  O E2  192.168.6.0/24 [110/20] via 172.16.123.2, 00:37:17, Ethernet0/0
  O  192.168.1.0/24 [110/54] via 172.16.123.2, 00:37:17, Ethernet0/0
  O  192.168.1.0/24 is directly connected, Ethernet0/0
  C  192.168.1.0/24 is directly connected, Loopback0
O IA  192.168.2.0/24 [110/49] via 172.16.123.2, 00:37:17, Serial1/0
    0 192.168.3.0/24 [110/49] via 172.16.123.3, 00:37:17, Serial1/0
```

Router 2

```
Router 2
r2#sh ip ro

172.16.0.0/16 is variably subnetted, 11 subnets, 4 masks
  O IA  172.16.136.0/24 [110/58] via 172.16.123.1, 00:26:20, Serial1/0.123
```
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[110/58] via 172.16.32.3, 00:26:20, Serial1/1
[110/58] via 172.16.123.3, 00:26:20, Serial1/0.123
C 172.16.32.0/24 is directly connected, Serial1/1
O IA 172.16.35.0/24 [110/106] via 172.16.32.3, 00:26:20, Serial1/1
[110/106] via 172.16.123.3, 00:26:21, Serial1/0.123
O IA 172.16.35.0/30 [110/106] via 172.16.123.1, 00:26:21, Serial1/0.123
O IA 172.16.31.0/24 [110/96] via 172.16.123.1, 00:26:21, Serial1/0.123
C 172.16.24.0/24 is directly connected, Serial1/0.24
O E1 172.16.15.0/28 [110/68] via 172.16.123.1, 00:26:21, Serial1/0.123
O E1 172.16.15.0/24 [110/68] via 172.16.123.1, 00:26:21, Serial1/0.123
C 172.16.2.0/24 is directly connected, TokenRing0/0
O 172.16.123.0/24 is a summary, 00:26:23, Null0
C 172.16.123.0/29 is directly connected, Serial1/0.123
[110/20] via 172.16.123.3, 00:26:23, Serial1/0.123
[110/20] via 172.16.32.3, 00:26:23, Serial1/1
I 192.168.4.0/24 [100/7382] via 172.16.24.4, 00:00:04, Serial1/0.24
O IA 192.168.5.0/24 [110/59] via 172.16.123.1, 00:26:23, Serial1/0.123
[110/59] via 172.16.32.3, 00:26:23, Serial1/0.123
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
I 10.0.0.0/8 [100/6982] via 172.16.24.4, 00:00:04, Serial1/0.24
O E2 10.2.6.0/23 [110/20] via 172.16.123.1, 00:26:23, Serial1/0.123
[110/20] via 172.16.123.3, 00:26:23, Serial1/0.123
[110/20] via 172.16.32.3, 00:26:23, Serial1/1
O E2 192.168.6.0/24 [110/20] via 172.16.123.1, 00:26:24, Serial1/0.123
[110/20] via 172.16.123.3, 00:26:24, Serial1/0.123
[110/20] via 172.16.32.3, 00:26:24, Serial1/1
O E2 192.168.1.0/24 [110/49] via 172.16.123.1, 00:26:24, Serial1/0.123
C* 192.168.2.0/24 is directly connected, Loopback0
O 192.168.3.0/24 [110/49] via 172.16.32.2, 00:26:24, Serial1/1
[110/49] via 172.16.123.3, 00:26:24, Serial1/0.123

I. Router 3

r3#sh ip ro

172.16.0.0/16 is variably subnetted, 13 subnets, 5 masks
O 172.16.136.0/24 is a summary, 00:37:46, Null0
C 172.16.136.0/26 is directly connected, Ethernet0/0
C 172.16.32.0/24 is directly connected, Serial1/2
O 172.16.35.0/24 is a summary, 00:37:46, Null0
C 172.16.35.0/30 is directly connected, Serial1/3
O 172.16.31.0/24 is a summary, 00:37:46, Null0

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C 172.16.31.0/30 is directly connected, Serial1/1
O E2 182.16.24.0/24 [110/20] via 172.16.32.2, 00:37:46, Serial1/2
    [110/20] via 172.16.123.2, 00:37:47, Serial1/0
O E1 172.16.15.0/24 [110/30] via 172.16.136.1, 00:37:47, Ethernet0/0
    [110/30] via 172.16.136.5, 00:37:47, Ethernet0/0
O E1 172.16.15.0/28 [110/30] via 172.16.136.1, 00:37:47, Ethernet0/0
    [110/30] via 172.16.136.5, 00:37:47, Ethernet0/0
O 172.16.123.0/24 is a summary, 00:37:57, Null0
C 172.16.123.0/29 is directly connected, Serial1/0
O E2 192.168.4.0/24 [110/20] via 172.16.32.2, 00:37:47, Serial1/2
    [110/20] via 172.16.123.2, 00:37:47, Serial1/0
O 172.16.5.0/24 via 172.16.32.2, 00:37:47, Ethernet0/0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O E2 10.0.0.0/8 [110/20] via 172.16.32.2, 00:37:47, Serial1/2
    [110/20] via 172.16.123.2, 00:37:47, Serial1/0
O E2 10.2.6.0/23 [110/20] via 172.16.136.6, 00:37:48, Ethernet0/0
O E2 192.168.6.0/24 [110/20] via 172.16.136.6, 00:37:48, Ethernet0/0
O E2 192.168.1.0/24 [110/782] via 172.16.123.1, 00:37:58, Serial1/0
O IA 192.168.2.0/24 [110/782] via 172.16.136.6, 00:37:48, Serial1/2
    [110/782] via 172.16.123.2, 00:37:48, Serial1/0
C 192.168.3.0/24 is directly connected, Loopback0

Router 4

R4#sh ip ro
Gateway of last resort is 172.16.24.2 to network 192.168.2.0

    172.16.0.0/24 is subnetted, 8 subnets
I 172.16.136.0 [100/181571] via 172.16.24.2, 00:00:57, Serial0/0
I 172.16.32.0 [100/10476] via 172.16.24.2, 00:00:57, Serial0/0
I 172.16.35.0 [100/181571] via 172.16.24.2, 00:00:57, Serial0/0
I 172.16.31.0 [100/181571] via 172.16.24.2, 00:00:57, Serial0/0
C 172.16.24.0 is directly connected, Serial0/0
I 172.16.15.0 [100/181571] via 172.16.24.2, 00:00:57, Serial0/0
I 172.16.2.0 [100/8539] via 172.16.24.0, 00:00:58, Serial0/0
I 172.16.123.0 [100/181571] via 172.16.24.2, 00:00:58, Serial0/0
I 192.168.26.0/24 [100/181571] via 172.16.24.2, 00:00:58, Serial0/0
C 192.168.4.0/24 is directly connected, Loopback0
I 192.168.5.0/24 [100/181571] via 172.16.24.2, 00:00:58, Serial0/0
    10.0.0.0/22 is subnetted, 1 subnets

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C 10.1.4.0 is directly connected, Ethernet0/0
I 192.168.6.0/24 [100/181571] via 172.16.24.2, 00:01:00, Serial0/0
I 192.168.1.0/24 [100/181571] via 172.16.24.2, 00:01:00, Serial0/0
I* 192.168.2.0/24 [100/8976] via 172.16.24.2, 00:01:00, Serial0/0
I 192.168.3.0/24 [100/181571] via 172.16.24.2, 00:01:00, Serial0/0

Router 5
R5#sh ip ro
172.16.0.0/16 is variably subnetted, 10 subnets, 4 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
O IA 172.16.32.0/24 [110/106] via 172.16.136.1, 00:37:55, Ethernet0/0
O IA 172.16.35.0/24 [110/116] via 172.16.136.1, 00:37:55, Ethernet0/0
C 172.16.35.0/30 is directly connected, Serial0/0
O 172.16.31.0/30 [110/58] via 172.16.136.1, 00:37:55, Ethernet0/0
O E2 172.16.24.0/24 [110/20] via 172.16.136.6, 00:31:40, Ethernet0/0
D 172.16.15.0/24 is a summary, 00:54:13, Null0
C 172.16.15.0/28 is directly connected, TokenRing0/0
O IA 172.16.123.0/24 [110/58] via 172.16.136.1, 00:37:56, Ethernet0/0
O E2 192.168.26.0/24 [110/20] via 172.16.136.6, 00:31:40, Ethernet0/0
O E2 192.168.4.0/24 [110/20] via 172.16.136.1, 00:37:56, Ethernet0/0
C 192.168.5.0/24 is directly connected, Loopback0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O E2 10.0.0.0/8 [110/20] via 172.16.136.1, 00:37:57, Ethernet0/0
O E2 10.2.6.0/23 [110/20] via 172.16.136.6, 00:37:57, Ethernet0/0
O E2 192.168.6.0/24 [110/20] via 172.16.136.6, 00:37:57, Ethernet0/0
O E2 192.168.16.0/24 [110/20] via 172.16.136.6, 00:31:49, Ethernet0/0
O IA 192.168.1.0/24 [110/11] via 172.16.136.1, 00:37:57, Ethernet0/0
O IA 192.168.2.0/24 [110/59] via 172.16.136.1, 00:37:57, Ethernet0/0
O IA 192.168.3.0/24 [110/11] via 172.16.136.3, 00:37:57, Ethernet0/0

Router 6
R6#sh ip ro
172.16.0.0/16 is variably subnetted, 10 subnets, 4 masks
C 172.16.136.0/26 is directly connected, FastEthernet0/0
O IA 172.16.32.0/24 [110/97] via 172.16.136.1, 00:35:11, FastEthernet0/0
O IA 172.16.35.0/24 [110/107] via 172.16.136.1, 00:35:11, FastEthernet0/0
O 172.16.35.0/30 [110/49] via 172.16.136.5, 00:35:11, FastEthernet0/0
O 172.16.31.0/30 [110/49] via 172.16.136.1, 00:35:11, FastEthernet0/0
O E2 172.16.24.0/24 [110/20] via 172.16.136.6, 00:35:11, FastEthernet0/0
Configuration Verification

Only relevant portions of the configuration have been included.

Router 1

r1#sh run
interface Loopback0
   ip address 192.168.1.1 255.255.255.0
   ip ospf network point-to-point
!
interface Ethernet0/0
   ip address 172.16.136.1 255.255.255.192
   half-duplex
!
interface TokenRing0/0
   ip address 172.16.15.1 255.255.255.240
   ip summary-address eigrp 15 172.16.15.0 255.255.255.0 5
   ring-speed 16
   standby priority 101 preempt
   standby ip 172.16.15.14
   standby track Se1/0 5
interface Serial1/0
    ip address 172.16.123.1 255.255.255.248
    encapsulation frame-relay
    ip ospf priority 0
    frame-relay map ip 172.16.123.2 122 broadcast
    frame-relay map ip 172.16.123.3 122 broadcast
    no frame-relay inverse-arp

interface Serial1/1
    ip address 172.16.31.1 255.255.255.252

router eigrp 15
    network 172.16.15.0 0.0.0.15
    no auto-summary
    no eigrp log-neighbor-changes

router ospf 1
    log adjacency-changes
    area 0 range 172.16.123.0 255.255.255.0
    area 1 range 172.16.31.0 255.255.255.0
    area 1 range 172.16.136.0 255.255.255.0
    redistribute eigrp 15 metric-type 1 subnets
    network 172.16.31.0 0.0.0.3 area 1
    network 172.16.123.0 0.0.0.7 area 0
    network 172.16.136.0 0.0.0.63 area 1
    network 192.168.1.0 0.0.0.255 area 0

Router 2

r2#sh run
interface Loopback0
    ip address 192.168.2.2 255.255.255.0
    ip ospf network point-to-point

interface BRI0/0
    no ip address
    shutdown

interface Ethernet0/0
    no ip address
    shutdown
    half-duplex

interface TokenRing0/0
ip address 172.16.2.2 255.255.255.0
ing-speed 16
!
interface Serial1/0
no ip address
encapsulation frame-relay
no frame-relay inverse-arp
!
interface Serial1/0.24 point-to-point
ip address 172.16.24.2 255.255.255.0
frame-relay interface-dlci 224
!
interface Serial1/0.123 multipoint
ip address 172.16.123.2 255.255.255.248
frame-relay map ip 172.16.123.1 221 broadcast
frame-relay map ip 172.16.123.3 223 broadcast
!
interface Serial1/1
ip address 172.16.32.2 255.255.255.0
!
router ospf 1
log-adjacency-changes
area 0 range 172.16.123.0 255.255.255.0
redistribute igrp 24 subnets
network 172.16.2.0 0.0.0.255 area 0
network 172.16.32.0 0.0.0.255 area 0
network 172.16.123.0 0.0.0.7 area 0
network 192.168.2.0 0.0.0.255 area 2
neighbor 172.16.123.3
neighbor 172.16.123.1
!
router igrp 24
redistribute ospf 1
passive-interface TokenRing0/0
passive-interface Serial1/0.123
passive-interface Serial1/1
network 172.16.0.0
default-metric 56 1000 255 1 2500
!
ip kerberos source-interface any
ip classless
ip default-network 192.168.2.0

Router 3
r3#sh run

interface Loopback0
  ip address 192.168.3.3 255.255.255.0
  ip ospf network point-to-point

interface Ethernet0/0
  ip address 172.16.136.3 255.255.255.192
  half-duplex

interface BRI0/0
  no ip address
  shutdown

interface Serial1/0
  ip address 172.16.123.3 255.255.255.248
  encapsulation frame-relay
  ip ospf priority 0
  frame-relay map ip 172.16.123.1 322 broadcast
  frame-relay map ip 172.16.123.2 322 broadcast
  no frame-relay inverse-arp

interface Serial1/1
  ip address 172.16.31.2 255.255.255.252
  clockrate 64000

interface Serial1/2
  ip address 172.16.32.3 255.255.255.0
  clockrate 64000

interface Serial1/3
  ip address 172.16.35.1 255.255.255.252
  clockrate 64000

router ospf 1
  log-adjacency-changes
  area 0 range 172.16.123.0 255.255.255.0
  area 1 range 172.16.31.0 255.255.255.0
  area 1 range 172.16.35.0 255.255.255.0
  area 1 range 172.16.136.0 255.255.255.0
  network 172.16.31.0 0.0.0.3 area 1
  network 172.16.32.0 0.0.0.255 area 0
  network 172.16.35.0 0.0.0.3 area 1
  network 172.16.123.0 0.0.0.7 area 0
  network 172.16.136.0 0.0.0.63 area 1
  network 192.168.3.0 0.0.0.255 area 0

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Router 4

```
r4#sh run
interface Serial0/0
   ip address 172.16.24.4 255.255.255.0
   encapsulation frame-relay
   ip split-horizon
   frame-relay map ip 172.16.24.2 422 broadcast
   no frame-relay inverse-arp
!
interface Serial0/1
   no ip address
   shutdown
!
router igrp 24
   passive-interface Ethernet0/0
   passive-interface Loopback0
   network 10.0.0.0
   network 172.16.0.0
   network 192.168.4.0
```

Router 5

```
r5#sh run
interface Loopback0
   ip address 192.168.5.5 255.255.255.0
   ip ospf network point-to-point
!
interface Ethernet0/0
   ip address 172.16.136.5 255.255.255.192
   half-duplex
!
interface Serial0/0
   ip address 172.16.35.2 255.255.255.252
!
interface TokenRing0/0
   ip address 172.16.15.5 255.255.255.240
   ip summary-address eigrp 15 172.16.15.0 255.255.255.0 5
   ring-speed 16
   standby priority 100 preempt
   standby ip 172.16.15.14
!
interface Serial0/1
```
no ip address
shutdown

interface ATM1/0
  no ip address
  shutdown
  no atm ilmi-keepalive
!
router eigrp 15
  network 172.16.15.0 0.0.0.15
  no auto-summary
  no eigrp log-neighbor-changes
!
router ospf 1
  log-adjacency-changes
  area 1 range 172.16.35.0 255.255.255.0
  area 1 range 172.16.136.0 255.255.255.0
  redistribute eigrp 15 metric-type 1 subnets
  network 172.16.35.0 0.0.0.3 area 1
  network 172.16.136.0 0.0.0.63 area 1
  network 192.168.5.0 0.0.0.255 area 1

Router 6

r6#sh run
interface Loopback0
  ip address 192.168.6.6 255.255.255.0
  no ip directed-broadcast
  ip summary-address eigrp 6 192.168.26.0 255.255.255.0 5
  ip summary-address eigrp 6 192.168.16.0 255.255.255.0 5
!
interface FastEthernet0/=  
  ip address 172.16.136.6 255.255.255.192
  no ip directed-broadcast
  duplex auto
  speed auto
!
interface ATM1/0
  no ip address
  no ip directed-broadcast
  shutdown
  no atm ilmi-keepalive
!
interface Ethernet2/0
  ip address 192.168.16.6 255.255.255.128 secondary

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ip address 192.168.26.6 255.255.255.128 secondary
ip address 10.2.6.6 255.255.254.0
no ip directed-broadcast
!
router eigrp 5
  redistribute connected
  passive-interface Ethernet2/0
  network 10.2.6.0 0.0.1.255
  network 192.168.6.0
  no auto-summary
!
router ospf 1
  redistribute eigrp 6 subnets
  network 172.16.136.0 0.0.0.63 area 1
Lab Preparation Scenario: ISDN

Topics Covered

- Frame Relay
- IGRP
- EIGRP
- Snapshot Routing
- IP Unnumbered
- Idle timeouts
- Route Redistribution

Difficulty Level: CCIE TM

Average Completion Time: 2 Hours

Standard Topology

Standard TCP/IP Addressing and SPID Information

R1 (3620)
### CCIE LAB

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.1.1 /24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E0/0</td>
<td>172.16.136.1 /26</td>
<td>Ethernet Segment to Catalyst3/1</td>
</tr>
<tr>
<td>T0/0</td>
<td>172.16.15.1 /28</td>
<td>Token Ring Segment to 3920</td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.31.1 /30</td>
<td>Serial to R3</td>
</tr>
<tr>
<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

**R2 (3620)**

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.2.2 /24</td>
<td>Loopback</td>
</tr>
<tr>
<td>T0/0</td>
<td>172.16.2.2 /24</td>
<td>Token Ring Segment to 3920</td>
</tr>
<tr>
<td>BRI0/0</td>
<td>172.16.230.2 /24</td>
<td>BRI to R3</td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.32.2/24</td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

**R3 (2610)**

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.3.3 /24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E0/0</td>
<td>172.16.136.3 /26</td>
<td>Ethernet Segment to Catalyst 3/3</td>
</tr>
<tr>
<td>BRI0/0</td>
<td>172.16.230.3 /24</td>
<td>ISDN to R2</td>
</tr>
<tr>
<td>S1/3</td>
<td>172.16.35.1 /20</td>
<td>Serial to R5</td>
</tr>
<tr>
<td>S1/2</td>
<td>172.16.32.3/24</td>
<td>Serial to R2</td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.31.2/30</td>
<td>Serial to R1</td>
</tr>
<tr>
<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

**R4 (2610)**

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.4.4 /24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E0/0</td>
<td>10.1.4.4 /22</td>
<td>Ethernet Segment to BB1</td>
</tr>
<tr>
<td>S0/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

**R5 (3620)**

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>172.168.5.5 /24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E0/0</td>
<td>172.16.135.5 /26</td>
<td>Ethernet Segment to Catalyst 3/5</td>
</tr>
<tr>
<td>T0/0</td>
<td>172.16.15.5 /28</td>
<td>Token Ring Segment to 3920</td>
</tr>
<tr>
<td>S0/0</td>
<td>172.16.35.2 /30</td>
<td>Serial link to R3</td>
</tr>
<tr>
<td>A1/0</td>
<td>172.16.56.5 /30</td>
<td>ATM - R6</td>
</tr>
</tbody>
</table>

**R6 (3620)**

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.6.6 /24</td>
<td>Loopback</td>
</tr>
<tr>
<td>FA0/0</td>
<td>172.16.136.6 /26</td>
<td>Ethernet segment - R2</td>
</tr>
<tr>
<td>E2/0</td>
<td>10.2.6.6 /23</td>
<td>Ethernet segment - BB2</td>
</tr>
<tr>
<td>A1/0</td>
<td>172.16.56.6 /30</td>
<td>ATM - R5</td>
</tr>
</tbody>
</table>

**ISDN Information**

| Switch Type | Basic-NI1 |

**R2**

SPID1: 42255501210101

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Technical Tasks

A. Configure Frame Relay on R2 and R4.
   Use DLCI 244 and 442.
   Do not use any other DLCI’s.
   Use IP address 172.16.24.0/24.
   Configure IGRP on R2 and R4.
   Shutdown interface S1/1, as it will not be used in this exercise.
B. Configure EIGRP on R1, R3, R4 and R6.
C. Configure ISDN on R2 to call R3 every 8 hours to process IGRP routes.
   Configure R2 and R3 to bring the ISDN line up if any IP traffic is destined for the remote end.
   Once traffic has been idle for 15 minutes bring down the connection.
   Use the Loopback0 IP address for the BRI IP address for both routers. Use Chap authentication.
D. Redistribute Routes between EIGRP and IGRP on R3.
   You are allowed one static route on R2.
   All routers should be able to ping R4 eth0/0.

Instructor’s Comments and Technical Tips

A. N/A
B. N/A
C. Configure snapshot routing.
   Do not forget to use the broadcast statement to allow for routing updates.
D. Remember the rules for redistributing between FLSM and VLSM.

Technical Verification

Technical Verification For Task A

```
r2# sho fram map
Serial1/0.244(up): point-to-point dlci, dlci 244(0xF4,0x3C40), broadcast
   status defined, active
r2#
```

```
r2# sho ip route
        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, E – EGP
i – IS-IS, 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, 2 subnets
C  172.16.24.0 is directly connected, Serial0/0.442
C  172.16.2.0 is directly connected, TokenRing0/0
I  10.0.0.0/8 [100/6982] via 172.16.24.4, 00:00:51, Serial0/0.442
C  192.168.2.0/24 is directly connected, Loopback0

r2#

r4#sho fram map
Serial0/0.442(down): point-to-point dlce, dlci 442(0x1BA,0x6CA0), broadcast
status defined, inactive
r4#

r4#sho ip route
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, E – EGP
i – IS-IS, 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, 2 subnets
C  172.16.24.0 is directly connected, Serial0/0.442
I  172.16.2.0 [100/8539] via 172.16.24.2, 00:00:10, Serial0/0.442
C  192.164.0.0/24 is directly connected, Loopback0
10.0.0.0/22 is subnetted, 1 subnets
C  10.1.4.0 is directly connected, Ethernet0/0

Technical Verification For Task B

r1#sho ip route
D – EIGRP, EX – EIGRP external, O – OSPF, IA – OSPF inter area

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N1 – OSPF NSSA external type 1, N2 – OSPF NSSA external type 2
E1 – OSPF external type 1, E2 – OSPF external type 2, E – EGP
i – IS-IS, 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

172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
C  172.16.136.0/26 is directly connected, Ethernet0/0
C  172.16.31.0/30 is directly connected, Serial1/1
C  172.16.15.0/28 is directly connected, TokenRing0/0
10.0.0.0/23 is subnetted, 1 subnets
D  10.2.6.0 [90/307200] via 172.16.136.6, 00:05:40, Ethernet0/0
C10.2.6.0 [90/307200] via 172.16.136.6, 00:05:40, Ethernet0/0
C  192.168.1.0/24 is directly connected, Loopback0
r1#

r3#sho ip route
D – EIGRP, EX – EIGRP external, O – OSPF, IA – OSPF inter area
N1 – OSPF NSSA external type 1, N2 – OSPF NSSA external type 2
i – IS-IS, 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

172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
C  172.16.136.0/26 is directly connected, Ethernet0/0
C  172.16.31.0/30 is directly connected, Serial1/1
D  172.16.15.0/28 [90/297728] via 172.16.136.1, 00:06:49, Ethernet0/0
    [90/297728] via 172.16.136.5, 00:06:49, Ethernet0/0
10.0.0.0/23 is subnetted, 1 subnets
D10.2.6.0 [90/307200] via 172.16.136.6, 00:06:24, Ethernet0/0
C  192.168.3.0/24 is directly connected, Loopback0
r3#

r5#sho ip route
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, E – EGP
i – IS-IS, 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

172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
C 172.16.136.0/26 is directly connected, FastEthernet0/0
D 172.16.31.0/30 [90/1777920] via 172.16.15.1, 00:07:00, TokenRing0/0
C 172.16.15.0/28 is directly connected, TokenRing0/0
C 192.168.5.0/24 is directly connected, Loopback0

10.0.0.0/23 is subnetted, 1 subnets

D 10.2.6.0 [90/307200] via 172.16.136.6, 00:06:41, Ethernet0/0
r5#

r6#sho up route
Codes: C – connected, S – static, I – IGRP, 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, E – EGP
i – IS-IS, 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

172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
C 172.16.136.0/26 is directly connected, FastEthernet0/0
D 172.16.31.0/30 [90/1764352] via 172.16.136.1, 00:07:01, FastEthernet0/0
D 172.16.15.0/28 [90/178688] via 172.16.136.5, 00:07:01, FastEthernet0/=

10.0.0.0/23 is subnetted, 1 subnets
C 10.2.6.0 is directly connected, Ethernet2/0
C 192.168.6.0/24 is directly connected, Loopback0

Technical Verification For Task C

r2#sho snapshot
BRI0/0 is up, line protocol is upSnapshot client
Options: dialer support, stay asleep or carrier up
Length of active period: 15 minutes
Length of quiet period: 480 minutes
Length of retry period: 18 minutes
   For dialer address 1
   Current state: quiet, remaining: 468 minutes

r2#

r3# sho snapshot
BRI0/0 is up, line protocol is up
   Snapshot server
   Options: dialer support
   Length of active period: 15 minutes
r3#

Technical Verification For Task D

r1# sho ip route
   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, E – EGP
   i – IS-IS, 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

172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
   C  172.16.136.0/25 is directly connected, Ethernet0/0
   C  172.16.31.0/30 is directly connected, Serial1/1
   D  172.16.15.0/28 [90/2977728] via 172.16.136.5, 01:39:29, Ethernet0/0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
   D EX  10.0.0.0/8 [170/41075200] via 172.16.136.3, 00:28:15, Ethernet0/0
D10.2.6.0/23 [90/307200] via 172.16.136.6, 01:39:29, Ethernet0/0
   D  192.168.1.0/24 is directly connected, Loopback0
   D EX  192.168.2.0/24 [170/40665600] via 172.16.136.3, 00:28:16, Ethernet0/0
   D EX  192.168.3.0/24 [170/509600] via 172.16.136.3, 01:39:31, Ethernet0/0
r1#

r2# sho ip route
   D – EIGRP, EX – EIGRP external, O – OSPF, IA – OSPF inter area
   N1 – OSPF NSSA external type 1, N2 – OSPF NSSA external type 2
   i – IS-IS, 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

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Gateway of last resort is not set

172.16.0.0/24 is subnetted, 3 subnets
S 172.16.136.0 [1/0] via 192.168.3.3
C 172.16.24.0 is directly connected, Serial1/0.244
C 172.16.2.0 is directly connected, TokenRing0/0
I 10.0.0.0/8 [100/6982] via 172.16.24.4, 00:00:00, Serial1/0.244
C 192.168.2.0/24 is directly connected, Loopback0
192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.3.3/32 is directly connected, BRI0/0
S 192.168.3.0/24 is directly connected, BRI0/0
R2#

r3#sho ip route

D – EIGRP, EX – EIGRP external, O – OSPF, IA – OSPF inter area
N1 – OSPF NSSA external type 1, N2 – OSPF NSSA external type 2
i – IS-IS, 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.

172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
C 172.16.31.0/30 is directly connected, Serial1/1
D 172.16.15.0/28 [90/297728] via 172.16.136.5, 01:39:41, Ethernet0/0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
I 10.0.0.0/8 [100/160350] via 192.168.2.2, 00:20:26, BRI0/0
D 10.2.6.0/23 [90/307200] via 172.16.136.6, 01:39:41, Ethernet0/0
192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.2.2/32 is directly connected, Ethernet0/0
I 192.168.2.0/24 [100/158750] via 192.168.2.2, 00:28:30, BRI0/0
C 192.168.3.0/24 is directly connected, Loopback0
R3#

r4#sho ip route

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, E – EGP
i – IS-IS, 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, 3 subnets
I 172.16.136.0 [110/160250] via 172.16.24.2, 00:00:21, Serial0/0.442
C 172.16.24.0 is directly connected, Serial0/0.442
I 172.16.2.0 [100/8539] via 172.16.24.2, 00:00:21, Serial0/0.442
C 192.168.4.0/24 is directly connected, Loopback0
10.0.0.0/22 is subnetted, 1 subnets
C 10.1.4.0 is directly connected, Ethernet0/0
I 192.168.2.0/24 [100/8976] via 172.16.24.2, 00:00:21, Serial0/0.442
I 192.168.3.0/24 [100/160250] via 172.16.24.2, 00:00:22, Serial0/0.442
r4#

r5#sho ip route

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, E – EGP
i – IS-IS, 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

172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
D 172.16.31.0/30 [90/1787392] via 172.16.136.1, 01:40:08, Ethernet0/0
C 172.16.15.0/28 is directly connected, TokenRing0/0
C 192.168.5.0/24 is directly connected, Loopback0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D EX 10.0.0.0/8 [170/41075200] via 172.16.136.3, 00:28:48, Ethernet0/0
D 10.2.6.0/23 [90/307200] via 172.16.136.6, 01:42:50, Ethernet0/0
D EX 192.168.2.0/24 [170/40665600] via 172.16.136.3, 00:28:50,
Ethetn0/0
D EX 192.168.3.0/24 [170/409600] via 172.16.136.3, 01:41:59, Ethernet0/0
r5#

r6#sho ip route

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, E – EGP
i – IS-IS, L1 – IS-IS level-1, L2 – IS-IS level-2, ia – IS-IS inter area

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Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
C  172.16.136.0/26 is directly connected, FastEthernet0/0
D  172.16.31.0/30
    [90/1764352] via 172.16.136.1, 01:40:19, FastEthernet0/0
    172.16.15.0/28 [90/178688] via 172.16.136.5, 01:42:55,
    FastEthernet0/

10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D EX  10.0.0.0/9 [170/41052160] via 172.16.136.3, 00:29:00,
    FastEthernet0/0
C  10.2.6.0/23 is directly connected, Ethernet2/0
C  192.168.6.0/24 is directly connected, Loopback0
D EX  192.168.2.0/24 [170/40642560] via 172.16.136.3, 00:29:01, FastEthernet0/0
D EX  192.168.3.0/24 [170/156160] via 172.16.136.3, 01:42:11,
    FastEthernet0/0

Configuration Verification

Only relevant portions of the configuration have been included.

**Router 1**

```
rl#sh run
!
hostname rl
!
!
interface Loopback0
   ip address 192.168.1.1 255.255.255.0
!
interface Ethernet0/0
   ip address 172.16.136.1 255.255.255.192
   half-duplex
!
interface TokenRing0/0
   ip address 172.16.15.1 255.255.255.240
   shutdown
   ring-speed 16
!
interface Serial1/0
```
no ip address
encapsulation frame-relay
shutdown
!
interface Serial1/1
  ip address 172.16.31.1 255.255.255.252
!
router eigrp 1
  network 172.16.0.0
  no auto-summary
  no eigrp log-neighbor-changes
!
end

r1#

Router 2

R2#sh run
!
hostname r2
!
!
username r3 password 0 cisco
!
interface Loopback0
  ip address 192.168.2.2 255.255.255.0
!
interface BRI0/0
  ip unnumbered Loopback0
  encapsulation ppp
dialer idle-timeout 900
dialer redial interval 5 attempts 40 re-enable 60
dialer map snapshot 1 name r3 broadcast 5550131
dialer map ip 192.168.3.3 name r3 broadcast 5550131
dialer map ip 192.168.3.3 name r3 broadcast 5550132
dialer hold-queue 10
dialer load-threshold 125 either
dialer-group 1
  isdn switch-type basic-ni
  isdn spid1 42255501210101 5550121
  isdn spid2 42255501220101 5550122
  snapshot client 15 480 suppress-statechange-update dialer
  no cdp enable
pp authentication chap
interface TokenRing0/0
  ip address 172.16.2.2 255.255.255.0
  ring-speed 16
interface Serial1/0
  no ip address
  encapsulation frame-relay
  no frame-relay inverse-arp
interface Serial1/0.244 point-to-point
  ip address 172.16.24.2 255.255.255.0
  frame-relay interface-dlci 244
interface Serial1/1
  ip address 172.16.32.2 255.255.255.0
  shutdown
router igrp 1
  redistribute static
  network 172.16.0.0
  network 192.168.2.0
ip route 172.16.136.0 255.255.255.0 192.168.3.3
end

r2#

Router 3

R3#sh run
hostname r3
!
interface Loopback 0
  ip address 192.168.3.3 255.255.255.0
interface Ethernet0/0
  ip address 172.16.136.3 255.255.255.192
  half-duplex
interface BRI0/0
  ip unnumbered Loopback0
encapsulation ppp
dialer map snapshot 1 name r2 broadcast 5550121
dialer map ip 192.168.2.2 name r2 broadcast 5550121
dialer map ip 192.168.2.2 name r2 broadcast 5550122
dialer hold-queue 10

dialer load-threshold 125 either

dialer-group 1
isdn switch-type basic-ni
isdn spid1 42255501310101 5550131
isdn spid2 42255501320101 5550132

snapshot server 15 dialer

ppp authentication chap
!
interface Serial1/0
no ip address
encapsulation frame-relay
shutdown
!
interface Serial1/1
ip address 172.16.31.2 255.255.255.252
clockrate 64000
!
interface Serial1/2
ip address 172.16.32.3 255.255.255.0
shutdown
clockrate 64000
!
interface Serial1/3
ip address 172.16.35.1 255.255.255.252
shutdown
clockrate 64000
!
router eigrp 1
redistribute igrp 1 metric 64 100 255 1 1500
network 172.16.0.0
no auto-summary
no eigrp log-neighbor-changes
!
router igrp 1
redistribute eigrp 1 metric 1500 10 255 1 1500
network 192.168.3.0
!
end

r3#
Router 4

**R4#sh run**

```
! hostname r4
!
interface Loopback0
  ip address 192.168.4.4 255.255.255.0
!
interface Ethernet0/0
  ip address 10.1.4.4 255.255.252.0
  half-duplex
!
interface Serial0/0
  no ip address
  encapsulation frame-relay
  no frame-relay inverse-arp
!
interface Serial0/0.422 point-to-point
  ip address 172.16.24.4 255.255.255.0
  frame-relay interface-dlci 442
!
interface Serial0/1
  no ip address
  shutdown
!
router igrp 1
  network 10.0.0.0
  network 172.16.0.0
!
end
```

r4#

Router 5

**R5#sh run**

```
! hostname r5
!
```
interface Loopback0
  ip address 192.168.5.5 255.255.255.0
!
interface Ethernet0/0
  ip address 172.16.136.5 255.255.255.192
  half-duplex
!
interface Serial0/0
  ip address 172.16.35.2 255.255.255.252
  shutdown
  no fair-queue
!
interface TokenRing0/0
  ip address 172.16.15.5 255.255.255.240
  ring-speed 16
!
interface Serial0/1
  no ip address
  shutdown
!
interface ATM1/0
  no ip address
  shutdown
  no atm ilmi-keepalive
!
router eigrp 1
  network 172.16.0.0
  no auto-summary
  no eigrp log-neighbor-changes
!
end

Router 6

R6#sh run
!
hostname r6
!
interface Loopback0
  ip address 192.168.6.6 255.255.255.0
  no ip directed-broadcast
!
interface FastEthernet0/0  
ip address 172.16.136.6 255.255.255.192
no ip directed-broadcast
duplex auto
speed auto
!
interface ATM1/0  
no ip address
no ip directed-broadcast
shutdown
no atm ilmi-keepalive
!
interface Ethernet2/0  
ip address 10.2.6.6 255.255.254.0
no ip directed-broadcast
!
router eigrp 1  
  network 10.0.0.0
  network 172.16.0.0
  no auto-summary
!
!
end
r6#
Lab Preparation Scenario: Network Time Protocol (NTP)

Topics Covered
- Frame Relay
- EIGRP
- NTP stratum
- NTP authentication
- Time Zones
- Day light savings time
- Catalyst NTP configuration

Difficulty Level: CCIE
Average completion Time: 1 Hour

Standard Topology

Standard TCP/IP Addressing and SPID Information
### CCIE LAB

<table>
<thead>
<tr>
<th>R1 (3620)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Loop0</strong></td>
<td>192.168.1.1/24</td>
</tr>
<tr>
<td><strong>E/0/0</strong></td>
<td>172.16.136.1/26</td>
</tr>
<tr>
<td><strong>T/0/0</strong></td>
<td>172.16.15.1/28</td>
</tr>
<tr>
<td><strong>S1/1</strong></td>
<td>172.16.31.1/30</td>
</tr>
<tr>
<td><strong>S1/0</strong></td>
<td>unassigned</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>R2 (3620)</th>
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</thead>
<tbody>
<tr>
<td><strong>Loop0</strong></td>
<td>192.168.2.2/24</td>
</tr>
<tr>
<td><strong>T/0/0</strong></td>
<td>172.16.2.2/24</td>
</tr>
<tr>
<td><strong>BRI0/0</strong></td>
<td>172.16.230.2/24</td>
</tr>
<tr>
<td><strong>S1/1</strong></td>
<td>172.16.32.2/24</td>
</tr>
<tr>
<td><strong>S1/0</strong></td>
<td>unassigned</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>R3 (2610)</th>
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</thead>
<tbody>
<tr>
<td><strong>Loop0</strong></td>
<td>192.168.2.2/24</td>
</tr>
<tr>
<td><strong>E0/0</strong></td>
<td>172.16.136.3/26</td>
</tr>
<tr>
<td><strong>BRI0/0</strong></td>
<td>172.16.230.3/24</td>
</tr>
<tr>
<td><strong>S1/3</strong></td>
<td>172.16.35.1/30</td>
</tr>
<tr>
<td><strong>S1/2</strong></td>
<td>172.16.32.3/24</td>
</tr>
<tr>
<td><strong>S1/1</strong></td>
<td>172.16.31.2/30</td>
</tr>
<tr>
<td><strong>S1/0</strong></td>
<td>unassigned</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>R3 (2610)</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Loop0</strong></td>
<td>192.168.4.4/24</td>
</tr>
<tr>
<td><strong>E0/0</strong></td>
<td>10.1.4.4/22</td>
</tr>
<tr>
<td><strong>S0/0</strong></td>
<td>Unassigned</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>R5 (3620)</th>
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<tbody>
<tr>
<td><strong>Loop0</strong></td>
<td>192.168.5.5/24</td>
</tr>
<tr>
<td><strong>E0/0</strong></td>
<td>172.16.136.5/26</td>
</tr>
<tr>
<td><strong>T/0/0</strong></td>
<td>172.16.15.5/28</td>
</tr>
<tr>
<td><strong>S0/0</strong></td>
<td>172.16.35.2/30</td>
</tr>
<tr>
<td><strong>A1/0</strong></td>
<td>172.16.56.5/30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>R6 (3640)</th>
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</thead>
<tbody>
<tr>
<td><strong>Loop0</strong></td>
<td>192.168.6.6/24</td>
</tr>
<tr>
<td><strong>FA0/0</strong></td>
<td>172.16.136.6/26</td>
</tr>
<tr>
<td><strong>E2/0</strong></td>
<td>10.2.6.6/23</td>
</tr>
<tr>
<td><strong>A1/0</strong></td>
<td>172.16.56.6/30</td>
</tr>
</tbody>
</table>

### ISDN Information

<table>
<thead>
<tr>
<th>Switch Type</th>
<th>Basic-NI 1</th>
</tr>
</thead>
</table>

### R2

| SPID1: | 42255501210101 |
| SPID2: | 42255501220101 |

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Technical Tasks

A. Configure the frame relay so R3 is the Hub use DLCI’s 311, and 344. Use sub-interfaces on R1, R2 and R4 but not on R3. Use IP address 172.16.123.0/24 with the router number as the 4th octet.
B. Configure EIGRP on all routers should be able to ping one another.
C. Configure R5 and R6 to be NTP serves. Set the stratum number to 6 on R6 and makes R5 less important. Set the NTP source address to be the loopback interface. Configure the routers so only the loopback interfaces on R1, R2, R# and R4 and the catalyst are allowed to peer. Configure MD5 authentication. Configure the R5 and R6 for Eastern Standard Time and to observe day light savings time. Set the time on the R6 to 13:01 on August 1, 2002. Set R5 to receive the time from R6.
D. Configure R1, R2, R3 and R4 to use R5 and R6 as NTP servers. R1 and R3 are in the same Time zone and observe daylight savings time, however R2 is in the Pacific Time zone it also observes daylight savings time and R4 is in the Seoul, South Korea but does not observe daylight savings time. Make sure the routers display the correct time for their time zone. Configure the routers to report the local time and time zone in the log and for debug messages.
E. Configure IP address 172.16.136.15 on cat5000 switch. Set default gateway to R6. Configure the catalyst get its time from R5 and R6.

Instructor’s Comments and Technical Tips

A. N/A
B. N/A
C. Normally, a network would want to get the time from a source on the Internet. In this case we do not have access so we configure the servers on our network. Even if Internet access is available you may wish only to have a few routers get the time from the Internet and the other routers update from there.
D. When multiple servers are configured the one with the lowest stratum should be selected.
E. Do not forget to configure authentication. Also remember to update the access list configured in step C.

Technical Verification

Technical Verification For Task A

r1#sho frame map
Serial1/0.1(up): point-to-point dlci, dlci 113(0*71,0*1C10), broadcast
Status defined, active
r1#

r2#sho frame map
Serial 1/0.1 (up): point-to-point dlci, dlci 223(0*DF, 0*34F0), broadcast
Status defined, active

r2#

```
**r3#sho frame map**
Serial1/0.1(up): ip 172.16.123.1 dlci 311(0*137, 0*4C70), static, broadcast, CISCO, status defined, active
Serial1/0(up): ip 172.16.123.1 dlci 322(0*124, 0*5020), static, broadcast, CISCO, status defined, active
Serial1/0(up): ip 172.16.123.4 dlci 344(0*158, 0*5480), static, broadcast, CISCO, status defined, active
```

r3#

```
**r4#sho frame map**
Serial0/0.1(up): point-to-point dlci, dlci 443(0*1BB, 0*6CB0), broadcast
    Status defined, active
```

r4#

Technical Verification For task B

```
**r1#sho ip route**
Codes: C- connected, S- static, I- Igrp, R- RIP, M- mobile, B- BGP
O- 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, E- EGP
i-IS-IS, L1- 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
    172.16.0.0/16 is variably subnetted, 6 subnets, 4 masks
    C  172.16.132.0/26 is directly connected, Ethernet0/0
    D  172.16.32.0/24[90/20537600] via 172.16.136.3, 01:10:14, Ethernet
    C  172.16.31.0/30 is directly connected, TokenRing0/0
    C  172.16.15.0/28 is directly connected, TokenRing0/0
    D  172.16.2.0/24[90/20553728] via 172.16.136.3, 01:06:21, Ethernet
    C  172.16.123.0/24 is directly connected, Serial1/0/1
    D  192.168.4.0/24[90/20665600] via 172.16.136.3, 01:10:11, Ethernet
    D  192.168.5.0/24[90/409600] via 172.16.136.5, 01:10:15, Ethernet
    10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
```
CCIE LAB

D 10.2.6.0/23[90/307200] via 172.16.136.6, 01:10:15, Ethernet0/0
D 10.1.4.0/22[90/20563200] via 172.16.136.3, 00:03:31, Ethernet0/0
D 192.168.6.0/24[90/409600] via 172.16.136.6, 01:10:15, Ethernet0/0
C 192.168.1.0/24 is directly connected, Loopback0
D 192.168.2.0/24[90/20665600] via 172.16.136.3, 01:06:21, Ethernet0/0
D 192.168.3.0/24[90/409600] via 172.16.136.3, 01:10:16, Ethernet0/0
r1#

r2#sho ip route
Codes: C-connected, S-static, I-IGRP, 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, E-EGP
i-IS-IS, 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 download static route

Gateway of last resort is not set
172.16.0.0/16 is variably subnetted, 6 subnets, 4 masks
D 172.16.136.0/26[90/1787392] via 172.16.32.3, 01:06:37, Serial1/1
[90/1787392] via 172.16.123.3, 01:06:37, Serial1/0.1
C 172.16.32.0/24 is directly connected, Serial1/1
D 172.16.31.0/30[90/21024000] via 172.16.32.3, 01:06:37, Serial1/1
[90/21024000] via 172.16.123.3, 01:06:37, Serial1/0.1
D 172.16.15.0/28[90/1803520] via 172.16.32.3, 01:06:37, serial1/1
[90/1803520] via 172.16.123.3, 01:06:38, Serial1/0.1
C 172.16.2.0/24 is directly connected, TokenRing0/0
C 172.16.123.0/24 is directly connected, Serial1/0.1
D 192.168.4.0/24[90/21152000] via 172.16.32.3, 01:06:38, Serial1/1
D 192.168.5.0/24[90/1915392] via 172.16.32.3, 01:06:38, Serial1/1
[90/1915392] via 172.16.123.3, 01:06:38, Serial1/0.1
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D 10.2.6.0/23[90/1812992] via 172.16.136.6, 01:06:38, Serial1/1
[90/1812992] via 172.16.123.3, 01:06:38, Serial1/0.1
D 10.1.4.0/22[90/21049600] via 172.16.32.3, 00:03:47, Serial1/1
D 192.168.6.0/24[90/1915392] via 172.16.32.3, 01:06:38, Serial1/1
[90/1915392] via 172.16.123.3, 01:06:38, Serial1/1
D 192.168.1.0/24[90/1915392] via 172.16.32.3, 01:06:38, Serial1/1
[90/1915392] via 172.16.123.3, 01:06:38, Serial1/0.1
C 192.168.2.0/24 is directly connected, Loopback0
D 192.168.3.0/24[90/1889792] via 172.16.123.3, 01:06:38, Serial1/0.1
r2#
r3#sho ip route
Codes: C-connected, S-static, I-IGRP, 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, E-EGP
   i-IS-IS, 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

    172.16.0.0/16 is variably subnetsed, 6 subnets, 4 masks
     C 172.16.136.0/26 is directly connected, Ethernet0/0
     C 172.16.32.0/24 is directly connected, Serial1/0
     C 172.16.31.0/30 is directly connected, Serial1/1
     D 172.16.15.0/28[90/297728] via 172.16.136.5, 01:10:37, Ethernet0/0
          [90/297728] via 172.16.136.5, 01:10:37, Ethernet0/0
     D 172.16.2.0/24[90/20528128] via 172.16.32.2, 01:06:45, Serial1/2
          [90/20528128] via 172.16.123.2, 01:06:45, Serial1/0
     C 172.16.123.0/24 is directly connected, Serial1/0
     D 192.168.4.0/24[90/20640000] via 172.16.123.4, 01:06:45, Serial1/0
     D 192.168.5.0/24[90/409600] via 172.16.32.2, 01:06:44, Serial1/2
          [90/409600] via 172.16.123.2, 01:06:44, Serial1/0
     C 192.168.3.0/24 is directly connected, Loopback0
r3#

r4#sho ip route
Codes: C-connected, S-static, I-IGRP, 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, E-EGP
   i-IS-IS, 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
    172.16.0.0/16 is variably subnetsed, 5 subnets, 4 masks
     D 172.16.136.0/26[90/2195456] via 172.16.123.3, 01:10:44, serial0/0.1
     D 172.16.32.0/24[90/21024000] via 172.16.123.3, 01:10:44, Serial0/0.1
D 172.16.31.0/30[90/21024000] via 172.16.123.3, 01:10:44, Serial0/0.1
D 172.16.15.0/28[90/2211584] via 172.16.123.3, 01:10:44, Serial0/0.1
C 172.168.123.0/24 is directly connected, Serial0/0.1
C 192.168.4.0/24 is directly connected, Loopback0
D 192.168.4.0/24[90/2323456] via 172.16.123.3, 01:10:45, Serial0/0.1
10.0.0.0/8 is variably subnetted , 2 subnets, 2 masks
D 10.2.6.0/23[90/2323456] via 172.16.123.3, 01:10:45, Serial0/0.1
C 10.1.4.0/22 is directly connected, Ethernet0/0
D 192.168.6.0/24[90/2323456] via 172.16.123.3, 01:10:45, Serial0/0.1
D 192.168.1.0/24[90/2323456] via 172.16.123.3, 01:10:45, Serial0/0.1
D 192.168.3.0/24[90/2297856] via 172.16.123.3, 01:10:45, Serial0/0.1
r4#

r5#sho ip route
Codes: C-connected, S-static, I-IGRP, 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, E-EGP
I-IS-IS, L1- IS-IS level-1, L2- IS-IS level-2, ia-IS-IS inter area
*-candidate default, U-per-user static route, ia-IS-IS inter area
P-periodic download static route

Gateway of last resort is not set
172.16.0.0/16 is variable subnetted, 6 subnets, 4 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
D 172.16.32.0/24[90/20537600] via 172.16.136.1, 02:30:44, Ethernet0/0
D 172.16.31.0/30[90/1787392] via 172.16.136.1, 02:30:44, Ethernet0/0
C 172.16.15.0/28 is directly connected, TokenRing0/0
D 172.16.2.0/24[90/20553728] via 172.16.136.3, 01:07:07, Ethernet0/0
D 172.16.123.0/24[90/1787392] via 172.16.136.1, 01:11:00, Ethernet0/0
D 192.168.4.0/24[90/20665600] via 172.16.136.3, 01:10:56, Ethernet0/0
C 192.168.5.0/24 is directly connected, Loopback0
10.0.0.0/8 is variably subnetted , 2 subnets, 2 masks
D 10.2.6.0/23[90/307200] via 172.16.136.6, 02:40:06, ethernet0/0
D 10.1.4.0/22[90/20563200] via 172.16.136.3, 00:04:15, Ethernet0/0
D 192.168.6.0/24[90/409600] via 172.16.136.6, 02:40:06, Ethernet0/0
D 192.168.1.0/24[90/409600] via 172.16.136.1, 02:40:04, Ethernet0/0
D 192.168.2.0/24[90/20665600] via 172.16.136.3, 01:07:05, Ethernet0/0
D 192.168.3.0/24[90/409600] via 172.16.136.3, 01:23:49, Ethernet0/0
r5#

r6#sho ip route
Codes: C-connected, S-static, I-IGRP, R-RIP, M-mobile, B-BGP
D-EIGRP, EX-EIGRP external, O-OSPF, IA-OSPF inter area
CCIE LAB

N1-OSPF NSSA external type 1, N2-OSPF NSSA external type 2
E1-OSPF external type 1, E2-OSPF external type 2, E-EGP
i-IS-IS, L1-Is-IS level-1, L2- IS-IS level2, 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

172.16.0.0/16 is Variably subnetted, ^ subnets, $ masks
C 172.16.136.0/26 is directly connected, FastEthernet0/0
D 172.16.32.0/24
    [90/20514560] via 172.16.136.3, 02:30:37, FastEthernet0/0
D 172.16.31.0/30
    [90/1764352] via 172.16.136.1, 02:30:37, FastEthernet0/0
D 172.16.15.0/28[90/178688] via 172.16.136.1, 02:40:00, FastEthernet0/0
    [90/178688] via 172.16.136.5, 02:40:00, FastEthernet0/0
D 172.16.2.0/24
    [90/20530688] via 172.16.136.3, 01:07:00, FastEthernet0/0
D 172.16.123.0/24
    [90/1764352] via 172.16.136.1, 01:10:54, FastEthernet0/0
D 10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 10.2.6.0/23 is directly connected, Ethernet2/0
D 10.1.4.0/22[90/20540160] via 172.16.136.3, 00:04:08, FastEthernet0/0
C 192.168.6.0/24 is directly connected, Loopback0
D 192.168.1.0/24[90/156160] via 172.16.136.1, 03:00:25, FastEthernet0/0
D 192.168.2.0/24[90/20642560] via 172.16.136.3, 01:06:58, FastEthernet0/0
D 192.168.3.0/24[90/156160] via 172.16.136.3, 01:23:42, FastEthernet0/0
r6#

Technical Verification For Task C

Console>(enable) sho ntp

r5#sho ntp?
Associations NTP associations
Status  NTP status
r5#sho ntp assoc

<table>
<thead>
<tr>
<th>address</th>
<th>ref</th>
<th>clock</th>
<th>st</th>
<th>when</th>
<th>poll</th>
<th>reach</th>
<th>delay</th>
<th>offset</th>
<th>disp</th>
</tr>
</thead>
<tbody>
<tr>
<td>~192.138.6.6 127.127.7.1</td>
<td>6</td>
<td>67</td>
<td>128</td>
<td>337</td>
<td>3.6</td>
<td>2.93</td>
<td>1.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+~127.127.7.1 127.127.7.1</td>
<td>7</td>
<td>33</td>
<td>64</td>
<td>337</td>
<td>0.0</td>
<td>0.00</td>
<td>0.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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- 187 -
### r5# show ntp status

Clock is synchronized, stratum 7, reference is 192.168.6.6
Nominal freq is 250.0000 Hz, actual freq is 250.0000 Hz, precision is $2^{24}$
Reference time is BF1274EE. 7CC7391 (08:38:48 EST Wed Aug 1 2001)
Clock offset is 2.9309 msec, root delay is 3.59 msec
Root dispersion is 6.29 msec, peer dispersion is 3.33 msec

### r6# show ntp assoc

<table>
<thead>
<tr>
<th>Address</th>
<th>Reference</th>
<th>Clock</th>
<th>Stratum</th>
<th>When</th>
<th>Poll</th>
<th>Reach</th>
<th>Delay</th>
<th>Offset</th>
<th>Disp</th>
</tr>
</thead>
<tbody>
<tr>
<td>~127.127.7.1</td>
<td>127.127.7.1</td>
<td>5</td>
<td>13</td>
<td>377</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

*master (synced), # master (unsynced), + selected, - candidate, ~configured

### r6# show ntp status

clock is synchronized, stratum 6, reference is 127.127.7.1 nominal freq is 250.0000 Hz, actual freq is 250.0000 Hz, precision is $2^{24}$ reference time is BF127541.34380752 (08:32:01:203 EST WED Aug 1 2001) clock offset is 0.0000 msec, root delay is 0.00 msec
root dispersion is 0.02 msec, peer dispersion is 0.02 msec
r6#

**Technical Verification For Task d**

### r1# show ntp assoc

<table>
<thead>
<tr>
<th>Address</th>
<th>Reference</th>
<th>Clock</th>
<th>Stratum</th>
<th>When</th>
<th>Poll</th>
<th>Reach</th>
<th>Delay</th>
<th>Offset</th>
<th>Disp</th>
</tr>
</thead>
<tbody>
<tr>
<td>~192.168.6.6</td>
<td>127.127.7.1</td>
<td>6</td>
<td>47</td>
<td>64</td>
<td>377</td>
<td>3.6</td>
<td>6.83</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>+~192.168.5.5</td>
<td>192.168.6.6</td>
<td>7</td>
<td>8</td>
<td>64</td>
<td>377</td>
<td>4.8</td>
<td>2.96</td>
<td>0.7</td>
<td></td>
</tr>
</tbody>
</table>

*master (synced), # master (unsynced), + selected, - candidates, ~ configured

### r1# show ntp status

clock is synchronized, stratum 7, reference is 192.168.6.6 nominal freq is 25.0000 Hz, actual freq is 249.9992 Hz, precision is $2^{24}$ reference time is BF127579.95241 E53 (08:32:57.582 EST WED AUG 1 2001) clock offset is 6.8252 msec, root delay is 3.57 msec root dispersion is 9.55 msec, peer dispersion is 2.70 msec
r1#

### r2# show ntp assoc

<table>
<thead>
<tr>
<th>Address</th>
<th>Reference</th>
<th>Clock</th>
<th>Stratum</th>
<th>When</th>
<th>Poll</th>
<th>Reach</th>
<th>Delay</th>
<th>Offset</th>
<th>Disp</th>
</tr>
</thead>
</table>

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*~192.168.6.6 127.127.7.1 6 95 128 377 20.0 -4.48 4.2
+~192.168.5.5 192.168.6.6 7 109 128 377 21.1 -9.21 5.1
* master (synced), #master(unsynced), + selected, -candidate, ~configured

r2# sho ntp status
clock is synchronized, stratum 7, reference is 192.168.6.6 nominal freq is 250.0000 Hz, actual freq is 250.0000
Hz, precision is 2**24 reference time is BF127585.C11BF19A (05:33:09.754 PST WED AUG 1 2001) clock	noise is -4.4843 msec, root delay is 20.00 msec
r2#

r3# sho ntp assoc
address ref clock st when poll reach delay offset disp
*~192.168.6.6 127.127.7.1 6 22 64 377 2.8 16.92 0.2
+~192.168.5.5 192.168.6.6 7 58 64 377 4.1 12.63 0.9
*master (synced), #master(unsynced), +selected, -candidate, ~configured

r3# sho ntp status
clock is synchronized, stratum 7, reference is 192.168.6.6 nominal freq is 249.5901 Hz, actual freq is 249.5888
Hz, precision is 2**16 reference time is BF1275E9.AD784745 (08:34:49.677 EST WED Aug 1 2001) clock	noise is 16.9214 msec, root delay is 2.78 msec root dispersion is 20.36 msec, root delay is 2.78 msec root
dispersion is 20.36 msec, peer dispersion is 3.42 msec
r3#

r4# sho ntp assoc
address ref clock st when poll reach delay offset disp
*~192.168.6.6 127.127.7.1 6 27 64 377 19.0 18.64 1.2
+~192.168.5.5 192.168.6.6 7 0 64 377 20.2 14.03 0.5
*master (synced), #master(unsynced), +selected, -candidate, ~configured

r4# sho ntp status
Clock is synchronized, stratum 7, reference is 192.168.6.6 nominal freq is 249.5901 Hz, actual freq is 249.5896
Hz, precision is 2**16 reference time is BF127F9.D02DB03A (20:35:05.813 KISH Wed Aug 1 2001) clock	noise is 18.6360 msec, root delay is 19.00 msec root dispersion is 23.54 msec, peer dispersion is 4.88 msec
r4#

Technical Verification For Task E

Console>(enable) sho ntp
Current time: WED Aug 1 2001, 08:27:56 EST

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Timezone: ‘EST’, offset from UTC is –5 hours
Summertime: ‘EST’, enable
Start: Sun Apr 1 2001, 02:00:00
End: Sun Oct 28 2001, 02:00:00
Offset: 60 minutes

Last NTP update: WED aug 1 2001, 08:27:26
Broadcast client mode: disabled
Broadcast delay: 3000 microseconds
Client mode: enabled
Authentication: enabled

<table>
<thead>
<tr>
<th>NTP-server</th>
<th>Server Key</th>
</tr>
</thead>
<tbody>
<tr>
<td>192.168.6.6</td>
<td>1</td>
</tr>
<tr>
<td>192.168.5.5</td>
<td>1</td>
</tr>
</tbody>
</table>

Key Number Mode
-------------
1 trusted
Console>(enable)

Configuration Verification

Only relevant portions of the configured have been included.

Router 1

r1#sh run
interface Loopback0
ip address 192.168.1.1 255.255.255.0
ip ospf network point-to-point
!
interface Ethernet0/0
ip address 172.16.136.1 255.255.255.192
ip ospf authentication-key ccie
half-duplex
!
interface TokenRing0/0
ip address 172.16.15.1 255.255.255.240
ring-speed 16
!
interface Serial1/0
no ip address
encapsulation frame-relay
!
interface Serial 1/0.1 multipoint
ip address 172.16.124.1 255.255.255.248
ip ospf network point-to-multipoint
frame-relay interface-dlci 114
frame-relay interface-dlci 122
!
interface Serial1/1
ip address 172.16.31.1 255.255.255.252
!
router ospf 1
log-adjacency-changes
area 0 range 172.16.124.0 255.255.255.128
area 1 authentication
network 172.16.31.0 0.0.0.3 area 1
network 172.16.124.0 0.0.7 area 0
network 172.16.136.0 0.0.0.63 area 1
network 192.168.1.0 0.0.0.255 area 0
Lab Preparation Scenario: Network/Port (NAT and PAT)

Address Translation (NAT and PAT)

Topics Covered
- Frame Relay
- BGP IBGP
- BGP EBGP
- NAT Static
- PAT dynamic
- Standard access-list
- Extended Access-list

Difficulty Level: CCIE TM

Average Completion Time: 2 Hours

Standard Topology

Standard TCP/IP Addressing and SPID Information

R1 (3620)
Loop0 192.168.1.1 /24  Loopback
E0/0  172.16.136.1 /26  Ethernet Segment to Catalyst 3/1
T0/0  172.16.15.1 /28  Token Ring Segment to 3920
S1/1  172.16.31.1 /30  Serial to R3
S1/0  unassigned  Frame-relay

R2 (3620)
Loop0 192.168.2.2 /24  Loopback
T0/0  172.16.2.2 /24  Token Ring Segment to 3920
BRI0/0 172.16.230.2 /24  BRI to R3
S1/1  172.16.32.2 /24  Serial to R3
S1/0  unassigned  Frame-relay

R3 (2610)
Loop0 192.168.3.3 /24  Loopback
E0/0  172.16.136.3 /26  Ethernet Segment to Catalyst 3/3
BRI0/0 172.16.230.3 /24  ISDN to R2
S1/3  172.16.35.1 /30  Serial to R5
S1/2  172.16.32.3 /24  Serial to R2
S1/1  172.16.31.2 /30  Serial to R1
S1/0  unassigned  Frame-relay

R4 (2610)
Loop0 192.168.3.3 /24  Loopback
E0/0  10.1.4.4 /22  Ethernet Segment to BB1
S0/0  unassigned  Frame-relay

R5 (3620)
Loop0 192.168.5.5 /24  Loopback
E0/0  172.16.136.5 /26  Ethernet Segment to Catalyst 3/5
T0/0  172.16.15.5 /28  Token Ring Segment to 3920
S0/0  172.16.35.2 /30  Serial link to R3
A1/0  172.16.56.5 /30  ATM - R6

R6 (3640)
Loop0 192.168.6.6 /24  Loopback
FA0/0  172.16.136.6 /26  Ethernet Segment to - R2
E2/0  10.2.6.6 /23  Ethernet Segment to - BB2
A1/0  172.16.56.6 /30  ATM - R5

ISDN Information
Switch Type  Basic-NI1

R2

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Technical Tasks

A. Configure Frame Connection between R2 and R4 using DICIs 224 and 422 respectfully. Use subinterfaces on both routers using the DLCI number as the Subinterface Number. Use IP addressing of 172.16.24.0/29. Use the router number for the last octet of the IP address on each router. Do not use any other DLCIs. Configure EIGRP on R2 and R4 putting the frame-relay network and the Loopback in EIGRP.

B. Configure BGP on R2 and R4 in AS 1000. Peer the routers using the loopback interface IP address. Put R3 in BGP AS 500 and run EBGP to R2 again use the Loopback interfaces to peer the routers. Put the minimum routers necessary on R2 and R3 to complete the peering.

C. Insert routers for R2 Token 0/0, Serial 1/1, Frame Relay Interface, and R4 Ethernet0/0 into BGP and pass to R3.

D. Put R1 E1/0, R3 E 1/0, and R6 FA1/0 in OSPF Area 0. Put R3 Serial 1/1 and R1 Serial 1/1 in area 1. Put R5 Serial 0/0 R5 Token0/0 and R3 Serial 1/3 in area 5. Make R3 the Default route for the OSPF Network.

E. R3 is acting as a firewall with R2 and R4 on the outside. Allow R5 Token0/0 interface to establish TCP sessions thru R3 as IP address 172.16.32.10. Allow outside access to HTTP for R5 tokenring 0/0. Interface. Allow subnet 172.16.136.0/26 to access R2 and R4 using only the IP Address of R3's connection to R2. Do not create a NAT Pool. These routers should always be able to establish TCP sessions. R1,R3,R5,R6 should always be able to ping R2 and R4 however make sure R2 and R4 cannot initiate the ping. Make sure all routing protocols work.

Instructor’s Comments and Technical Tips

A. N/A

B. Remember to use update-source and EBGP multi-hop to create the connections.

C. If the route being inserted into BGP is not a classful mask it must be defined on the network statement.
D. This should build a connection to R2, R4, and R5 only thru R3.
E. This is creating R5 into a DMZ area and simulate access to a WEB server.
F. The Telnet command can be used for testing to telnet from specific interfaces or to telnet using specific ports (i.e. port 80).
   Make sure when you create a dynamic NAT or PAT that the addresses in static NAT's are excluded from the range.

Technical Verification

Technical Verification For Task A

r2#sho frame-relay map
Serial 1/0.224 (up): point-to-point dlc, dlc 224(0xE0,0x3800), broadcast
   Status defined, active
r2#

r2#sho ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
   i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
   * - candidate default, U - per-user static route, o - ODR
   J. P - periodic downloaded static route

Gateway of last resort is not set

   172.16.0.0/16 is variably subnetted, 3 subnets, 2 masks
C 172.16.32.0/24 is directly connected, Serial1/1
C 172.16.24.0/29 is directly connected, Serial1/0.224
C 172.16.2.0/24 is directly connected, TokenRing0/0
D 192.168.4.0/24 [90/1889792] via 172.16.24.4, 00:01:52:, Serial 1/0.224
C 192.168.2.0/24 is directly connected, Loopback0
r2#
02:24:41: %IBM 2692-1-SRBQ_OVERFLOW: Queue size on TokenRing0/0 exceeded 3
r2#

r4#sho frame-relay map
Serial0/0.422 (up): point-to-point dlc, dlc 422(0x1A6,0x6860), broadcast
   Status defined, active
r4#
r4#sho ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
    i - IS-IS, 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

    172.16.0.0/29 is subnetted, 1 subnets
    C   172.16.24.0 is directly connected, Serial0/0.422
    C   192.168.4.0/24 is directly connected, Loopback0
    10.0.0.0/22 is subnetted, 1 subnets
    C   10.1.4.0 is directly connected, Ethernet0/0
    D   192.168.2.0/24 [90/2297856] via 172.16.24.2, 00:03:02. Serial0/0.422
r4#

Technical Verification For Task B

r2#sho ip bgp sum
BGP router identifier 192.168.2.2, local AS number 1000
BGP table version is 1, main routing table version 1

Neighbor  V  AS  MsgRcvd  MsgSent  TblVer  InQ  OutQ  Up/Down  State/PfxRcd

192.168.3.3  4  500 9 9 1 0 0 00:06:25 0
192.168.4.4  4 1000 18 18 1 0 0 00:15:59 0
r2#

r2#sho ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
    i - IS-IS, 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

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Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 3 subnets, 2 masks
C 172.16.32.0/24 is directly connected, Serial 1/1
C 172.16.24.0/29 is directly connected, Serial 1/0.224
C 172.16.2.0/24 is directly connected, TokenRing0/0
D 192.168.4.0/24 [90/1889792] via 172.16.24.4, 00:16:31, Serial 1/0.224
C 192.168.2.0/24 is directly connected, Loopback0

**192.168.3.0/32 is subnetted, 1 subnets**
S 192.168.3.3 [1/0] via 172.16.32.3

r2#

r3#sho ip bgp sum

BGP router identifier 192.168.3.3, local AS number 500
BGP table version is 1, main routing table version 1

<table>
<thead>
<tr>
<th>Neighbor</th>
<th>V</th>
<th>AS</th>
<th>MsgRcvd</th>
<th>MsgSent</th>
<th>TblVer</th>
<th>InQ</th>
<th>OutQ</th>
<th>Up/Down</th>
<th>State/PfxRcd</th>
</tr>
</thead>
<tbody>
<tr>
<td>192.168.2.2</td>
<td>4</td>
<td>1000</td>
<td>7</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>00:04:48</td>
<td>0</td>
</tr>
</tbody>
</table>

r3#sho ip route

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BG
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, E - EGP
i - IS-IS, 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

172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
C 172.16.32.0/24 is directly connected, Serial1/2
C 172.16.31.0/30 is directly connected, Serial1/1

**192.168.2.0/32 is subnetted, 1 subnets**
S 192.168.2.2 [1/0] via 172.16.32.2
C 192.168.3.0/24 is directly connected, Loopback0

r3#

r4#sho ip bgp sum
BGP router identifier 192.168.4.4, local AS number 1000
BGP table version is 1, main routing table version 1
Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd

192.168.2.2 4 1000 20 20 1 0 0 00:17:22 0
r4#

Technical Verification For Task C

R2#sho ip bgp
BGP table version is 5, local router ID is 192.168.2.2
Status codes: s suppressed, d damped, h history, * valid, >best, i - internal
Origin codes: i - IGP, e - EGP, ? - incomplete

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*&gt;i10.1.4.0/22</td>
<td>192.168.4.4</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>i</td>
</tr>
<tr>
<td>*&gt; 172.16.2.0/24</td>
<td>0.0.0.0</td>
<td>0</td>
<td>32768</td>
<td>i</td>
<td></td>
</tr>
<tr>
<td>*&gt; 172.16.24.0/29</td>
<td>0.0.0.0</td>
<td>0</td>
<td>32768</td>
<td>i</td>
<td></td>
</tr>
<tr>
<td>*&gt; 172.16.32.0</td>
<td>0.0.0.0</td>
<td>0</td>
<td>32768</td>
<td>i</td>
<td></td>
</tr>
</tbody>
</table>
r2#

r3#sho ip bgp
BGP table version is 5, local router ID is 192.168.3.3
Status codes: s suppressed, d damped, h history, * valid, >best, i - internal
Origin codes: i - IGP, e - EGP, ? - incomplete

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*&gt; 10.1.4.0/22</td>
<td>192.168.2.2</td>
<td>0</td>
<td>1000</td>
<td>i</td>
<td></td>
</tr>
<tr>
<td>*&gt; 172.16.2.0/24</td>
<td>192.168.2.2</td>
<td>0</td>
<td>0</td>
<td>1000</td>
<td>i</td>
</tr>
<tr>
<td>*&gt; 172.16.24.0/29</td>
<td>192.168.2.2</td>
<td>0</td>
<td>0</td>
<td>1000</td>
<td>i</td>
</tr>
<tr>
<td>*&gt; 172.16.32.0/24</td>
<td>192.168.2.2</td>
<td>0</td>
<td>0</td>
<td>1000</td>
<td>i</td>
</tr>
</tbody>
</table>
r3#

r4#sho ip bgp
BGP table version is 5, local router ID is 192.168.4.4
Status codes: s suppressed, d damped, h history, * valid, >best, i - internal
Origin codes: i - IGP, e - EGP, ? - incomplete

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*&gt; 10.1.4.0/22</td>
<td>0.0.0.0</td>
<td>0</td>
<td>32768</td>
<td>i</td>
<td></td>
</tr>
<tr>
<td>*&gt;i172.16.2.0/24</td>
<td>192.168.2.2</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>i</td>
</tr>
</tbody>
</table>
Technical Verification For Task D

r1# shos ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
i - IS-IS, 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 172.16.136.3 to network 0.0.0.0

172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
O 172.16.35.0/30 [110/839] via 172.16.136.3, 00:03:04, Ethernet0/0
C 172.16.31.0/30 is directly connected, Serial1/1
C 172.16.15.0/28 is directly connected, TokenRing0/0
C 192.168.1.0/24 is directly connected, Loopback0
O*E2 0.0.0.0/0 [110/1] via 172.16.136.3, 00:06:32, Ethernet0/0
r1#

r3# shos ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
i - IS-IS, 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

172.16.0.0/16 is variably subnetted, 7 subnets, 5 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
C 172.16.32.0/24 is directly connected, Serial1/2
C 172.16.35.0/30 is directly connected, Serial1/3
C 172.16.31.0/30 is directly connected, Serial1/1
r3#sho ip route
Gateway of last resort is 172.16.35.1 to network 0.0.0.0

172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
C 172.16.35.0/30 is directly connected, Serial0/0
C 172.16.15.0/28 is directly connected, TokenRing0/0
C 192.168.5.0/24 is directly connected, Loopback0
O*E3 0.0.0.0/0 [110/0] via 172.16.35.1, 00:05:38, Serial0/0
r3#

r5#sho ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
i - IS-IS, 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 172.16.35.1 to network 0.0.0.0

172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
C 172.16.136.0/26 is directly connected, FastEthernet0/0
O IA 172.16.35.0/30 [110/830] via 172.16.136.3, 00:06:24, FastEthernet0/0

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O IA 172.16.31.0/30 [110/49] via 172.16.136.1, 00:09:54, FastEthernet0/0
O IA 172.16.15.0/28 [110/788] via 172.16.136.3, 00:06:24, FastEthernet

10.0.0.0/23 is subnetted, 1 subnets
C 10.2.6.0 is directly connected, Ethernet2/0
C 192.168.6.0/24 is directly connected, Loopback0
O*E2 0.0.0.0/0 [110/1] via 172.16.136.3, 00:09:54, FastEthernet0/0

r6#

Technical Verification For Task E

r1#show ip route

r3#ping 172.16.24.4

Type escape sequence to abort
Sending 5, 100-byte ICMP Echos to 172.16.24.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/38/40 ms
r3#

show ip nat trans

Pro Inside global Inside local Outside local Outside global
icmp 172.16.32.3:4576 172.16.136.3:4576 172.16.24.4:4576 172.16.24.4:4576
icmp 172.16.32.3:4577 172.16.136.3:4577 172.16.24.4:4577 172.16.24.4:4577
icmp 172.16.32.3:4578 172.16.136.3:4578 172.16.24.4:4578 172.16.24.4:4578
icmp 172.16.32.3:4579 172.16.136.3:4579 172.16.24.4:4579 172.16.24.4:4579
icmp 172.16.32.3:4580 172.16.136.3:4580 172.16.24.4:4580 172.16.24.4:4580
---172.16.32.10 172.16.15.5 --- ---

r3#

r1#ping 10.1.4.4

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.4.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/38/40 ms
r1#

r3#show ip nat trans

Pro Inside global Inside local Outside local Outside global
icmp 172.16.32.3:9330 172.16.136.1:9330 10.1.4.4:9330 10.1.4.4:9330
icmp 172.16.32.3:9331 172.16.136.1:9331 10.1.4.4:9331 10.1.4.4:9331
icmp 172.16.32.3:9332 172.16.136.1:9332 10.1.4.4:9332 10.1.4.4:9332

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icmp  172.16.32.3:9333  172.16.136.1:9333  10.1.4.4:9333  10.1.4.4:9333
icmp  172.16.32.3:9334  172.16.136.1:9334  10.1.4.4:9334  10.1.4.4:9334
--- 172.16.32.10        172.16.15.5        ---          ---

r6#ping 172.16.24.4

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.24.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/36/40 ms
#

r3#sho ip nat trans

Pro Inside global Inside local Outside local Outside global
--- 172.16.32.10 172.16.15.5 --- ---
icmp  172.16.32.3:2554 172.16.136.6:2554 172.16.24.4:2554 172.16.24.4:2554
icmp  172.16.32.3:2555 172.16.136.6:2555 172.16.24.4:2555 172.16.24.4:2555
icmp  172.16.32.3:2556 172.16.136.6:2556 172.16.24.4:2556 172.16.24.4:2556
icmp  172.16.32.3:2557 172.16.136.6:2557 172.16.24.4:2557 172.16.24.4:2557
icmp  172.16.32.3:2558 172.16.136.6:2558 172.16.24.4:2558 172.16.24.4:2558
r3#

r2#telnet 172.16.32.10 80
Trying 172.16.32.10 80
% Connection refused by remote host

r3#sho ip access-list

Standard IP access-list 1
  deny  172.16.15.5
  permit 172.16.136.0, wildcard bits 0.0.0.63
Extended IP access list 100
  permit tcp host 192.168.2.2 host 192.168.3.3 eq bgp (68 matches)
  permit icmp any any echo-reply (25 matches)
  permit tcp any any established

  permit tcp any host 172.16.32.10 eq www (2 matches)
r3#

r4#telnet 172.16.32.10 80
Trying 172.16.32.10, 80 ... 
% Connection refused by remote host

r4#

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Standard IP access list 1
   deny 172.16.15.5
   permit 172.16.136.0, wildcard bits 0.0.0.63

Extended IP access list 100
   permit tcp host 192.168.2.2 host 192.168.3.3 eq bgp (88 matches)
   permit icmp any any echo-replay (30 matches)
   permit tcp any any established
   permit tcp any host 172.16.32.10 eq www (4 matches)

r3#

Configuration Verification

Only relevant portions of the configuration have been included.

Router 1

r1#sho run
!
hostname r1
!
!
interface Loopback0
   ip address 192.168.11 255.255.255.0
!
interface Ethernet0/0
   ip address 172.16.136.1 255.255.255.192
   half-duplex
!
interface TokenRing0/0
   ip address 172.16.15.1 255.255.255.240
   ring-speed 16
!
interface Serial1/0
   no ip address
   encapsulation frame-relay
   shutdown
!
interface Serial 1/1
   ip address 172.16.31.1 255.255.255.252
!
router ospf 1
   log-adjacency-changes
   network 172.16.31.0 0.0.0.3 area 1
network 172.16.136.0 0.0.0.63 area 0
!

Router 2

r2#sho run
!
hostname r2
!
!
interface Loopback0
 ip address 192.168.2.2 255.255.255.0
!
interface BRI 0/0
 no ip address
 shutdown
!
interface Ethernet0/0
 no ip address
 shutdown
 half-duplex
!
interface TokenRing0/0
 ip address 172.16.2.2 255.255.255.0
 ring speed 16
!
interface Serial1/0
 no ip address
 encapsulation frame-relay
 no frame-relay inverse-arp
!
interface Serial 1/0.224 point-to-point
 ip address 172.16.24.2 255.255.255.248
 frame-relay interface-dlci 224
!
interface Serial1/1
 ip address 172.16.32.2 255.255.255.0
!
router eigrp 1
 network 172.16.24.0 0.0.0.7
 network 192.168.2.0
 no auto-summary
no eigrp log-neighbor-changes
!
router bgp 1000
  no synchronization
  bgp log-neighbor-changes
  network 172.16.2.0 mask 255.255.255.0
  network 172.16.24.0 mask 255.255.255.248
  network 172.16.32.0 mask 255.255.255.0
  neighbor 192.168.3.3 remote-as 500
  neighbor 192.168.3.3 ebgp-multihop 255
  neighbor 192.168.3.3 update-source Loopback0
  neighbor 192.168.4.4 remote-as 1000
  neighbor 192.168.4.4 update-source Loopback0
!
ip kerberos source-interface any
ip classless
ip route 192.168.3.3 255.255.255.255 172.16.32.3
no ip http server
!

Router 3

r3#sho run

hostname r3
!
!
interface Loopback0
  ip address 192.168.3.3 255.255.255.0
!
interface Ethernet0/0
  ip address 172.16.136.3 255.255.255.192
  ip nat inside
  half-duplex
!
interface BRI 0/0
  no ip address
  shutdown
!
interface Serial 1/0
  no ip address
encapsulation frame-relay
shutdown

interface Serial 1/1
   ip address 172.16.31.2 255.255.255.252
   ip nat inside
   clockrate 64000

interface Serial 1/2
   ip address 172.16.32.3 255.255.255.0
   ip access-group 100 in
   ip nat outside
   clockrate 64000

interface Serial1/3
   ip address 172.16.35.1 255.255.255.252
   ip nat inside
   clockrate 64000

router ospf 1
   log-adjacency-changes
   network 172.16.31.0 0.0.0.3 area 1
   network 172.16.35.0 0.0.0.3 area 5
   network 172.16.136.0 0.0.0.63 area 0
   default information-originate always

router bgp 500
   bgp log-neighbor-changes
   neighbor 192.168.2.2 remote-as 1000
   neighbor 192.168.2.2 ebgp-multihop 255
   neighbor 192.168.2.2 update-source Loopback0

ip kerberos source-interface any
ip nat inside source list 1 interface Serial 1/2 overload
ip nat inside source static 172.16.15.5 172.16.32.10
ip classless
ip route 192.168.2.2 255.255.255.255 172.16.32.2
no ip http server

access-list 1 deny 172.16.15.5
access-list 1 permit 172.16.136.0 0.0.0.63
access-list 100 permit tcp host 192.168.2.2 host 192.168.3.3 eq bgp
access-list 100 permit icmp any any echo-reply
access-list 100 permit tcp any any established
access-list 100 permit tcp any host 172.16.32.10 eq www

Router 4

r4#sho run
hostname r4
!
interface Loopback0
  ip address 192.168.4.4 255.255.255.0
!
interface Ethernet0/0
  ip address 10.1.4.4 255.255.252.0
    half-duplex
!
interface Serial 0/0
  no ip address
  encapsulation frame-relay
  no frame-relay inverse-arp
!
interface Serial0/0.422 point-to-point
  ip address 172.16.24.4 255.255.255.248
    frame-relay interface-dlci 422
!
interface Serial0/1
  no ip address
  shutdown
!

router eigrp 1
  network 172.16.24.0 0.0.0.7
  network 192.168.4.0
  no auto-summary
  no eigrp log-neighbor-changes
!
route bgp 1000
  no synchronization
  bgp log-neighbor-changes
  network 10.1.4.0 mask 255.255.252.0
  neighbor 192.168.2.2 remote-as 1000
neighbor 192.168.2.2 update-source Loopback0
!

**Router 5**

```
r5#sho run
!
hostname r5
!
interface Loopback0
   ip address 192.168.5.5 255.255.255.0
!
interface Ethernet0/0
   ip address 172.16.136.5 255.255.255.192
   half-duplex
!
interface Serial0/0
   ip address 172.16.35.2 255.255.255.252
!
interface TokenRing0/0
   ip address 172.16.15.5 255.255.255.240
   ring-speed 16
!
interface Serial0/1
   no ip address
   shutdown
!
interface ATM1/0
   no ip address
   shutdown
   no atm ilmi-keepalive
!
router ospf 1
   log-adjacency-changes
   network 172.16.15.0 0.0.0.255 area 5
   network 172.16.35.0 0.0.0.3 area 5
!
```

**Router 6**

```
r6#sho run
!
```
hostname r6
!
!
interface Loopback0
  ip address 192.168.6.6 255.255.255.0
  no ip directed-broadcast
!
interface FastEthernet0/0
  ip address 172.16.136.6 255.255.255.192
  no ip directed-broadcast
duplex auto
  speed auto
!
interface ATM 1/0
  no ip address
  no ip directed-broadcast
  shutdown
  no atm ilmi-keepalive
!
interface Ethernet2/0
  ip address 10.2.6.6 255.255.254.0
  no ip directed-broadcast

router ospf 1
  network 172.16.136.0 0.0.0.63 area 0
!
Lab Preparation Scenario- Virtual Private Network (VPN)

Topics Covered
- Frame Relay
- IPSEC
- Pre-shared keys
- NAT
- EIGRP

Difficulty Level: CCIE TM

Average Completion Time: 2 Hours

Standard Topology

Standard TCP/IP Addressing and SPID Information

**R1 (3620)**
- Loop0 192.168.1.1 /24  Loopback
- E0/0 172.16.136.1 /26  Ethernet Segment to Catalyst 3/1
### CCIE LAB

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address/Netmask</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0/0</td>
<td>172.16.15.1/28</td>
<td>Token Ring Segment to 3920</td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.31.1/30</td>
<td>Serial to R3</td>
</tr>
<tr>
<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

**R2 (3620)**

- **Loop0**: 192.168.2.2/24 - Loopback
- **T0/0**: 172.16.2.2/24 - Token Ring Segment
- **BRI0/0**: 172.16.230.2/24 - BRI to R3
- **S1/1**: 172.16.32.2/24 - Serial to R3
- **S1/0**: unassigned - Frame-relay

**R3 (2610)**

- **Loop0**: 192.168.3.3/24 - Loopback
- **EO/O**: 172.16.136.3/26 - Ethernet Segment to Catalyst 3/3
- **BRI0/0**: 172.16.230.3/24 - ISDN to R2
- **S1/3**: 172.16.35.1/30 - Serial to R5
- **S1/2**: 172.16.32.3/24 - Serial to R2
- **S1/1**: 172.16.31.2/30 - Serial to R1
- **S1/0**: unassigned - Frame-relay

**R4 (2610)**

- **Loop0**: 192.168.4.4/24 - Loopback
- **E0/0**: 10.1.4.4/22 - Ethernet Segment to BB1
- **S0/0**: unassigned - Frame relay

**R5 (3620)**

- **Loop0**: 192.168.5.5/24 - Loopback
- **EO/O**: 172.16.136.5/26 - Ethernet Segment to Catalyst 3/5
- **T0/0**: 172.16.15.5/28 - Token Ring Segment to 3920
- **S0/0**: 172.16.35.2/30 - Serial Link to R3
- **A1/0**: 172.16.56.5/30 - ATM - R6

**R6 (3640)**

- **Loop0**: 192.168.6.6/24 - Loopback
- **FA0/0**: 172.16.136.6/26 - Ethernet Segment - R2
- **E2/0**: 10.2.6.6/23 - Ethernet Segment - BB2
- **A1/0**: 172.16.56.6/30 - ATM - R5

**ISDN Information**

- **Switch Type**: Basic-NI 1

**R2**

- **SPID 1**: 42255501210101
- **SPID 2**: 42255501220101

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Technical Tasks

A. Configure the Frame Relay so R2 is the Hub using DLCI 211,233,and 224. Use DLCI's and IP addressing as; R1-R2 112(63.250.101.0/30), R2-R3 322(63.250.103.0/30), R2-R4 422(63.250.104.0/30). Configure sub-interfaces on all the routers using the DLCI number as the subinterface number, R2 should always have 2 as the last octet. Do not use any other DLCI. Do not use any other LAN or WAN connections between R2 and R3. 
B. Configure R1,R2,R3, and R4 in EIGRP process 1 only put the frame interfaces in this process. Configure R1 eth0/0, to0/0,S1/1,R3 Eth0/0,S1/1,R6 and R5 in EIGRP process 10. Redistribute all Routes from R2 and R4 into EIGRP 10. Put no loopback interfaces in the EIGRP processes. 
C. Configure R1 and R4 for an IPSEC tunnel allowing 172.16.136.0/26 to access 10.1.4.0/22. Use Hash MD5 and pre-shared key name TestKing. Use NAT on both routers for any other traffic translating the IP address to the IP address of the Frame interface. Only static route is allowed on R1 and R4. Once complete all routers should be able to ping all frame relay interfaces but only the 172.16.136.0/26 interfaces should be able to ping 10.1.4.0/22 and vice versa. 
D. Configure R3 as a redundant IPSEC tunnel to R4. One static route is allowed on R3. Do not create any additional crypto maps on R4.

Instructor's Comments and Technical Tips

N/A
N/A
Creating a VPN tunnel takes careful consideration on what is being translated or not being translated at each step in the process. Use a rout map in the NAT to deny the IPSEC interface from being translated. Once a crypto map is created simply adding an other peer to the crypto map and isakmp key is all that is required on one router and duplicating the configuration of the other router when trying to access the same subnets.

Technical Verification

Technical Verification For Task A

r1#sho frame map
Serial1/0.112(up): point-to-point dlc1,dlc1 112(0x70,0x1C00), broadcast
status defined, active

r1#

**r2#sho fram map**

Serial1/0.211 (up): point-to-point dlc1, dlc1 211(0xD3,0x3430), broadcast
status defined, active

Serial1/0.223 (up): point-to-point dlc1, dlc1 223(0xDF, 0x34F0), broadcast
status defined, active

Serial1/0.224 (up): point-to-point dlc1, dlc1 224(0xE0, 0x3800), broadcast
status defined, active

r2#

**r3#sho frame map**

Serial 1/0.322 (up): point-to-point dlc1, dlc1 322(0x142, 0x5020), broadcast
status defined, active

r3#

**r4#sho frame map**

Serial0/0,422 (up): point-to-point dlc1, dlc1 42290x1A6,0x6860), broadcast
status defined, active

r4#

**Technical Verification For Task B**

**r1#sho ip route**

Codes: C - connected, S - static, I - IGRP, 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, E - EGP
    i - IS-IS, 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

    172.16.0.0/16 is variably subnetted, 4 subnets, 4 masks
    C  172.16.136.0/26 is directly connected, Ethernet
    C  172.16.31.0/30 is directly connected, Serial1/1
    C  172.16.15.0/28 is directly connected, TokenRing0/0
    D EX  172.16.2.0/24 [170/20553728] via 172.16.136.3, 00:44:50, Ethernet0/0
    10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
    D  10.2.6.0/23 [90/307200] via 172.16.136.6, 00:19:09, Ethernet0/0
    63.0.0.0/30 is subnetted, 3 subnets
C 63.250.101.0 is directly connected, Serial 1/0.112

D EX 63.250.103.0 [170/20537600] via 172.16.136.3, 00:44:51, Ethernet0/0
D EX 63.250.103.0 [170/21049600] via 172.16.136.3, 00:44:51, Ethernet0/0
C 192.168.1.0/24 is directly connected, Loopback0

r1#

r2#sho ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
i - IS-IS, 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 not set

172.16.0.0/24 is subnetted, 1 subnets.
C 172.16.2.0 is directly connected, TokenRing0/0
63.0.0.0/30 is subnetted, 3 subnets
C 63.250.101.0 is directly connected, Serial1/0.211
C 63.250.103.0 is directly connected, Serial1/0.223
C 63.250.104.0 is directly connected, Serial1/0.224
C 192.168.2.0/24 is directly connected, Loopback0

r3#sho ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
i - IS-IS, 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

172.16.0.0/16 is variably subnetted, 4 subnets, 4 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
C 172.16.31.0/30 is directly connected, Serial 1/1
D 172.16.15.0/28[90/297728] via 172.16.136.1, 00:19:33, Ethernet0/0
[90/297728] via 172.16.136.5, 00:19:33, Ethernet0/0
D 172.16.2.0/24[90/25528128] VIA 63.250.103.2, 01:12:41. Serial1/0.322
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
r4#sho ip route

Codes: C - connected, S - static, I - IGRP, 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, E - EGP
    i - IS-IS, 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, 2 subnets
    D 172.16.2.0[90/2185984] via 63.250.104.2, 01:12:17, Serial0/0.422
    C 192.168.4.0/24 is directly connected, Loopback0

10.0.0.0/22 is subnetted, 1 subnets
    C 10.1.4.0 is directly connected, Ethernet0/0

63.0.0.0/30 is subnetted, 3 subnets
    D 63.250.101.0[90/21024000] via 63.250.103.2,01:12:43,Serial1/0.322
    C 63.250.103.0 is directly connected, Serial 1/0.322
    D 63.250.104.0 [90/21024000] via 63.250.103.2, 01:12:13, Serial1/0.322
    C 192.168.3.0/24 is directly connected, Loopback0

r4#

r5#sho ip route

Codes: C - connected, S - static, I - IGRP, 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, E - EGP
    i - IS-IS, 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

    172.16.0.0/16 is variably subnetted, 4 subnets, 4 masks
    C 172.16.136.0/26 is directly connected, Ethernet0/0
    D 172.16.31.0/30[90/1787392] via 172.16.136.1,00:19:44, Ethernet00
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C  172.16.15.0/28 is directly connected, TokenRing0/0
D EX  172.16.2.0/24[170/20553728] via 172.16.136.3, 00:19:44, Ethernet0/0
C  192.168.5.0/24 is directly connected, Loopback0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D  10.2.6.0/23[90/307200] VIA 172.16.136.6, 00:19:30, Ethernet 0/0
63.0.0.0/30 is subnetted, 3 subnets
D EX  63.250.101.0[170/1787392] via 172.16.136.1, 00:19:45, Ethernet0/0
D EX  63.250.103.0[170/20537600] via 172.16.136.3, 00:19:45, Ethernet0/0
D EX  63.250.104.0[170/21049600] via 172.16.136.3, 00:19:45, Ethernet0/0
r5#

r6#sho ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
i - IS-IS, 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

172.16.0.0/16 is variably subnetted, 4 subnets, 4 masks
C  172.16.136.0/26 is directly connected, FastEthernet0/0
D  172.16.31.0/30
    [90/1764352] via 172.16.136.1, 00:19:42, FastEthernet0/0
D  172.16.15.0/24[90/178688] via 172.16.136.5, 00:19:42, FastEthernet0/0
    [90/178688] via 172.16.136.1, 00:19:42, FastEthernet0/0
D EX  172.16.15.0/24
    [170/20530688] via 172.16.136.3, 00:19:42, FastEthernet0/0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C  10.2.6.0/23 is directly connected, Ethernet2/0
C  192.168.6.0/24 is directly connected, Loopback 0
63.0.0.0/30 is subnetted, 3 subnets
D EX  63.250.101.0[170/1764352] via 172.16.136.1, 00:19:44, FastEthernet0/0
D EX  63.250.103.0
    [170/20514560] via 172.16.136.3, 00:19:44, FastEther0/0
D EX  63.250.140.0
    [170/21026560] via 172.16/136/3, 00:19:44, FastEthernet0/0
r6#

Technical Verification For Task C
r1#sho crypto map
Crypto Map "R4" 1 ipsce-iskmp
Peer = 63.250.104.1
Extended IP access list 100
    access-list 100 permit ip 172.16.136.0 0.0.0.63 10.1.4.0 0.0.3.255
Current peer: 63.250.104.1
Security association lifetime:4608000 kilobytes/3600 seconds
PFS (Y/N): N
    Transform sets={ transet,}
Interface using crypto map R4:
    Serial 1/0.112
r1#

r1#sho ip nat st
Total active translations : 0 (0 static, 0 dynamic; 0 extended)
Outside interface:
    Serial 1/0.112
Inside interfaces:
    Ethernet0/0
Hits: 33 Misses: 36
Expired translations: 36
Dynamic mappings :
    -- inside Source
route-map nonat interfaces Serial 1/0.112 recount 0
r1#

r1#sho route map
route-map nonat, permit, sequence 10
    Match clauses:
        ip address (access-lists): 101
    Set clauses:
        Policy routing matches: 0 packets, 0 bytes
r1#

r1#sho access-list
Extended IP access list 100
    permit ip 172.16.136.0 0.0.0.63 10.1.4.0 0.0.3.255 (61 matches)
Extended IP access list 101
    deny ip 172.16.136.0 0.0.0.63 10.1.4.0 0.0.3.255 (30 matches)
    permit ip any any (1411 matches)
r1#

r4#sho cry map
Crypto Map "R1-3" 1 ipsec-isakmp

**Peer = 63.25.101.1**

Extended IP access list 100

```plaintext
access-list 100 permit ip 10.1.4.0 0.0.3.255 172.16.136.0 0.0.0.63
```

Current peer:63.250.103.1

Security association lifetime: 4608000 kilobytes/3600 seconds

PFS (Y/N): N

Interfaces using crypto map R1-3:

Serial0/0.422

```
r4#
```

```
r4#sho ip nat stat
```

Total active translations : 0 (0 static, 0 dynamic; 0 extended)

```
Outside interfaces:
Serial0/0.422
```

```
Inside Interfaces:
Ethernet0/0
Hits: 0  Misses: 10
Expired translations: 10
Dynamic mappings:
-- Inside Source
route-map nonat interface Serial0/0.422 refcount 0
```

```
r4#
```

```
r4#sho route-map
route-map nonat, permit, sequence 10
  Match clauses:
    ip address ( access-list): 101
  Set clauses:
    Policy routing matches: 0 packets, 0 bytes
```

```
r4#
```

```
r4#sho access-list
Extended IP access list 100
  permit ip 10.1.4.0 0.0.3.255 172.16.136.0 0.0.0.63 (92 matches)
Extended IP access list 101
  deny ip 10.1.4.0 0.0.3.255 172.16.136.0 0.0.0.63
  permit ip 10.1.4.0 0.0.3.255 any (10 matches)
```

```
r4#
```

**Technical Verification For Task D**

```
r4#sho crypto map
```

---

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Crypto Map "R1-3" 1 ipsec-isakmp
   Peer = 63.250.101.1
   Peer = 63.250.103.1
   Extended IP access list 100
      access-list 100 permit ip 10.1.4.0 0.0.3.255 172.16.136.0 0.0.0.63
   Current peer: 63.250.103.1
   Security association lifetime: 4608000 kilobytes/3600 seconds
   PFS (Y/N): N
   Transform sets = { transet, }
   Interfaces using crypto map R1-3
   Serial0/0.422

r4#

r3#sho crypto map
Crypto map "R4" 1 ipsec-isakmp
   Peer = 63.250.104.1
   Extended IP access list 100
      excess-list 100 permit ip 172.16.136.0 0.0.0.63 10.1.4.0 0.0.3.255
   Current peer: 63.250.204.1
   Security association lifetime: 4608000 kilobytes/3600 seconds
   PFS (Y/N): N
   Transform sets = { tranest, }
   Interfaces using crypto map R4:
   Serial1/0.322

r3#

r3#sho ip nat stat
Total active translations: 0 (0 static, 0 dynamic; 0 extended)
Outside interfaces:
   Serial1/0.322
Inside interfaces:
   Ethernet0/0
   Hits: 24   Misses: 31
   Expired translations: 31
   Dynamic mappings:
      -- Inside Source

route-map nonat interface Serial 1/0.322 recount 0
r3#

r3#sho route-map
route-map nonat, permit, sequence 10

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Matches clauses:

**ip address (access-lists): 101**

Set clauses:
Policy routing matches: 0 packets, 0 bytes, 0 bytes

r3#

r3#sho access access-list
Extended IP access list 100
  permit ip 172.16.136.0 0.0.0.63 10.1.4.0 0.0.3.255 (11 matches)
  permit ip 172.16.136.0 0.0.0.63 63.250.104.0 0.0.0.3 (5 matches)
Extended IP access list 101
  deny ip 172.16.136.0 0.0.0.63 63.250.104.0 0.0.0.3 (5 matches)
  permit ip any any (595 matches)

r3#

Configuration Verification

*only relevant portions of the configuration have been included.*

**Router 1**

r1#sh run

! hostname r1
!
!
crypto isakmp policy 1
  hash md5
  authentication pre-share
crypto isakmp key TestKing address 63.250.104.1
!
!
crypto ipsec transform-set transet esp-des esp-md5-hmac
!
crypto R41 ipsec-isakmp
  set peer 63.250.104.1
  set transform-set transet
  match address 100
!
!
interfaces Ethernet 0/0
  ip address 172.16.136.1 255.255.255.192
  ip nat inside
half-duplex

interface serial 1/0
    no ip address
    encapsulation frame-relay
    no frame-relay inverse-arp

interface Serial 1/0.112 point-to-point
    ip address 63.250.101.1 255.255.255.252
    ip nat outside
    frame-relay interface-dlci 112
    crypto map R4

router eigrp 10
    redistribute static
    redistribute eigrp 1
    network 172.16.0.0
    no auto-summary
    no eigrp-log-neighbor-changes

router eigrp 10
    network 63.0.0.0
    no auto-summary
    no eigrp-log-neighbor-changes

ip nat inside source route-map nonat interface Serial 1/0.112 overload
ip route 10.1.4.0 255.255.255.252 63.250.101.2

access-list 100 permit ip 172.16.136.0 0.0.0.63 10.1.4.0 0.0.3.255
access-list 101 deny ip 172.16.136.0 0.0.0.63 10.1.4.0 0.0.3.255
access-list 101 permit ip any any

route-map nonat permit 10
match ip address 101
match ip address 101
r1#

Router 2

r2#sho run

hostname r2
interface Serial 1/0
  no ip address
  encapsulation frame-relay
  no frame-relay inverse-arp
  frame-relay lmi-type ansi

interface Serial 1/0.211 point-to-point
  ip address 63.250.101.2 255.255.255.252
  frame-relay interface-dlci 211

interface Serial 1/0.223 point-to-point
  ip address 63.250.103.2 255.255.255.252
  frame-relay interface-dlci 223

interface Serial 1/0.224 point-to-point
  ip address 63.250.104.2 255.255.255.252
  frame-relay intreface-dlci 224

router eigrp 1
  network 63.0.0.0
  network 172.16.0.0
  no auto-summary
  no eigrp log-neighbor-changes

end

r2#

Router 3

r3#sho run

hostname

crypto isakmp policy 1
  hash md5
    authentication pre-share
crypto isakmp key TestKing address 63.250.104.1

crypto ipsec transform-set transet esp-des esp-md5-hmac
crypto map R4 1 ipsec-isakmp
  set peer 63.250.104.1
  set transform-set transet
  match address 100

interface Ethernet0/0
  ip address 172.16.136.3 255.255.255.192
  ip nat inside
  half-duplex

interface Serial 1/0
  no ip address
  encapsulation frame-relay
  no frame-relay inverse-arp

interface Serial 1/0.322 point-to-point
  ip address 63.250.103.1 255.255.255.252
  ip nat outside
  frame-relay interface-dlci 322
  crypto map R4

router eigrp 1
  network 63.0.0.0
  no auto-summary
  no eigrp log-neighbor-changes

router eigrp 10
  redistribute static
  redistribute eigrp 1
  network 172.16.0.0
  no auto-summary
  no eigrp log-neighbor-changes

ip nat inside source route-map nonat interface Serial 1/0.322 overload

ip route 10.1.4.0 255.255.252.0 63.250.103.2

access-list 100 permit ip 172.16.136.0 0.0.0.63 10.1.4.0 0.0.3.255
access-list 101 deny ip 172.16.136.0 0.0.0.63 10.1.4.0 0.0.3.255
access-list 101 permit ip any any
!
route-map nonat permit 10
match ip address 101
!!
end

r3#

Router 4

r4# sho run
!
hostname r4
!
crypto isakmp policy 1
hash md5
authentication pre-share
crypto isakmp key TestKing address 63.250.101.1
crypto isakmp key TestKing address 63.250.101.1
!
!
crypto ipsec transform-set transet esp-des esp-md5-hmac
!
crypto map R1-3 1 ipsec-isakmp
set peer 63.250.101.1
set peer 63.250.103.1
set transform-set transet
match address 100
!
!
interface Ethernet0/0
ip address 10.1.4.4 255.255.252.0
ip nat inside
half-duplex
!
interface Serial0/0
no ip address
encapsulation frame-relay
no frame-relay inverse-arp
!
interface Serial0/0.422 point-topoint
ip address 63.250.104.1 255.255.255.252
ip nat outside
  frame-relay interface-dlci 422
crypto map R1 - 3
!
router eigrp 1
  network 63.0.0.0
  no auto-summary
  no eigrp log-neighbor-changes
!
ip nat inside source route-map nonat interface Serial 0/0.422 overload

ip route 172.16.136.0 255.255.255.0 63.250.104.2

!
access-list 100 permit ip 10.1.4.0 0.0.3.255 172.16.136.0 0.0.0.63
access-list 101 deny ip 10.1.4.0 0.0.3.255 172.16.136.0 0.0.0.63
access-list 101 permit ip 10.1.4.0 0.0.3.255 any

route-map nonat permit
match ip address 101
!
!
!
end

r4#

Router 5

r5#sho run
!
hostname
!
!
interface Loopback0
  ip address 192.168.5.5 255.255.255.0
!
interface Ethernet 0/0
  ip address 172.16.136.5 255.255.255.192
  half-duplex
!
interface Serial 0/0
  ip address 172.16.35.2 255.255.255.252

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interface TokenRing 0/0
   ip address 172.16.15.5 255.255.255.240
   ring-speed16
!
!
router eigrp 10
   network 172.16.0.0
   no auto-summary
   no eigrp log-neighbor-changes
!
!
en end

r5#

Router 6

r6#sho run
!
hostname r6
!
enabled password cisco
!
!
interface Loopback 0
   ip address 192.168.6.6 255.255.255.0
   no ip directed-broadcast
!
interface FastEthernet 0/0
   ip address 172.16.136.6 255.255.255.192
   no ip directed-broadcast
duplex auto
   speed auto
!
!
interface Ethernet 2/0
   ip address 10.2.6.6 255.255.254.0
   no ip directed-broadcast
!
router eigrp 10
   network 10.0.0.0

   network 172.16.0.0

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no auto-summary
!
end

r6#
Lab Preparation Scenario - VPN Route Filtering

Topics Covered

- Frame Relay
- OSPF
- RIP
- BGP
- MPLS
- Redistribution

Difficulty Level: CCIE TM

Average Completion Time: 2 Hours

Standard Topology

Standard TCP/IP Addressing and SPID Information

**R1 (3620)**
- Loop0 192.168.1.1/24
- Loopback
- E0/0 172.16.136.1/26
- Ethernet Segment to Catalyst 3/1
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T0/0 172.16.15.1/28 Token Ring Segment to 3920
S1/1 172.16.31.1/30 Serial to R3
S1/0 unassigned Frame-relay

**R2 (3620)**
Loop0 192.168.2.2/24 Loopback
T0/0 172.16.2.2/24 Token Ring Segment to 3920
BR1/0 172.16.230.2/24 BRI to R3
S1/1 172.16.32.2/24 Serial to R3
S1/0 unassigned Frame-relay

**R3 (2610)**
Loop0 192.168.3.3/24 Loopback
E0/0 172.16.136.3/26 Ethernet Segment to Catalyst 3/3
BR1 0/0 172.16.230.3/24 ISDN to R2
S1/3 172.16.35.1/30 Serial to R5
S1/2 172.16.32.3/24 Serial to R2
S1/1 172.16.31.2/30 Serial to R1
S1/0 unassigned Frame-relay

**R4 (2610)**
Loop0 192.168.4.4/24 Loopback
E0/0 10.1.4.4/22 Ethernet Segment to BB1
S0/0 unassigned Frame-relay

**R5 (3620)**
Loop0 192.168.5.5/24 Loopback
E0/0 172.16.136.5/26 Ethernet Segment to Catalyst 3/5
T0/0 172.16.15.5/28 Token Ring Segment to 3920
S0/0 172.16.35.2/30 Serial Link to R3
A1/0 172.16.56.5/30 ATM - R6

**R6 (3640)**
Loop0 192.168.6.6/24 Loopback
FA0/0 172.16.136.6/26 Ethernet Segment - R2
E2/0 10.2.6.6/23 Ethernet Segment - BB2
A1/0 172.16.56.6/30 ATM - R5

**ISDN Information**
Switch Type: Basic - NI 1

**R2**
SPID1: 42255501210101
SPID2: 42255501220101

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R3
SPID1:  42255501310101
SPID2:  42255501320101

Technical Tasks

A. Configure Frame Relay between R2 and R4. Use no sub-interfaces and use only the DLCI's 244 and 442. Configure IP subnet 172.16.24.0/28 using the router number as the last octet.
B. Configure OSPF as follows. Area 0-R1 serial 1/1, R2 serial 1/2, R3 serial 1/1, and serial 1/2; Area 1 - R1 loopback0; Area 2- R2 loopback0; and Area 3-R3 Loopback0.
C. Configure BGP AS 9000 on R1, R2 and R3. Use the loopback interface to connect the routers.
D. Configure MPLS between R2 and R3 using VRF name vrf01. Make R6 and R4 the CE routers running RIP. Change R3 Ethernet IP address to 172.16.36.3/24 and R6 FA0/0 to 172.16.36.6/24. R4 should see routers for 10.2.6.0/23 and 172.16.36.0/24 via RIP. R6 should see router for 10.1.4.0/22 via RIP.
E. Configure MPLS between R1 and R3 using VRF name vrf02. Make r5 a CE router running RIP. R5 should see routers for 172.16.36.0/24 and 10.2.6.0/23 via RIP. R6 should see routers for 172.16.15.0/28, 172.16.136.0/26 and 192.168.5.0/24 via RIP. R4 should not see any router from R5.

Instructor's Comments and Technical Tips

Use frame relay map statements.
See OSPF labs if necessary.
Be sure to turn off synchronization.
Although is does not say it you will need to modify the Loopbacks on R3 and R4 to a 32 bit subnet mask as it is required for MPLS.
Make sure MPLS is enabled on the interface between R2 and R3. IP CEF is also required.
Make sure to import and export the required targets.

Technical Verification

Technical Verification For Task A

```
r2#sho fram map
Serial 0/0 (up): ip 172.16.24.4 dlc 244(0xF4,0x3C40), static, broadcast,
   CISCO, status defined, active
r2#
```

```
r4#sho fram map
```

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Serial0/0 (up): ip 172.16.24.2 dlci 442(0x1BA,0x6CA0), static, broadcast, CISCO, status defined, active

r4#

Technical Verification For Task B

r1#sho ip osp interf
Serial 1/1 is up, line protocol is up
Internet Address 172.16.31.1/30, Area 0
Process ID 1, Router ID 192.168.1.1, Network type POINT_TO_POINT, Cost:48
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
  Hello due in 00:00:00
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 2
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbour Count is 1, Adjacent neighbour count is 1
  Adjacent with neighbour 192.168.3.3
  Suppress hello for 0 neighbour(s)
Loopback0 is up, line protocol is up
  Internet address 192.168.1.1/32, Area 1
  Process ID 1, Router ID 192.168.1.1, Network type LOOPBACK, Cost: 1
  Loopback interface is treated as a stub Host

r1#

r2#sho ip os inter
Serial 1/1 is up, line protocol is up
Internet address 172.16.32.2/24, Area 0
  Process ID 1, Router ID 192.168.2.2, Network Type POINT_TO_POINT, Cost: 48
  Transmit Delay is 1 sec, State POINT_TO_POINT,
  Time interval configured, Hello 10, Dead 40, Wait 40, Retransmit 5
  Hello due in 00:00:01
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 2, maximum is 2
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbour Count is 1, Adjacent neighbour count is 1
  Adjacent with neighbour 192.168.3.3
  Suppress Hello For 0 neighbour(s)
Loopback0 is up , line protocol is up
  Internet address 192.168.2.2/32, Area 2
  Process ID 1, Router ID 192.168.2.2, Network Type LOOPBACK, Coast: 1
Loopback interface is treated as a stub Host

r2#

r3#sho ip o inte
Serial 1/2 is up, line protocol is up
  Internet address 172.16.32.3/24, Area 0
  Process ID 1, Router ID 192.168.3.3, Network type POINT_TO_POINT, Cost: 781
  Transmit Delay is 1 sec, State POINT_TO_POINT,
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
  Hello due in 00:00:01
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum 2
  Last flood scan time 0 msec, maximum is 0 msec
  Neighbour Count is 1, Adjacent neighbour count is 1
  Adjacent with neighbour 192.168.2.2
  Suppress hello for 0 neighbour(s)

Serial1/1 is up, line protocol is up
  Internet address 172.16.31.2/30, Area 0
  Process ID 1, Router ID 192.168.3.3, Network type POINT_TO_POINT, Cost:781
  Transmit Delay is 1 sec,State POINT_TO_POINT
  Timer intervals configured,Hello 10 , Dead 40, Wait 40, Retransmit 5
  Hello due in 00:00:06
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum 2
  Last flood scan time  is 0 msec, maximum is 0 msec
  Neighbour Count is 1, Adjacent neighbour count is 1
  Adjacent with neighbor192.168.1.1
  Suppress hello for 0 neighbour(s)

Loopback0 is up, line protocol is up
  Internet address 192.168.3.3/32, Area 3
  Process ID 1, Router ID 192.168.3.3, Network type LOOPBACK, Cost:1
  Loopback interface is treated as a stub host

r3#

**Technical Verification For Task C**

r1#sho ip bsp sum
BGP router identifier 192.168.1.1,local AS number 9000
BGP table version is 1, main routing table version 1

<table>
<thead>
<tr>
<th>Neighbour</th>
<th>V</th>
<th>AS</th>
<th>Msgrcvd</th>
<th>MsgSent</th>
<th>TbiVerInq</th>
<th>OutQ</th>
<th>Up/Down</th>
<th>State/PfxRcd</th>
</tr>
</thead>
</table>

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r2# sho ip bgp sum
BGP router identifier 192.168.2.2, Local AS number 9000
BGP table version 1

<table>
<thead>
<tr>
<th>Neighbour</th>
<th>V</th>
<th>AS</th>
<th>MsgRcvd</th>
<th>Msg Sent</th>
<th>TbIVer</th>
<th>InQ</th>
<th>OutQ</th>
<th>Up/Down</th>
<th>State/PfxRcd</th>
</tr>
</thead>
<tbody>
<tr>
<td>192.168.1.1</td>
<td>4</td>
<td>9000</td>
<td>204</td>
<td>208</td>
<td>1</td>
<td>0</td>
<td>00:18:05</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>192.168.3.3</td>
<td>4</td>
<td>9000</td>
<td>212</td>
<td>220</td>
<td>1</td>
<td>0</td>
<td>03:22:45</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

r2#

r3# sho ip bgp sum
BGP router identifier 192.168.3.3, local AS number 9000
BGP table version is 1, main routing table version 1

<table>
<thead>
<tr>
<th>Neighbour</th>
<th>V</th>
<th>AS</th>
<th>MsgRcvd</th>
<th>Msg Sent</th>
<th>TbIVer</th>
<th>InQ</th>
<th>OutQ</th>
<th>Up/Down</th>
<th>State/PfxRcd</th>
</tr>
</thead>
<tbody>
<tr>
<td>192.168.1.1</td>
<td>4</td>
<td>9000</td>
<td>317</td>
<td>227</td>
<td>1</td>
<td>0</td>
<td>00:18:10</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>192.168.2.2</td>
<td>4</td>
<td>9000</td>
<td>220</td>
<td>212</td>
<td>1</td>
<td>0</td>
<td>03:22:56</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Technical Verification For Task D

r2# sho ip vrf de
VRF vrf01; default RD 9000:1
Interfaces:
    Serial1/0    Loopback 10
Connected addresses are not in global routing table
Export VPN rout - target communities
RT:9000:1
Import VPN rout - target communities
RT:9000:1
No import route-map
No export route-map
r2#

r2# sho ip rip da vrf vrf 01
10.0.0.0/8 auto summary
10.1.4.0/22
    [1] via 172.16.24.4, 00:00:22, Serial1/0
10.2.6.0/23 redistributed
    [1] via 192.168.3.3,
172.16.0.0/16 auto-summary

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172.16.24.0/28 directly connected, Serial1/0
172.16.36.0/24 redistributed
  [1] via 192.168.3.3
r2#

r3# sho ip vrf det
VRF vrf01; default RD 9000:1
Interfaces:
  Ethernet0/0
  Connected addresses are not in global routing table
  Export VPN rout-target communities
  RT:9000:1
  Import VPN route-target communities
  RT:9000:1
  No import route-map
No export route-map

r3# sho ip rip data vrf vrf 01
  10.0.0.0/8 auto-summary
  10.1.4.0/22 redistributed
    [1] via 192.168.2.2
  10.2.6.0/23
    [1] via 172.16.36.6,00:00:05, Ethernet 0/0
  172.16.0.0/16 auto-summary
  172.16.24.0/28 redistributed
    [1] via 192.168.2.2,
  172.16.36.0/24 directly connected, Ethernet 0/0
r3#

r4# sho ip route
Codes:  C - connected, Static, I - IGRP, 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, E - EGP
       i - IS- IS, 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
  172.16.0.0/16 is variably subnetted, 2 subnets , 2 masks
  R 172.16.36.0/24 [120/1] via 172.16.24.2, 00:00:00, Serial 0/0
  C 172.16.24.0/28 is directly connected, Serial0/0
  C 192.168.4.0/24 is directly connected, Loopback 0
  10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
r6# sho ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, 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
172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
 R  172.16.136.0/26 [120/1] via 172.16.36.3, 00:00:05, FastEthernet0/0
 C  172.16.36.0/24 is directly connected, FastEthernet0/0
 R  172.16.24.0/28 [120/1] via 172.16.36.3, 00:00:05, FastEthernet0/0
 R  172.16.15.0/28 [120/1] via 172.16.36.3, 00:00:05, FastEthernet0/0
 R  192.168.5.0/24 [120/1] via 172.16.36.3, 00:00:05, FastEthernet0/0
 10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
 C  10.2.6.0/23 is directly connected, Ethernet2/0
 R  10.1.4.0/22 [120/1] via 172.16.36.3, 00:00:06, FastEthernet0/0
 C  192.168.6.0/24 is directly connected, Loopback0
r6#

Technical Verification For Task E

r1# sho ip vrf det
VRF vrf01; default RD<not set>
   No interfaces
   Connected addresses are not in global routing table
   Export VPN route-target communities
      RT:9000:1
      No Import VPN route-target communities
      No Import route-map
      No export route-map
VRF vrf02; default RD 9000:2
   Interfaces:
      TokenRing0/0
      Connected addresses are not in global routing table
      Export VPN route-target communities
      RT:9000:2
      Import VPN route-target communities

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RT:9000:2    RT:9000:1
No import route-map
No export route-map
r1#

r1#sh ip rip da vrf vrf 02
 10.0.0.0/  auto-summary
 10.2.6.0/23 redistributed
[1] via 192.168.3.3,
172.16.0.0/16   auto-summary
172.16.15.0/28  directly connected, TokenRing0/0
172.16.36.0/24 redistributed
[1] via 192.168.3.3,
172.16.136.0/26
[1] via 172.16.15.5, 00:00:05, TokenRing0/0
192.168.5.0/24   auto-summary
192.168.5.0/24
[1] via 172.16.15.5, 00:00:05, TokenRing0/0
r1#

r3#sho ip vrf det
VRF vrf01; default RD 9000:1
  Interfaces:
   Ethernet0/0
   Connected addresses are not in global routing table
  Export VPN route-target communities
   RT:9000:1
  Import VPN route-target communities
   RT:9000:1   RT:9000:2
   No import route-map
   No export route-map
VRF vrf02; default RD 9000:2
  No interfaces
  Connected addresses are not in global routing table
  Export VPN route-target communities
   RT:9000:1   RT:9000:2
  Import VPN route-target communities
   RT:9000:2   RT:9000:1
  No import route-map
  No export route-map
r3#

r3#sho ip rip data vrf vrf 02
10.0.0.0/8   auto-summary
r4#sho ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
    i - IS-IS, 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

    172.16.0.0/16 is variable subnetted, 2 subnets, 2 masks
R    172.16.36.0/24 [120/1] via 172.16.24.2, 00:00:00, Serial0/0
C    172.16.24.0/28 is directly connected, Serial0/0
C    192.168.4.0/24 is directly connected, Loopback0
C    10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
R    10.2.6.0/23 [120/1] via 172.16.24.2, 00:00:00, Serial0/0
C    10.1.4.0/22 is directly connected, Ethernet0/0

r5#sho ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
    i - IS-IS, 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

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172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
C  172.16.136.0/26 is directly connected, Ethernet0/0
R  172.16.36.0/24 [120/1] via 172.16.15.1, 00:00:16, TokenRing0/0
C  172.16.15.0/28 is directly connected, TokenRing0/0
C  192.168.5.0/24 is directly connected, Loopback0
R  10.0.0.0/23 is subnetted, 1 subnets
10.0.2.60[120/1] via 172.16.15.1, 00:00:16, TokenRing0/0
r5#

**r6#sho ip route**

Codes: C - connected, S - static, I - IGRP, 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, E - EGP
i - IS-IS, 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 download static route

Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
R  172.16.136.0/26[120/1] VIA 172.16.36.3, 00:00:05, FastEthernet0/0
C  172.16.36.0/24 is directly connected, FastEthernet0/0
R  172.16.24.0/28 [120/1] via 172.16.36.3, 00:00:05, FastEthernet0/0
R  172.16.15.0/28 [120/1] via 172.16.36.3, 00:00:05, FastEthernet0/0
R  192.168.5.0/24 [120/1] via 172.16.36.3, 00:00:05, FastEthernet0/0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C  10.2.60/23 is directly connected, Ethernet2/0
R  10.1.40.0/22[120/1] via 172.16.36.3, 00:00:06, FastEthernet0/0
C  192.168.6.0/24 is directly connected, Loopback0
r6#

**Configuration Verification**

*Only relevant portions of the configuration have been included.*

**Router 1**

r1#sh run
!
hostname
!

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ip vrf vrf02
  rd 9000:2
  route-target export 9000:2
  route-target import 9000:1
ip cef
!
interface loopback 0
  ip address 192.168.1.1 255.255.255.255
!
interface Ethernet0/0
  ip address 172.16.136.1 255.255.255.192
  half - duplex
!
interface TokenRing0/0
  ip vrf forwarding vrf02
  ip address 172.16.15.1 255.255.255.240
  ring-speed 16
!
interface Serial 1/1
  ip address 172.16.31.1 255.255.255.252
  tag-switching ip
!
router ospf 1
  log-adjacency-changes
  network 172.16.31.0 0.0.0.3 area 0
  network 192.168.1.1 0.0.0.0 area 1
  network 192.168.1.0 0.0.0.255 area 1
!
router rip
  version 2
  no auto-summary
!
  address family ipv4 vrf vrf02
  version 2
  redistribute bgp 9000 metric 1
  network 172.16.0.0
  no auto-summary
  exit-address-family
!
router bgp 9000
  bgp log-neighbor-changes
  neighbor 192.168.2.2 remote- as 9000
  neighbor 192.168.2.2 update- source Loopback 0
neighbor 192.168.3.3 remote-as 9000
neighbor 192.168.3.3 update-source Loopback 0
no auto-summary
!
address-family vpnv4
neighbor 192.168.3.3 activate
neighbor 192.168.3.3 second-community extended
no auto-summary
exit-address-family
!
end

r1#

Router 2

R2#sh run
!
!
hostname r2
!
ip vrf vrf01
   rd 9000:1
   route-target export 9000:1
   route-target export 9000:1
ip cef
!
!
!
interface Loopback0
   ip address 192.168.2.2 255.255.255.255.0
   ring-speed 16
!
interface Serial 1/0
   ip vrf forwarding vrf01
   ip address 172.16.24.2 255.255.255.240
   encapsulation frame-relay
   frame-relay map ip 172.16.24.4 244 broadcast
   no frame-relay inverse-arp
   frame-relay lmi-type ansi
!
interface Serial1/1
   ip address 172.16.32.2 255.255.255.0
   tag-switching ip

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! router ospf 1
   log-adjacency-changes
   network 172.16.32.0 0.0.0.255 area0
   network 192.168.2.2 0.0.0.0 area 2
!
router rip
   version 2
   no auto-summary
!
   address-family ipv4 vrf vrf01
   version 2
   redistribute bgp 9000 metric 1
   network 172.16.0.0
   no auto-summary
   exit-address-family
!
router bgp 9000
   bgp log-neighbor-changes
   neighbor 192.168.1.1 remote-as 9000
   neighbor 192.168.1.1 update-source Loopback0
   neighbor 192.168.3.3 remote-as 9000
   neighbor 192.168.3.3 update-source Loopback0
   no auto-summary
!
   address-family ipv4 vrf vrf01
   redistribute rip
   no-auto-summary
   no synchronization
   exit-address-family
!
   address-family vpnv4
   neighbor 192.168.1.1 activate
   neighbor 192.168.1.1 send-community extended
   neighbor 192.168.3.3 activate
   neighbor 192.168.3.3 send-community extended
   no auto-summary
   exit-address-family
!
end

r2#
Router 3

R3#sh run
!
!
hostname r3
!
!
ip vrf vrf01
   rd 9000:1
   router target export 9000:1
   router-target import 9000:1
   router-target import 9000:2
!
ip vrf vrf02
   rd 9000:2
   route-target export 9000:1
   route-target import 9000:2
ip cef
!
interface Loopback0
   ip address 192.168.3.3 255.255.255.255
!
interface Ethernet0/0
   ip vrf forwarding vrf01
   ip address 172.16.36.3 255.255.255.0
   half-duplex
!
interface Serial 1/1
   ip address 172.16.31.2 255.255.255.252
   tag-switching ip
   clockrate 64000
!
interface Serial1/2
   ip address 172.16.32.3 255.255.255.0
   tag-switching ip
   clockrate 64000
!
interface Serial 1/3
   ip address 172.16.35.1 255.255.255.252
   shutdown
clockrate 64000

router ospf 1
  log-adjacency-changes
  network 172.16.31.0 0.0.0.3 area 0
  network 172.16.32.0 0.0.0.255 area 0
  network 192.168.3.3 0.0.0.0 area 3

router rip
  version 2
  no-autosummary

  address-family ipv4 vrf vrf02
  version 2
  redistribute bgp 9000 metric
  network 172.16.0.0
  no-autosummary
  exit-address-family

  address-family ipv4 vrf vrf01
  version 2
  redistribute bgp 9000 metric 0
  network 172.16.0.0
  no auto-summary
  exit-address-family

router bgp 9000
  no synchronization
  bgp log-neighbor-changes
  neighbor 192.168.1.1 remote-as 9000
  neighbor 192.168.1.1 update-source Loopback0
  neighbor 192.168.2.2 remote-as 9000
  neighbor 192.168.2.2 update-source Loopback0
  no auto-summary

  address family ipv4 vrf vrf02
  no auto-summary
  no synchronization
  exit-address-family

  address-family vpnv4
  neighbor 192.168.1.1 activate
  neighbor 192.168.1.1 send-community extended
  neighbor 192.168.2.2 activate
neighbor 192.168.2.2 send-community extended
no auto-summary
exit address-family
!
end

r3#

Router 4

R4#sh run
!

hostname r4
!
ip cef
!
!
interface Loopback 0
  ip address 192.168.4.4 255.255.255.0
!
interface Ethernet0/0
  ip address 10.1.4.4 255.255.252.0
  half duplex
!
interface Serial0/0
  ip address 172.16.24.4 255.255.255.240
  encapsulation frame-relay
  frame-relay map ip 172.16.24.2 442 broadcast
  no frame-relay inverse-arp
!
!
router rip
  version 2
  network 10.0.0.0
  network 172.16.0.0
  no auto-summary
!
!
end
r4#

Router 5

R5#sh run
!
hostname r5
!
interface Loopback0
    ip address 192.168.5.5 255.255.255.0
!
interface Ethernet0/0
    ip address 172.16.136.5 255.255.255.192
    half-duplex
!
interface Serial0/0
    ip address 172.16.136.5 255.255.255.252
    shutdown
!
interface TokenRing0/0
    ip address 172.16.15.5 255.255.255.240
    ring-speed 16
!
routing rip
    version 2
    network 172.16.0.0
    network 192.168.5.0
    no auto-summary
!
!
end

r5#

Router 6

R6#sh run
!
!
hostname r6
!

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```
interface Loopback0
  ip address 192.168.6.6 255.255.255.0
  no ip directed-broadcast
!
interface FastEthernet0/0
  ip address 172.16.36.6 255.255.255.0
  no ip directed-broadcast
duplex auto
  speed auto
!

interface Ethernet2/0
  ip address 10.2.6.6 255.254.0
  no ip directed-broadcast
!
  router rip
    version 2
    network 10.0.0.0
    network 172.16.0.0
    no auto-summary
!
end

r6#
```
Lab Preparation Scenario - System Logging

**Topics Covered**

- Logging
- Facility
- Console logging
- Terminal line logging
- Logging Options
- Logging host
- Catalyst logging

**Difficulty Level:** CCIE™

**Average Completion Time:** 1 Hour

**Standard Topology**

**Standard TCP/IP Addressing and SPID Information**

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.1.1/24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E0/0</td>
<td>172.16.136.1/2</td>
<td>Ethernet Segment to Catalyst 3/1</td>
</tr>
<tr>
<td>T0/0</td>
<td>172.16.15.1/28</td>
<td>Token Ring Segment to 3920</td>
</tr>
</tbody>
</table>

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S1/1  172.16.31.1/30  Serial to R3
S1/1  Unassigned  Frame-relay

**R2 (3620)**

Loop0  192.168.2.2/24  Loopback
T0/0  172.16.2.2/24  Token Ring Segment to 3920
BR10/0  172.16.230.2/24  BRI to R3
S1/1  172.16.32.2/24  Serial to R3
S1/0  unassigned  Frame-relay

**R3 (2610)**

Loop0  192.168.3.3 /24  Loopback
E0/0  172.16.136.3 /26  Ethernet Segment to BB1
BR10/0  172.16.230.2 /24  ISDN to R2
S1/3  172.16.35.1 /30  Serial to R5
S1/2  172.16.32.3 /24  Serial to R2
S1/1  172.16.31.2 /30  Serial to R1
S1/0  unassigned  Frame-relay

**R4 (2610)**

Loop0  192.168.4.4 /24  Loopback
E0/0  10.1.4.4 /22  Ethernet Segment to BB1
S0/0  unassigned  Frame-relay

**R5 (3620)**

Loop0  192.168.5.5 /24  Loopback
E0/0  172.16.136.5 /26  Ethernet Segment to Catalyst 3/5
T0/0  172.16.15.5 /28  Token Ring Segment to 3920
S0/0  172.16.35.2 /30  Serial link to R3
A1/0  172.16.56.5/30  ATM - R6

**R6 (3640)**

Loop0  192.168.6.6 /24  Loopback
FA0/0  172.16.136.6 /26  Ethernet Segment - R2
E2/0  10.2.6.6 /23  Ethernet Segment - BB2
A1/0  172.16.56.6/36  ATM - R5

**ISDN Information**

Switch Type  Basic-NI 1

**R2**

SPID1:  42255501210101
SPID2:  42255501220101

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Technical Tasks

NOTE: Only router 6 and the Catalyst will be used in this Lab.

A. Turn Logging on R6. Configure R6 to send logging messages to a server with IP address 10.2.7.254. The server is a UNIX server running facility local5. Configure the Router to report using the loop-back interface.
   Configure the router to only report error conditions worse to the syslog server.
B. Configure the router to disable logging messages tp the console.
   Configure the router to buffer the 4K of logged messages.
C. Configure the router to timestamp log messages with the date and time showing local time and time zone.
D. Configure the catalyst switch to log messages to the same server.
   Set the catalyst to send errors to the server.
   Set the catalyst to timestamp the log messages.
   Disable logging to the consol.

Instructor's Comments and Technical Tips

A. There are a verity of logging commands.
B. There is no console typically attached to a router it is a good practice to run off logging to it.
C. Time stamping log massages will help in debugging problems.
D. The catalyst can also be configured to log to Unix server.

Technical Verification

Technical Verification For Task A

```
r6#sho logging
Sys logging: enabled (0 messages dropped, 0 flushes, 0 overruns)
Consol logging: level debugging, 14 messages logged
Monitor logging: level debugging , 0 messages logged
Buffer logging: disabled
Trap logging : level errors , 18 message lines logged
Logging to 10.2.7.254 , 0 message lines logged
r6#
```

Technical Verification For Task B

```
r6#sho logging
Syslog logging : enabled (0 messages dropped , 0 flushes , 0 overruns)
```

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Consol logging : disabled
Monitor logging : level errors, 0 messages logged
Buffer logging : level errors, 0 message lines logged
Trap logging : level errors, 18 message lines logged
Logging to 10.2.7.254, 0 message lines logged

Log Buffer (4096 bytes):

Technical Verification For Task C
N/A

Technical Verification For Task D

Cat> (enable) sho logging
Logging buffer size : 500
timestamp option : enabled
Logging history size: 1
Logging console : disabled
Logging telnet: enabled
Logging server : enabled
{10.2.70254}
server facility : LOCALS
server severity : errors(3)

<table>
<thead>
<tr>
<th>Facility</th>
<th>Default Severity</th>
<th>Current Session Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>cdp</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>cops</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>drip</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>dtp</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>dvlan</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>earl</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>fddi</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>filesys</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>gvrp</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>ip</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>kernel</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>mcast</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>mgmt</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>mls</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>pagp</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>
protfil 2
pruning 2
qos 3
radius 2
security 2
snmp 2
spantree 2
sys 5
tac 2
tcp 2
telnet 2
tftp 2
udld 4
vmps 2
vtp 2

0(emergencies) 1(alerts) 2(critical)
3(errors) 4(warnings) 5(notification)
6(information) 7(debugging)
cat> (enable)

Configuration Verification
Only relevant portion of the configuration have been included.

Router 6

r6#sho run
service timestamps debug up time
service timestamps log datetime localtime show - timezone
no service password - encryption
!
hostname r6
!
logging buffered 4096 errors
no logging console
logging monitor errors
enable password cisco
!
!
!
!
!
!
logging trap errors
no logging console
logging source - interface Loopback0
logging 10.2.7.254

end

r6#

Catalyst

Cat> (enable) sho config
This command shows non-default configurations only.
Use 'show config all' to show both default and non-default configurations.

...........
begin
!# *****NON-DEFAULT CONFIGURATION*****
! !
! #syslog
set logging console disable
set logging server enable
set logging server 10.2.7.254
set logging server facility LOCALS
set logging server severity 3

end
cat> (enable)
Lab Preparation Scenario - Hot Standby Routing Protocol (HSRP)

Topics Covered

- HSRP
- HSRP preemptive
- HSRP tracking
- HSRP priority

Difficulty Level: CCIE TM

Average Completion Time: 1 Hour

Standard Topology

Standard TCP/IP Addressing and SPID Information

**R1 (3620)**

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.1.1 /24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E0/0</td>
<td>172.16.136.1 /26</td>
<td>Ethernet Segment to Catalyst 3/1</td>
</tr>
<tr>
<td>T0/0</td>
<td>172.16.15.1 /28</td>
<td>Token Ring Segment to 3920</td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.31.1 /30</td>
<td>Serial to R3</td>
</tr>
</tbody>
</table>

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### R2 (3620)
<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.2.2/24</td>
<td>Loopback</td>
</tr>
<tr>
<td>T0/0</td>
<td>172.16.2.2/24</td>
<td>Token Ring Segment to 3920</td>
</tr>
<tr>
<td>BRI0/0</td>
<td>172.16.230.2/24</td>
<td>BRI to R3</td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.32.2/24</td>
<td>Serial to R3</td>
</tr>
<tr>
<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

### R3 (2610)
<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.3.3/24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E0/0</td>
<td>172.16.136.3/26</td>
<td>Ethernet Segment to Catalyst 3/3</td>
</tr>
<tr>
<td>BRI0/0</td>
<td>172.16.230.3/24</td>
<td>ISDN to R2</td>
</tr>
<tr>
<td>S1/3</td>
<td>172.16.35.1/30</td>
<td>Serial to R5</td>
</tr>
<tr>
<td>S1/2</td>
<td>172.16.32.3/24</td>
<td>Serial to R2</td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.31.2/30</td>
<td>Serial to R1</td>
</tr>
<tr>
<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

### R4 (2610)
<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.4.4/24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E0/0</td>
<td>10.1.4.4/22</td>
<td>Ethernet Segment to BB1</td>
</tr>
<tr>
<td>S0/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

### R5 (3620)
<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.5.5/24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E0/0</td>
<td>172.16.136.5/26</td>
<td>Ethernet Segment to Catalyst 3/5</td>
</tr>
<tr>
<td>T0/0</td>
<td>172.16.15.5/28</td>
<td>Token Ring Segment to 3920</td>
</tr>
<tr>
<td>S0/0</td>
<td>172.16.35.2/30</td>
<td>Serial link to R3</td>
</tr>
<tr>
<td>A1/0</td>
<td>172.16.56.5/30</td>
<td>STM - R6</td>
</tr>
</tbody>
</table>

### R6 (3640)
<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.6.6/24</td>
<td>Loopback</td>
</tr>
<tr>
<td>FA0/0</td>
<td>172.16.136.6/26</td>
<td>Ethernet segment to - R2</td>
</tr>
<tr>
<td>E2/0</td>
<td>10.2.6.6/23</td>
<td>Ethernet segment to - BB2</td>
</tr>
<tr>
<td>A1/0</td>
<td>172.16.56.6/30</td>
<td>ATM - R5</td>
</tr>
</tbody>
</table>

### ISDN Information
<table>
<thead>
<tr>
<th>Switch Type</th>
<th>Description</th>
</tr>
</thead>
</table>

### R2
- **SPID1:** 42255501210101
- **SPID2:** 42255501220101

### R3

---

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Technical Tasks

A. Configure a Frame Connection between R1 and R2 using DLCI's 122 and 221. Do not use any other PVC.
   Do not use sub-interfaces. Use IP address 172.16.12.0/30 with the router number being the fourth octet.
B. Configure EIGRP on R1, R2, R3, R5, and R6 (R4 will not be used in this exercise). Advertise all the
   172.16.0.0/16 addresses except token ring 0/0 on r2.
   Do not summarize any addresses.
C. Configure IP address 172.16.136.15/29 on CAT5K.
   Set primary default rout to IP address
D. 172.16.136.10.
E. Configure R1 and R3 to respond to request for IP addresses 172.16.136.10.
   Configure R3 to have a priority of 110. Leave r1 on the default priority.
F. Configure the network so if serial 1/2 goes down on R3 that R1 takes over.
   Once the interface is backup R3 should be taken back over as primary.

Instructor's Comments and Technical Tips

A. N/A
B. By default EIGRP will summarize routs to the classful mask.
   This can be turned off under EIGRP routing process.
C. Multiple default routs can be set on the catalyst switch.
   A primary can be defined to distinguish between them.
D. The higher the priority of an HSRP router the more important.
   To force the Router to switch over the preemptive command.
E. The decrement value defaults to 10.
   It can be increased to get proper fail over.

Technical Verification

Technical Verification For Task A

r1#sho frame map
Serial 1/0 (up): ip 172.16.12.2 dlci 122(0x7A, 0x1CA0), static, broadcast,
   CISCO, status defined, active
r1#

r2#sho frame map
Serial 1/0 (up): ip 172.16.12.1 dlci 221(0xDD, 0x34D0), static,
broadcast,
CISCO, status defined, active

r2#

Technical Verification For Task B

r1#sho ip route
r1#sho ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - 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 download static route

Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 5 subnets, 4 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
D 172.16.32.0/24 [90/2273792] via 172.16.12.2, 00:00:48, Serial 1/0
C 172.16.31.0/30 is directly connected,Serial 1/1
C 172.16.12.0/30 is directly connected,Token ring
C 192.168.1.0/24 is directly connected, Loopback0

r1#

r2#sho ip route

Codes:C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF external type 1,N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - 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 download static route

Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 6 subnets, 4 masks
D 172.16.136.0/26 [90/1787392] via 172.16.32.3, 00:00:26,Serial 1/1
D [90/1787392] via 172.16.12.1, 00:00:26, Serial 1/0
C 172.16.32.0/24 is directly connected, Serial 1/1
D 172.16.31.0/30 [90/2273792] via 172.16.12.1, 00:00:26,Serial 1/0
C 172.16.12.0/30 is directly connected, Serial 1/0
r3#sho ip rout
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
    i - IS-IS, 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

Get away of last resort is not set

172.16.0.0 /16 is variably subnetted, 5 subnets, 4 masks
C  172.16.136.0 /26 is directly connected, Ethernet 0/0
C  172.16.32.0 /24 is directly connected, Serial 1/2
C  172.16.31.0 /30 is directly connected, Serial 1/1
D  172.16.12.0 /30 [90/178792] via 172.16.136.1, 00:02:13, Ethernet0/0
D  172.16.15.0 /28 [90/297728] via 172.16.136.1, 00:01:59, Ethernet0/0
C  172.16.15.0/24 is directly connected, Loopback0
r3#

r5#sho ip rout
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
    i - IS-IS, L1 - IS - IS level -1, L2 - IS-IS level -2, ia - IS-IS inter area
* - candidate default, U - per user static rout, o - ODR,
    P - periodic downloaded static route

Get away of last resort is not set

172.16.0.0/16 is variably subnetted, 5 subnets, 4 masks
C  172.16.136.0/26 is directly connected, Ethernet0/0
D  172.16.32.0/24 [90/2299392] VIA 172.16.136.1, 00:02:37, Ethernet0/0
D  172.16.31.0/30 [90/178792] VIA 172.16.136.1, 00:01:59, Ethernet0/0
D  172.16.12.0/30 [90/178792] via 172.16.136.1,00:03:50,Ethern
r6#sho ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
     D - EIGRP, EX - EIGRP external, O - OSPF, IA - 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, E - EGP
     i - IS-IS, 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

    172.16.0.0/16 is variably subnetted, 5 subnets, 4 masks
C  172.16.136.0/26 is directly connected, Fast Ethernet0/0
D  172.16.32.0/24
    [90/2276352] via 172.16.136.1, 00:03:12,FastEthernet0/0
D172.16.31.0/30
    [90/1764352] via 172.16.136.1, 00:15:49,FastEthernet0/0
D172.16.12.0/30
    [90/1764352] via 172.16.136.1, 00:04:25,FastEthernet0/0
D  172.16.15.0/28 [90/178688] via 172.16.136.1,00:31:09,FastEthernet0/0
    90[178688] via 172.16.136.5, 00:31:09,FastEthernet0/0
10.0.0.0/23 is subnetted, 1 subnetted, 1 subnets
C  10.2.6.0 is directly connected, Ethernet2/0
C  192.168.6.0/24 is directly connected, Loopback0
r6#

Technical Verification For Task C

**Console> (enable) sho ip route**

<table>
<thead>
<tr>
<th>Fragmentation</th>
<th>Redirect</th>
<th>Unreachable</th>
</tr>
</thead>
<tbody>
<tr>
<td>enabled</td>
<td>enabled</td>
<td>enabled</td>
</tr>
</tbody>
</table>

The primary gateway: 172.16.136.10

<table>
<thead>
<tr>
<th>Destination</th>
<th>Gateway</th>
<th>RouteMask</th>
<th>Flages</th>
<th>Use</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>default</td>
<td>172.16.136.10</td>
<td>0x0</td>
<td>UG</td>
<td>0</td>
<td>sc0</td>
</tr>
<tr>
<td>172.16.136.0</td>
<td>172.16.136.15</td>
<td>0xffffffff</td>
<td>U</td>
<td>39</td>
<td>sc0</td>
</tr>
<tr>
<td>default</td>
<td>default</td>
<td>0xffffffff</td>
<td>UH</td>
<td>0</td>
<td>sI0</td>
</tr>
</tbody>
</table>

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Technical Verification For Task D

```
r1#sho standby
Ethernet0/0 - Group 0
  Local state is Standby, priority 100, may preempt
  Hello time 3 holdtime 10
  Next hello sent in 00:00:00.614
  Hot standby IP address is 172.16.136.10 configured
  Active router is 172.16.136.3 expires in 00:00:09, priority 110
  Active router is local
  4 state changes, last state change 00:13:41
r1#
```

```
r3#sho standby
Ethernet0/0 - Group 0
  Local state is Active, priority 110, may preempt
  Hello time 3 holdtime 10
  Next hello sent in 00:00:01.706
  Hot standby IP address is 172.16.136.10 configured
  Active router is local
  Standby router is 172.16.136.1 expires in 00:00:09
  Standby virtual mac address is 0000.0c07.ac00
  2 state changes, last state change 00:14:34
r3#
```

Technical Verification For Task E

```
r1#sho standby
Ethernet0/0 - Group 0
  Local state is active, priority 100, may preempt
  Hello time 3,holdtime 10
  Next hello sent in 00:00:02.092
  Hot standby IP address is 172.16.136.10 configured
  Active router is local
  Standby router is 172.16.136.3 expires in 00:00:08
  Standby virtual mac address is 0000.0c07.ac00
  5 state changes, last state change 00:00:34
r1#
```

```
r3#sho standby
Ethernet0/0 - Group
  Local state is Speak, priority 95, may preempt
```

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Hellotime 3 holdtime 10
Next hello sent in 00:00:01.912
Hot standby IP address is 172.16.136.10 configured
Active router is 172.16.136.1 expires in 00:00:09, priority 100
**Standby router is unknown** expires in 00:00:03
3 state changes, last state change 00:00:06
Tracking interface states for 1 interface, 0 up
**Down Serial 1/2 Priority decrement: 15**

r3#

**r1#sho standby**
Ethernet0/0 - Group 0
Local state is Standby, priority 100, may preempt
Hellotime 3 holdtime 10
Next hello sent in 00:00:00.092
Hot standby IP address is 172.16.136.10 configured
**Active router is 172.16.136.3** expires in 00:00:07
Standby router is local
7 state changes, last state change 00:00:13

r1#

**r3#sho standby**
Ethernet0/0 - Group 0
Local state is active, priority 110, may preempt
Hellotime 3 hold time 10
Next hello sent in 00:00:01.616
Hot standby IP address is 172.16.136.10 configured
**Active router is local**
Standby router is unknown expired
Standby virtual mac address is 0000.0c07.ac00
5 state changes, last state change 00:00:09
Tracking interface states for 1 interface, 1 up:
**Up Serial1/2 Priority decrement: 15**

r3#

Technical Verification For Task E
---------------------------------------------

Configuration Verification

*Only relevant portions of the configuration have been included*

Router 1

r1#sh run

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Interface Loopback 0
   ip address 192.168.1.1 255.255.255.0
   ip ospf network point-to-point
!
interface Ethernet0/0
   ip address 172.16.136.1 255.255.255.192
   ip ospf authentication
   ip ospf authentication-key ccie
   half-duplex
!
interface TokenRing0/0
   ip address 172.16.15.1 255.255.255.240
   ring speed 16
!
interface Serial 1/0
   no ip address
   encapsulation frame-relay
!
interface Serial 1/0.1 multipoint
   ip address 172.16.124.1 255.255.255.248
   ip ospf network point-to-point
   frame-relay interface-dlci 114
   frame-relay interface-dlci 122
!
interface Serial1/1
   ip address 172.16.31.1 255.255.255.252
!
router ospf 1
   log-adjacency-changes
   area 0 range 172.16.124.0 255.255.255.128
   area 1 authentication
   network 172.16.31.0 0.0.0.3 area 1
   network 172.16.124.0 0.0.0.7 area 0
   network 172.16.136.0 0.0.0.63 area 1
   network 192.168.1.0 0.0.0.255 area 0
Lab Preparation Scenario - Network Time Protocol (SNMP)

Topics Covered
- SNMP variables
- SNMP traps enabling
- SNMP interface commands
- Read only and read write communities
- IP permit
- SNMP host limiting

Difficulty Level: CCIE
Average completion Time: 1 Hour

Standard Topology

Standard TCP/IP Addressing and SPID Information

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R1 (3620)
Loop0 192.168.1.1/24  Loopback
E/0/0 172.16.136.1/26  Ethernet Segment to Catalyst 3/1
T/0/0 172.16.15.1/28  Token ring Segment to 3920
S1/1 172.16.31.1/30  Serial to R3
S1/0  unassigned  Frame-relay

R2 (3620)
Loop0 192.168.2.2/24  Loopback
T/0/0 172.16.2.2/24  Token Ring segment to 3920
BRI0/0 172.16.230.2/24  BRI to R3
S1/1 172.16.32.2/24  Serial to R3
S1/0  unassigned  Frame-relay

R3 (2610)
Loop0 192.168.2.2/24  Loopback
E0/0 172.16.136.3/26  Ethernet Segment to Catalyst 3/3
BRI0/0 172.16.230.3/24  ISDN to R2
S1/3 172.16.35.1/30  Serial to R5
S1/2 172.16.32.3/24  Serial to R2
S1/1 172.16.31.2/30  Serial to R1
S1/0  unassigned  Frame-relay

R4 (2610)
Loop0 192.168.4.4/24  Loopback
E0/0 10.1.4.4/22  Ethernet Segment to Catalyst 3/5
S0/0  Unassigned  Frame-relay

R5 (3620)
Loop0 192.168.5.5/24  Loopback
E0/0 172.16.136.5/26  Ethernet Segment to Catalyst 3/5
T/0/0 172.16.15.5/28  Token Ring segment to 3920
S0/0 172.16.35.2/30  Serial link to R3
A1/0 172.16.56.5/30  ATM-R6

R6 (3640)
Loop0 192.168.6.6/24  Loopback
FA0/0 172.16.136.6/26  Ethernet segment-R2
E2/0 10.2.6.6/23  Ethernet segment-BB2
A1/0 172.16.56.6/30  ATM-R5

ISDN Information
Switch Type  Basic-NI 1

R2
SPID1: 42255501210101
SPID2: 42255501220101
**Technical Tasks**

*Note: only R3, R6 and cat5000 will be used in this lab*

A. Configure EIGRP routing as necessary.
B. Configure R3 for SNMP. Give community test read-only access and community TestKing read-write access. Only allow the IP address of 10.2.254 to access the TestKing community.
C. Configure R3 with the following variables; Contact-CCIE candidate, Location-Lab.
D. Enable R3 to send traps to 10.2.6.254. Disable up/down link traps for the serial1/2 interface.
E. Configure the catalyst switch to send SNMP traps to 10.2.6.254. Set the community for read to test and read/write community TestKing. Set the location to Lab and the name to cat. Set the IP address of the catalyst to 172.16.136.15 and the gateway to 172.16.136.6. Only allow 10.2.6.254 to access the TestKing community and 10.2.6.0/24 to access any SNMP communities.

**Instructor’s Comments and Technical Tips**

A. N/A
B. SNMP is enabled when the first SNMP command is issued.
C. Set standard SNMP variables.
D. When enabling traps link up/down is enabled for all interfaces by default. Issue an interface command to disable it for serial ½.
E. IP permit commands can be issued to allow hosts or subnets to access all SNMP communities. A particular host can be granted access to a community via a SNMP command.

**Technical Verification**

**Technical Verification For Task A**

```
r3#sho ip route
Codes: C- connected, S- static, I- Igrp, R- RIP, M- mobile, B- BGP
O- 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, E- EGP
```
i-IS-IS, L1- 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.

    172.16.0.0/26 is subnetted, 1 subnets
    C  172.16.136.0 is directly connected, Ethernet0/0
        10.0.0.0/23 is subnetted, 1 subnets
        D  10.2.6.0[90/307200] via 172.16.136.6, 00:00:05, Ethernet0/0
        D  192.168.6.0/24[90/409600] via 172.16.136.6, 00:00:05, Ethernet0/0
    C  192.168.3.0/24 is directly connected, Loopback0

r3#

r6#sho ip route
Codes: C- connected, S- static, I- Igrp, R- RIP, M- mobile, B- BGP
O- 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, E- EGP
i-IS-IS, L1- 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.

    172.16.0.0/26 is subnetted, 1 subnets
    C  172.16.136.0 is directly connected, FastEthernet0/0
        10.0.0.0/23 is subnetted, 1 subnets
    C  10.2.6.0 is directly connected, Ethernet2/0
    C  192.168.6.0/24 is directly connected, Loopback0
    D  192.168.3.0/24[90/156160] via 172.16.136.3, 0:00:39,FastEthernet0/0

r6#

**Technical Verification For Task B**

**sho snmp group**
groupname: ILMI  security model:v1
readview: *ilmi  writeview: *ilmi
notifyview:<no notifyview specified>
row status: active

groupname: ILMI  security model:v2c
readview: *ilmi  writeview: *ilmi
notifyview:<no notifyview specified>
row status: active
groupname: test       security model:v1
readview:v1 default  writeview: v1 default
notifyview:<no notifyview specified>
row status: active

groupname: test       security model:v2c
readview:v1 default  writeview: v1 default
notifyview:<no notifyview>
row status: active

groupname: TestKing   security model:v1
readview:v1 default  writeview: v1 default
notifyview:<no notifyview specified>
row status: active access-list: 1

groupname: TestKing   security model:v2c
readview: v1 default  writeview: v1 default
notifyview:<no notifyview specified>
row status: active access-list: 1

r3#sho access-list
Standard IP access list 1
Permit 10.2.6.254
r3#

Technical verification For Task C

R3#sho snmp
Chassis: JAD0426005T(3974116994)
Contact: CCIE Candidate
Location: Lab
0 SNMP packets input
0 Bad SNMP version errors
0 Unknown community name
0 Illegal operation for community name supplied
0 Encoding of request variables
0 Number of request variables
0 Number of altered variables
0 Get-request variables
0 Get-next PDUs
0 Set-request PDUs
0 SNMP packets output
0 Too big errors (Maximum packet size 1500)
0 No such name errors
0 Bad Values errors
0 General errors
0 Respnsne PDUs
0 Trap PUDs

SNMP logging: disabled

Technical Verification For Task D

r3#sho SNMP

Chassis: JADT (3974116994)
Interface serial1/2
Ip address 172.16.32.3.255.255.255.0
No snmp trap link-status
Clockrate 64000
!
snmp-server community test RW
snmp-server community TestKing RW 1
snmp-server trap-source Loopback0
snmp-server location Lab
snmp-server contact CCIE Candidate
snmp-server enable traps snmp authentication linkdown linkup coldstart warmstart
snmp-server enable traps isdn call-information
snmp-server enable traps isdn layer2
snmp-server enable traps isdn chan-not-avail
snmp-server enable traps isdn isdnu-interface
snmp-server enable traps hsrp
snmp-server enable traps config
snmp-server enable traps entity
snmp-server enable traps envmon
snmp-server enable traps bgp
snmp-server enable traps ipmulticast
snmp-server enable traps msdp
snmp-server enable traps rsvp
snmp-server enable traps frame-relay
snmp-server enable traps syslog
snmp-server enable traps rtr
snmp-server enable traps dlsw
snmp-server enable traps dial
snmp-server enable traps dsp card-status
snmp-server enable traps voice poor-qov
snmp-server enable traps xgcp
Technical Verification For task E

Cat>(enable) sho snmp

RMON: Disabled
Extended RMON: Extended RMON module is not present
Extended RMON Netflow: Disabled
Extended RMON Vlanmode: Disabled
Extended RMON Vlanagent: Disabled
Memory usage limit for new RMON entries: 85 percent
Traps Enabled:
Port, Module, Chassis, Bridge, Repeater, Vtp, Auth, ippermit, Vmps, config, entity, stpx, ssys
Slog, system
Port Traps Enabled: 1/1-2, 3/1-12

<table>
<thead>
<tr>
<th>Community-Access</th>
<th>Community-String</th>
</tr>
</thead>
<tbody>
<tr>
<td>read-only</td>
<td>test</td>
</tr>
<tr>
<td>read-write</td>
<td>TestKing</td>
</tr>
<tr>
<td>read-write-all</td>
<td>ip expert</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trap-Rec-Address</th>
<th>Trap-Rec-Community</th>
<th>Trap-Rec-Port</th>
<th>Trap-Rec-Owner</th>
<th>Trap-Rec_Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.2.6.254</td>
<td>TestKing</td>
<td>162</td>
<td>CLI</td>
<td>1</td>
</tr>
</tbody>
</table>

Cat>(enable)sho ip permit

Telnet permit list enabled.
Ssh permit list enabled.
**Snmp permit list enabled.**

<table>
<thead>
<tr>
<th>Permit list</th>
<th>Mask</th>
<th>Access-type</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.2.6.0</td>
<td>225.255.255.0</td>
<td>snmp</td>
</tr>
</tbody>
</table>

Denied IP Address last Accessed Time-Type

Cat>(enable)

Configuration Verification

*Only relevant potions of the configuration have been included.*

Router 3
R3#sh run
!
hostname r3
!
!
interface Loopback0
ip address 192.168.3.3 255.255.255.0
!
interface Ethernet0/0
ip address 172.16.136.3 255.255.255.192
half-duplex!
!
interface BR10/0
no ip address
shutdown
!
interface Serial1/0
no ip address
encapsulation fram-relay
shutdown
!
interface Serial1/1
ip address 172.16.31.2 255.255.255.252
clockrate 64000
!
interface Serial1/2
ip address 172.16.32.3 255.255.255.0
no snmp trap link-status
clockrate 64000
!
interface Serial1/3
ip address 172.16.35.1 255.255.255.252
shutdown
clockrate 64000
!
router eigrp 1
network 172.16.0.0
network 192.168.3.0
no auto-summary
no eigrp log-neighbour-changes
!
access-list 1 permit 10.2.6.254
! 
snmp-server community test RW
snmp-server community TestKing RW 1
snmp-server trap-source Loopback0
snmp-server location Lab
snmp-server contact CCIE Candidate
snmp-server enable traps snmp authentication linkdown linkup solstart warmstart
snmp-server enable traps isdn call-information
snmp-server enable traps isdn layer2
snmp-server enable traps isdn chan-not-avail
snmp-server enable traps isdn isdnu-interface
snmp-server enable traps hsrp

snmp-server enable traps config
snmp-server enable traps entity
snmp-server enable traps envmon
snmp-server enable traps bgp
snmp-server enable traps ipmulticast
snmp-server enable traps msdp

snmp-server enable traps rsvp
snmp-server enable traps frame-relay
snmp-server enable traps syslog
snmp-server enable traps rtr
snmp-server enable traps dlsw
snmp-server enable traps dial
snmp-server enable traps dsp card-status
snmp-server enable traps voice poor-qov
snmp-server enable traps xgcp
!
end
r3#

Router 6

R6#sh run
!
!
hostname r6
!
!
interface Loopback0
ip address 192.168.6.6 255.255.255.0

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no ip directed-broadcast
duplex auto
speed auto
!
interface ATM1/0
no ip address
no ip directed-broadcast
shutdown
no atm ilmi-keepalive
!
interface Ethernet2/0
ip address 10.2.6 255.255.254.0
no ip directed-broadcast
!
router eigrp 1
network eigrp 1
network 10.0.0.0
network 172.16.0.0
network 192.168.6.0
no auto-summary
end

r6#

Catalyst

!
Cat>(enable) sho run
!
#system
set system name Cat

set system location Lab
!
#snmp
set snmp community read-only test
set snmp community read-write TestKing
set snmp community read-write-all TestKing
set snmp trap enable module
set snmp trap enable chassis
set snmp trap enable bridge
set snmp trap enable repeater
set snmp trap enable vtp
set snmp trap enable auth
set snmp trap enable ipppermit
set snmp trap enable vmps
set snmp trap enable entity
set snmp trap enable config
set snmp trap enable stpx
set snmp trap enable syslog
set snmp trap enable system
set snmp trap 10.2.6.254 TestKing port 162 owner CLI index 1
!
#ip
set interface sc0 1 172.16.136.15/255.255.255.0 172.16.136.255
!
!
#permit list
set ip permit enable telnet
set ip permit enable ssh
set ip permit enable snmp
set ip permit 10.2.6.0 255.255.0 snmp
!
# default port status is enable
!
!
end
Cat>(enable)
Lab Preparation Scenario  - DHCP & DNS

Topics Covered
- Frame Relay
- Frame Relay Multipoint
- DHCP server
- DHCP pool
- DHCP Exclude
- DHCP DNS server
- DHCP Lease
- DHCP Database storage
- DHCP Client
- OSPF
- OSPF multipoint

Difficulty Level: CCIE
Average completion Time: 2 Hour

Standard Topology
### Standard TCP/IP Addressing and SPID Information

<table>
<thead>
<tr>
<th>R1 (3620)</th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.1.1/24</td>
<td>Loopback</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E/0/0</td>
<td>172.16.136.1/26</td>
<td>Ethernet Segment to Catalyst 3/1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T/0/0</td>
<td>172.16.15.1/28</td>
<td>Token ring Segment to 3920</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.31.1/30</td>
<td>Serial to R3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>R2 (3620)</th>
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</tr>
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<tbody>
<tr>
<td>Loop0</td>
<td>192.168.2.2/24</td>
<td>Loopback</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T/0/0</td>
<td>172.16.2.2/24</td>
<td>Token Ring segment to 3920</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BR10/0</td>
<td>172.16.230.2/24</td>
<td>BRI to R3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.32.2/24</td>
<td>Serial to R3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>R3 (2610)</th>
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</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.2.2/24</td>
<td>Loopback</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E0/0</td>
<td>172.16.136.3/26</td>
<td>Ethernet Segment to Catalyst 3/3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BR10/0</td>
<td>172.16.230.3/24</td>
<td>ISDN to R2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1/3</td>
<td>172.16.35.1/30</td>
<td>Serial to R5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1/2</td>
<td>172.16.32.3/24</td>
<td>Serial to R2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.31.2/30</td>
<td>Serial to R1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
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<th>R4 (2610)</th>
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</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.4.4/24</td>
<td>Loopback</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E0/0</td>
<td>10.1.4.4/22</td>
<td>Ethernet Segment to Catalyst 3/5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S0/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>R5 (3620)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.5.5/24</td>
<td>Loopback</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E0/0</td>
<td>172.16.136.5/26</td>
<td>Ethernet Segment to Catalyst 3/5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T/0/0</td>
<td>172.16.15.5/28</td>
<td>Token Ring segment to 3920</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S0/0</td>
<td>172.16.35.2/30</td>
<td>Serial link to R3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1/0</td>
<td>172.16.56.5/30</td>
<td>ATM-R6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>R6 (3640)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.6.6/24</td>
<td>Looback</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FA0/0</td>
<td>172.16.136.6/26</td>
<td>Ethernet segment-R2</td>
<td></td>
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</tr>
<tr>
<td>E2/0</td>
<td>10.2.6.6/23</td>
<td>Ethernet segment-BB2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1/0</td>
<td>172.16.56.6/30</td>
<td>ATM-R5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### ISDN Information

- **Switch Type**: Basic-NI 1

### R2

- **SPID1**: 42255501210101
- **SPID2**: 42255501220101
Technical Tasks

A. Configure the frame relay so R3 is the hub using DLCI 311, 322 and 344. Configure sub-interfaces on R1, R2, R3 and R4. Use ip subnet 172.16.123.0/24 with the router number being the 4th octet. Do not use any other DLC’s.

B. Make R4 a DHCP server. Create a pool for the 172.16.136.0/25 subnet but do not use the mask verb. Allow the entire subnet but exclude range 1-10 and address 15. Use the following parameters; DNS servers of 10.2.6.254 and 10.2.6.254, Lease time 8 hours. Configure the router to verify the IP address is not in use by pining 4 times.

C. Configure R4 to send the DHCP database information via TFTP to 10.2.6.254 Delaying the writing of records for 10 minutes.

D. Configure OSPF with R1 E1/0, R3 E1/0, R5 E1/0 and R6 FA1/0 in Area 0. R3 Serial ½, R2 Serial 1/1 and To0/0 on area 2. R3 Serial 1/1 and R1 Serial 1/1 and To0/0 and R5 To0/0 in area 1. The Frame relay cloud should be in area 7. All Loopbacks should be in whatever area is appropriate. For the Frame Relay cloud do not use the network type broadcast.

E. Configure cat5000 to get the IP Address from DHCP server. Make sure Cat always get IP address 172.16.136.15. Supply CAT with the DNS server and Default router from above and set hostname to Cat.

Instructor’s Comments and Technical Tips

A. N/A

B. Routers can be configured to forward DHCP packets or to respond to them.

C. A DHCP database Agent should be configured or the DHCP conflict resolution should be disabled.

D. The Network Type will need to be changed on the Frame Relay interfaces.

E. The catalyst switch will broadcast for a DHCP server then RARP. IF nothing is received after 10 minutes the switch will retain 0.0.0.0 for an IP address. By default UDP broadcast are not forwarded by routers. Once the switch receives an IP address it is permanently written to the Configuration.

Technical Verification

Technical Verification For Task A

```
r1#sho frame map
Serial1/0.1(up): point-to-point dlci, dlci 113(0*71,0*1C10), broadcast
    Status defined, active
r1#
```

```
r2#sho frame map
Serial 1/0.1 (up): point-to-point dlci, dlci 223(0*DF, 0*34F0), broadcast
    Status defined, active
r2#
```

```
r3#sho frame map
```
CCIE LAB

Serial1/0.1(up): ip 172.16.123.1 dlci 311(0*137, 0*4C70), static, broadcast, CISCO, status defined, active
Serial1/0(up): ip 172.16.123.1 dlci 322(0*124, 0*5020), static, broadcast, CISCO, status defined, active
Serial1/0(up): ip 172.16.123.4 dlci 344(0*158, 0*5480), static, broadcast, CISCO, status defined, active
r3#

r4#sho frame map
Serial0/0.1(up): point-to-point dlci, dlci 443(0*1BB, 0*6CB0), broadcast
    Status defined, active
r4#

Technical Verification For Task B

*NOTE: This show command was issued after completion of exercise E.

r4#sho ip dhcp server st
Memory usage 15644
Address pools 2
Database agents 1
Automatic bindings 0
Manual bindings 1
Expired bindings 0
Malformed messages 0

Message Received
BOOTREQUEST 0
DHCPDISCOVER 1
DHCPREQUEST 1
DHCPDECLINE 0
DHCPRELEASE 0
DHCPINFORM 0

Message Sent
BOOTRELAY 0
DHCPOFFER 1
DHCPACK 1
DHCPNAK 0
r4#
Technical Verification for Task C

```
r4#sho ip dhcp database
URL:tftp://10.2.6.254
Read: Never
Written: Never
Status: Nothing to report.
Delay: 600 seconds
Timeout: 300 seconds
Failures: 0
Successes: 0
```
r4#

Technical Verification For Task D

```
Sho ip ospf interf
Ethernet0/0 is up, line protocol is up
Internet address 172.16.136.1/26, Area 0
Process ID 1, Router ID 192.168.1.1, Network type BROADCAST, Cost: 10
Transmit Delay is 1 sec, State DR, Priority 1
Designation router (ID) 192.168.1.1, Interface address 172.16.136.1
Backup designation router (ID) 192.168.3.3, Interface address 172.16.136.3
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:02
Index1/1, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is1, maximum is 4
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor count is 3, Adjacent neighbor count is 3
Adjacent with neighbor 192.168.6.6

Adjacent with neighbor 192.168.5.5
Adjacent with neighbor 192.168.3.3 (Backup Designation Router)
Suppress hello for 0 neighbor(s)
Loopback0 is up, line protocol is up
Internet address 192.168.1.1/24, area 1
Process ID 1, Router ID 192.168.1.1, Network type LOOPBACK, Cost: 1
Loopback interface is treated as a stub Host
Serial1/1 is up, line protocol is up
Internet address 172.16.31.1/30, Area 1
Process ID 1, Router ID 192.168.1.1, Network type POINT_TO_POINT, Cost: 48
```

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Transmit delay is 1 sec, State POINT_TO_POINT,
Timer intervals configured, Hello 10, Dead 40, Retransmit 5
Hello due in 00:00:03
Index 2/3, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 2, maximum is 12
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor count is 1, adjacent neighbor counts is 1
Adjacent with neighbor 192.168.3.3
Suppress hello for 0 neighbor(s)
TokenRing0/0 is up, line protocol is up
Internet address 172.16.15.1/28, Area 1
Process ID 1, Router ID 192.168.1.1, network Type BROADCAST, Cost: 6
Transmit delay is 1 sec, State DR, Priority 1
Designed Router (id) 192.168.1.1, Internet address 172.16.15.1
Backup Designation router (id) 192.168.5.5, Interface address 172.16.15.5
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:09
Index ½, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 1, maximum is 2
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
Adjacent with neighbor 192.168.5.5 (Backup Designation Router)
Suppress hello for 0 neighbor(s)
Serial1/0.1 is up, line protocol is up
Internet address 172.16.123.1/24, Area 7
Process ID 1, Router ID 192.168.1.1, Network Type POINT_TO_MULTIPOINT, Cost: 48
Transmit delay is 1 sec, State POINT_TO_MULTIPOINT,
Timer intervals configured, Hello 30, Dead 120, Wait 120, Retransmit 5
Hello due in 00:00:17
Index 1/5, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 1, maximum is 5
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
Adjacent with neighbor 192.168.3.3
Suppress hello for 0 neighbor(s)
r1#

r2#sho ip os int
Loopback0 is up, line protocol is up
Internet address 192.168.2.2/24, Area 2

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Process ID, Router ID 192.168.2.2, Network Type LOOPBACK, Cost: 1
Loopback interface is treated as a stub Host
Serial1/1 is up, line protocol is up
Internet address 172.16.32.2/24, Area 2
Process ID 1, Router ID 192.168.2.2, Network Type POINT_TO_POINT, Cost: 48
Transmit delay is 1 sec, State POINT_TO_POINT,
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:07
Index 2/2, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 1, maximum is 1
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
Adjacent with neighbor 192.168.3.3
Suppress hello for 0 neighbor(s)
TokenRing0/0 is up, line protocol is up
Internet address 172.16.2.2/24, Area 2
Process ID 1, Router ID 192.168.2.2, Network Type BROADCAST, Cost: 6
Transmit Delay is 1 sec, state DR, Priority 1
Designated Router (id) 192.168.2.2, interface address 172.16.2.2
No backup designated router on this network
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:06
Index 1/1, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 0, maximum is 0
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 0, adjacent neighbor count is 0
Suppress hello for 0 neighbor(s)
Serial1/0.1 up, line protocol is up
Internet address 172.16.123.2/24, area 7
Process ID 1, Router ID 192.168.2.2, Network Type POINT_TO_MULTIPOINT, Cost: 48
Transmit Delay is 1 sec, State POINT_TO_MULTIPOINT,
Timer intervals configured, Hello 30, Dead 120, wait 120, Retransmit 5
Hello due in 00:00:29
Index ¼, flood length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 1, maximum is 1
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor 192.168.3.3
Suppress hello for 0 neighbor(s)
r2#
r3#sho ip ospf inter
Ethernet0/0 is up, line protocol is up
Internet address 172.16.136.3/26, Area 0
Internet ID 1, Router ID 192.168.3.3, Network Type BROADCAST, Cost: 10
Transmit Delay is 1 sec, State DR, Priority 1
Designation router (ID) 192.168.1.1, Interface address 172.16.136.1
Backup designation router (ID) 192.168.3.3, Interface address 172.16.136.3
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:07
Index 1/1, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 1, maximum is 5
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor count is 3, Adjacent neighbor count is 3
Adjacent with neighbor 192.168.6.6
Adjacent with neighbor 192.168.5.5
Adjacent with neighbor 192.168.1.1 (Designation Router)
Suppress hello for 0 neighbor(s)
Loopback0 is up, line protocol is up
Internet address 192.168.1.1/24, Area 1
Process ID 1, Router ID 192.168.3.3, Network type LOOPBACK, Cost: 1
Loopback interface is treated as a stub Host
Serial1/1 is up, line protocol is up
Internet address 172.16.31.2/30, Area 1
Process ID 1, Router ID 192.168.3.3, Network type POINT_TO_POINT, Cost: 781
Transmit delay is 1 sec, State POINT_TO_POINT,
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:00
Index 2/3, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 2, maximum is 3
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor count is 1, adjacent neighbor counts is 1
Adjacent with neighbor 192.168.1.1
Suppress hello for 0 neighbor(s)
Serial1/2 is up, line protocol is up
Internet address 172.16.32.3./24, Area 2
Process ID 1, Router ID 192.168.3.3, Network Type POINT_TO_POINT, Cost: 781
Transmit delay is 1 sec, State POINT_TO_POINT,
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:00
Index 1/2, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 1, maximum is 4
Last length scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
Adjacent with neighbor 192.168.2.2
Suppress hello for 0 neighbor(s)
Serial1/0.1 is up, line protocol is up
Internet address 172.16.123.3/24, Area 7
Process ID 1, Router ID 192.168.3.3, Network Type POINT_TO_MULTIPOINT, Cost: 781
Transmit delay is 1 sec, State POINT_TO_MULTIPOINT,
Timer intervals configured, Hello 30, Dead 120, Wait 120, Retransmit 5
Hello due in 00:00:04
Next 0*0(0)/0*0(0)
Index 1/5, flood queue length 0
Last flood scan length is 1, maximum is 5
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 3
Adjacent with neighbor 192.168.4.4
Adjacent with neighbor 192.168.1.1
Adjacent with neighbor 192.168.2.2
Suppress hello for 0 neighbor(s)
r2#

r4#sho ip ospf interf

Loopback0 is up, line protocol is up
Internet address 192.168.4.4/24, Area 4
Process ID 1, Router ID 192.168.4.4, Network type LOOPBACK, Cost: 1
Loopback interface is treated as a stub Host
Serial1/0.1 up, line protocol is up
Internet address 172.16.123.4/24, Area 7
Process ID 1, Router ID 192.168.4.4, Network Type POINT_TO_MULTIPOINT, Cost: 64
Transmit Delay is 1 sec, State POINT_TO_MULTIPOINT,
Timer intervals configured, Hello 30, Dead 120, Wait 120, Retransmit 5
Hello due in 00:00:17
Index 1/5, flood length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 1, maximum is 1
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor 192.168.3.3
Suppress hello for 0 neighbor(s)
r4#

r5#sho ip osp interf

Ethernet0/0 is up, line protocol is up
Internet address 172.16.136.5/26, Area 0

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Process ID, Router ID 192.168.5.5, Network Type BROADCAST, Cost: 10
Transmit delay is 1 sec, State DROTHER, Priority 1
Designated Router (ID) 192.168.5.5, interface address 172.16.136.1
Backup Designated router (ID) 192.168.3.3, Interface address 172.16.136.3
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:07
Index 2/2, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 1, maximum 4
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 3, Adjacent neighbor count is 2
Adjacent with neighbor 192.168.3.3 (Backup Designated Router)
Adjacent with neighbor 192.168.1.1 (Designated Router)
Suppress hello for 0 neighbor(s)
TokenRing0/0 is up, line protocol is up
Internet address 172.16.15.5/28, Area 1
Process ID 1, Router ID 192.168.5.5, Network Type BROADCAST, Cost: 6
Transmit Delay is 1 sec, state BDR, Priority 1
Designated Router (ID) 192.168.1.1, interface address 172.16.15.1
Backup Designated router (ID) 192.168.5.5, Interface address 172.16.15.5
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:02
Index 1/1, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 1, maximum is 3
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, adjacent neighbor count is 1
Adjacent with neighbor 192.168.1.1 (Designated Router)
Suppress hello for 0 neighbor(s)
Serial1/0.1 up, line protocol is up
Internet address 192.168.5.5/24, Area 5
Process ID 1, Router ID 192.168.5.5, Network Type LOOPBACK, Cost 1
Suppress hello for 0 neighbor(s)
Loopback0 is up, line protocol is up
Internet address 192.168.5.5/24, Area 5
Process ID 1, Router ID 192.168.5.5, Network Type LOOPBACK, Cost: 1
Loopback interface is treated as a stub Host
r5#

r6#sho ip ospf interf
FastEthernet0/0 is up, line protocol is up
Internet Address 172.16.136.6/26, Area 0
Process ID 1, Router ID 192.168.6.6, Network Type BROADCAST, Cost: 1
Transmit delay is 1 sec, State DROTHER, Priority 1
Designated Router (ID) 192.168.5.5, interface address 172.16.136.1
Backup Designated router (ID) 192.168.3.3, Interface address 172.16.136.3
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:09
Index 1/1, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 0, maximum 1
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 3, Adjacent neighbor count is 2
Adjacent with neighbor 192.168.3.3 (Backup Designated Router)
Adjacent with neighbor 192.168.1.1 (Designated Router)
Suppress hello for 0 neighbor(s)
Ethernet0/0 is up, line protocol is up
Internet address 10.2.6.6/23, Area 6
Process ID 1, Router ID 192.168.6.6, Network Type BROADCAST, Cost: 10
Transmit Delay is 1 sec, state DR, Priority 1
Designated Router (ID) 192.168.6.6, interface address 10.2.6.6
No backup Designated router on this network
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:01
Index 1/1, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 0, maximum is 0
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 0, adjacent neighbor count is 0
Suppress hello for 0 neighbor(s)
Loopback0 up, line protocol is up
Internet address 192.168.6.6/24, Area 6
Process ID 1, Router ID 192.168.6.6, Network Type LOOPBACK, Cost 1
Loopback interface is treated as a stub Host

r6#

Technical Verification For Task E

Console>(enable)set interface sc0 dhcp renew
Renewing IP address…
Console>(enable) sending RARP request with 00:09:2b:a3:bf:ff
Sending DHCP packet with address: 00:09:2b:a3:bf:ff
Sending DHCP packet with address: 00:09:2b:a3:bf:ff
10.2.6.254 added to DNS server table as primary server.
10.2.6.253 added to DNS server table as backup server.
System name set.
Default DNS domain name set to TestKing.net
Configuration Verification

Only relevant portions of the configuration have been included.

Router 1

r1#sho run
!
hostname r1
!
!
interface Loopback0
ip address 192.168.1.1 255.255.255.0
!
interface Ethernet0/0
ip address 172.16.15.1 255.255.255.190
half-duplex
!
interface Serial1/0
no ip address
encapsulation fram-relay
no frame-relay inverse-arp
!
interface Serial1/0.1 point-to-point
ip address 172.16.123. 255.255.255.0
ip ospf network point-to-multipoint
frame-relay interface-dlci 113
!
interface Serial1/1
ip address 172.16.31.1 255.255.255.252
!
router ospf 1
log-adjacency-changes
network 172.16.15.0.0.0.0.15 area 1
network 172.16.31.0.0.0.0.3 area 1
network 172.16.123.0.0.0.0.255 area 7
network 172.16.136.0.0.0.0.63 area 0
network 172.168.1.0.0.0.0.255 area 1
!
end

r1#

Router 2

r2#sho run
!
hostname r2
!
interface Loopback0
ip address 192.168.2.2 255.255.255.0
!
interface BR10/0
no ip address
shutdown
half-duplex
!
interface TokenRing0/0
ip address 172.16.2.2 255.255.255.0
ring-speed 16
!
interface Serial1/0
encapsulation frame-relay
no frame-relay inverse-arp
!
interface Serial1/1
ip address 172.16.32.2 255.255.255.0
!
router ospf 1
log-adjacency-changes
network 172.16.2.0.0.0.0.255 area 2
network 172.16.32.0.0.0.0.255 area 2
network 172.16.123.0.0.0.0.255 area 7
network 192.168.2.0.0.0.0.255 area 2
!
end

r2#
Router 3

r3#sho run
hostname r3
!
interface Loopback0
ip address 192.168.3.3 255.255.255.0
!
interface Ethernet0/0
ip address 172.16.136.3 255.255.255.192
ip helper-address 172.16.123.4
half-duplex
!
interface BR10/0
no ip address shutdown
!
interface Serial1/0
no ip address
encapsulation frame-relay
no frame-relay inverse-arp
!
interface serial1/0.1 multipoint
frame-relay interface-dlci 311
frame-relay interface-dlci 322
frame-relay interface-dlci 344
!
interface Serial1/1
ip address 172.16.31.2 255.255.255.252
clockrate 64000
!
interface Serial1/2
ip address 172.16.32.3 255.255.255.0
clockrate 64000
!
interface Serial1/3
ip address 172.16.35.1 255.255.255.252
shutdown
clockrate ospf 1
log-adjacency-changes
network 172.16.31.0 0.0.0.3 area 1
network 172.16.32.0 0.0.0.255 area 2
network 172.16.123.0 0.0.0.255 area 7
network 172.16.136.0 0.0.0.63 area 0
network 192.168.3.0 0.0.0.255 area 1
```
!
!
end

r3#

Router 4

r4#sho run
!
hostname r4
!
ip dhcp database tftp://10.2.6.254 write-delay 600
ip dhcp excluded-address 172.16.136.10
ip dhcp excluded-address 172.16.136.15
ip shcp ping packet 4
!
ip shcp pool TestKing
network 172.16.136.0 255.255.255.128
domain-name TestKing.net
default-router 172.16.136.3
option 66 ip 10.2.6.136.3
netbios-node-type-h-node
dns-server 10.2.6.254 10.2.6.254
lease 0 8
!
ip dhcp pool cat
!
!
interface Loopback0
ip address 192.168.4.4 255.255.255.0
!
interface Ethernet0/0
ip address 10.1.4.4 255.255.252.0
half-duplex
!
interface Serial0/0
no ip address
encapsulation frame-relay
no frame-relay inverse-arp
!
interface Serial0/0.1 point-to-point
```
ip address 172.16.123.4 255.255.255.0
ip ospf network point-to-multipoint
frame-relay interface-dlci 443
!
interface Serial0/1
no ip address
shutdown
!
router ospf 1
log-adjacency-changes
network 172.16.123.0.0.0.0.255 area 7
network 192.168.4.0.0.0.0.255 area 4
!
end

r4#

Router 5

r5#sho run
!
hostname r5
!
!
interface Loopback0
ip address 192.168.5.5 255.255.255.0
!
interface Ethernet0/0
ip address 172.16.136.2 255.255.255.252
!
interface TokenRing0/0
ip address 172.16.15.5 255.255.255.240
ring-speed 16
!
interface Serial0/1
no ip address
shutdown
!
interface ATM1/0
no ip address
shutdown
no atm imli-keepalive
!
router ospf 1
log-adjacency-changes
network 172.16.15.0.0.0.0.15 area 1
network 172.16.136.0.0.0.0.63 area 0
network 192.168.5.0.0.0.0.255 area 5
!
end

r5#

Router 6

R6#sho run
!
hostname r6
!
!
interface Loopback0
ip address 192.168.6.6 255.255.255.0
no ip directed-broadcast
!
interface FastEthernet0/0
ip address 172.16.136.6 255.255.255.192
no ip directed-broadcast
duplex auto
speed auto
!
interface ATM1/0
no ip address
no ip directed-broadcast
shutdown
no atm imli-keepalive
!
interface Ethernet2/0
ip address 10.2.6.6 255.255.254.0
no ip directed-broadcast
!
router ospf 1
network 10.2.6.0.0.0.1.255 area 6
network 172.16.136.0.0.0.0.63 area 0
network 192.168.6.0.0.0.0.255 area 6
!
!
end
Catalyst

Cat>(enable) sho run

This command shows non-default configurations only.
Use ‘show config all’ to show both default and non-default configurations.
..........  

begin
!
#*****NON-DEFAULT CONFIGURATION*****
!
!
!
#version 6.3(4)
!
set option fddi-user-pri enabled
!
#system
set system name Cat
!
#frame distribution method
set port channel all distribution mac both
!
#ip
#learn from dhcp server 172.16.123.4
#interface sc0 1 172.16.136.15/255.255.255.128 172.16.136.127
set ip route 0.0.0.0.0/0.0.0.0 172.16.136.3
!
#dns
set ip dns server 10.2.6.254 primary
set dns server 10.2.6.253
set ip dns domain TestKing.net
!
#spantree
#vlan <Vlanld>
set spantree priority 8192 1
!
#set boot command
set boot config-register 0*102
set boot system flash bootflash:
set boot system flash bootflash:cat5000-sup3.6-3-4.bin
!
#default port status is enable
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!
!
#module 1: 2-port 10/100BaseTX Supervisor
!
#module 2 empty
!
#module 3 : 12-port 10/100BaseTX Ethernet
!
#module 4 empty
!
#module 5 : 1-port MM OC-3 ATM
end
Cat>(enable)
Lab Preparation Scenario - MP-BGP

Topics Covered
- MP-BGP
- Multicast
- MP-BGP for MPLS VPN

Difficulty Level: CCIE

Average Completion Time: 2 to 4 hours

Standard Topology

Standard TCP/IP Addressing and SPIID Information

<table>
<thead>
<tr>
<th>Interface</th>
<th>Address Family</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.1.1/24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E/0/0</td>
<td>172.16.136.1/26</td>
<td>Ethernet Segment to Catalyst 3/1</td>
</tr>
<tr>
<td>T0/0</td>
<td>172.16.15.1/28</td>
<td>Token ring Segment to 3920</td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.31.1/30</td>
<td>Serial to R3</td>
</tr>
</tbody>
</table>
S1/0  unassigned  Frame-relay

R2 (3620)
Loop0  192.168.2.2/24  Loopback
T0/0   172.16.2.2/24  Token Ring segment to 3920
BRI0/0 172.16.230.2/24  BRI to R3
S1/1   172.16.32.2/24  Serial to R3
S1/0   unassigned  Frame-relay

R3 (2610)
Loop0  192.168.2.2/24  Loopback
E0/0   172.16.136.3/26  Ethernet Segment to Catalyst 3/3
BRI0/0 172.16.230.3/24  ISDN to R2
S1/3   172.16.35.1/30  Serial to R5
S1/2   172.16.32.3/24  Serial to R2
S1/1   172.16.31.2/30  Serial to R1
S1/0   unassigned  Frame-relay

R3 (2610)
Loop0  192.168.4.4/24  Loopback
E0/0   10.1.4.4/22  Ethernet Segment to Catalyst 3/5
S0/0   unassigned  Frame-relay

R5 (3620)
Loop0  192.168.5.5/24  Loopback
E0/0   172.16.136.5/26  Ethernet Segment to Catalyst 3/5
T0/0   172.16.15.5/28  Token Ring segment to 3920
S0/0   172.16.35.2/30  Serial link to R3
A1/0   172.16.56.5/30  ATM-R6

R6 (3640)
Loop0  192.168.6.6/24  Loopback
FA0/0  172.16.136.6/26  Ethernet segment-R2
E2/0   10.2.6.6/23  Ethernet segment-BB2
A1/0   172.16.56.6/30  ATM-R5

ISDN Information
Switch Type  Basic-NI 1

R2
SPID1:  42255501210101
SPID2:  42255501220101

R3
SPID1:  42255501310101
SPID2:  42255501320101

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Technical Tasks

A. Configure the frame-relay cloud with R3 as the hub and R@, and R$ as spokes. Use point-to-point interfaces between R3-R2 and R3-R4. Configure R3-R4 in subnet 172.16.100.8/29. Configure R3-R2 in the subnet 172.16.100.4/30.

B. Configure EIGRP AS 100 on R2, R# and R4. Add the loopbacks on each router into EIGRP. Configure the network statements to the network mask.

C. Configure MP-BGP on R2, R3 and R4. Configure the address family to support IPV4 Multicast.

D. Configure a network statement for 172.16.2.0 on R2 so the route distributed via the address family configure in Task D.

E. Configure R1 in AS 10000. Create a VPN called RED on R3. This VPN should peer with R1 AS 10000. The TokenRing and loopback interface from R1 should appear in the RED VPN routing table. Use route descriptor 100:1 and route target 100:1.

F. Configure MP-BGP on R2, R# and R4. Configure the address family to support IPV4 multicast.

G. Configure Green VPN on R%. Create a new interface called loopback100, use the IP address 10.10.10.255.255.255.255, add this loopback to the green VPN, do not use a network statement in the address family to do this. Use route descriptor 100:1 and route target 100:2.

H. Configure tag-switching on the PPP interface between R3 and R5. You should configure OSPF 100 between R3 and R5 in Area 0. Area 0 should include the loopback interface of R3 and R5 as well as the PPP link between them.

I. Configure AS100 on R5. R5 should peer with R3.

J. Configure MP-BGP between R3 and R3. The routes from R1 should visible on the Green VPN routing table on R5.

All subnets/interfaces that participate in routing must be reachable from all routers

Instructor’s Comments and Technical Tips

A. Point-to-point connections should be fine here but be aware of the behavior of routing protocols when you use Frame Relay. OSPF and ISIS have some special considerations when it comes to Frame Relay and NBMA networks.

B. The network mask should appear as inverse masks the same as in OSPF.

C. If you wish to use a minimal amount of peering within the same AS you must use a route-reflector. The route-reflector commands must also appear in the address family as well as the IPV4 BGP section.

D. The default for IPV4 is unicast, you must specify that you wish to use a multicast subset.

E. You must include the network statement in the address family.

F. The neighbor statement should be configured under the vrf address family. Once a vpn is created an address family is also created for the vrf. Any commands related to the vrf and it’s EBGP connection to R1 will appear under the address family.

G. Don’t forget to use the ip vrf forwarding command on the loopback interface. Use redistributed connection. CEF is also needed for MPLS!

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H. You must configure tag switching and an IGP between the routers for the VPN routing to work.
I. On R5 use the ping vrf vpn Green 10.10.10.10 to ping the local interface. Use the same ping command to check connectivity to R1.

Technical Verification

Technical Verification For Task A

```
r2#sh frame-relay map
Serial1/0.1 (up): point-to-point dlci, dlci 233(0*E9,0*3890), broadcast
    status defined, active
```
```
r3#sh frame-relay map
Serial1/0.1 (up): point-to-point dlci, dlci 344(0*158,0*5480), broadcast
    Status defined, active
Serial1/0.1 (up): point-to-point dlci, dlci 332(0*14C,0*50C0), broadcast
    Status defined, active
```
```
r4#sh frame-relay map
Serial0/0.1 (up): point-to-point dlci, dlci 433(0*1BB,0*6CB0), broadcast
    Status defined, active
```

Technical Verification For Task B

```
r2#show ip route
  172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
  C 172.16.2.0/24 is directly connected, TokenRing0/0
  D 172.16.100.8/29 [90/21024000] via 172.16.100.5, 01:22:04, Serial1/0.1
  C 172.16.100.4/30 is directly connected, Serial1/0.1
  192.168.4.0/32 is subnetted, 1 subnets
  D 192.168.4.4 [90/21152000] via 172.16.100.5, 01:22:02, Serial1/0.1
  192.168.2.0/32 is subnetted, 1 subnets
  C 192.168.2.2 is directly connected, Loopback0
  192.168.3.0/32 is subnetted, 1 subnets
  D 192.168.3.3 [90/1889792] via 172.16.100.5, 01:23:06, Serial1/0.1
```
```
r3#show ip route
  172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
  C 172.16.35.1/32 is directly connected, Serial1/3
  C 172.16.35.0/30 is directly connected, Serial1/3
  C 172.16.100.8/29 is directly connected, Serial1/0.2
  C 172.16.100.4/30 is directly connected, Serial1/0.1
  192.168.4.0/32 is subnetted, 1 subnets
```
Technical Verification For Task C and D

r3#show ip bgp neighbor 192.168.2.2

BGP neighbor is 192.168.2.2, remote AS 100, internal link
BGP version 4, remote router ID 192.168.2.2
BGP state=Established, up for 01:14:15
Last red 00:00:15, hold time is 180. keepalive interval is 60 seconds
Neighbor capabilities:
Route refresh: advertised and received(new)
Address family Ipv4 Unicast: advertised and received
Address family Ipv4 Multicast: advertised and received
Received 98 messages, 0 notifications, 0 in queue
Sent 101 messages, 0 notifications, 0 in queue
Route refresh request: received 0, sent 1
Default minimum time between advertisement runs is 5 seconds

For address family: Ipv4 Unicast
BGP table version 3, neighbor version 3
Index 2, Offset 0, Mask0*4
Route-reflector Client
0 accepted prefixes consume 0 bytes
Prefix advertised 2, suppressed 0, withdrawn 1
Number of NLRs in the update sent: max 1, min 0
For address family: Ipv4 Multicast
BGP table version 2, neighbor version 2
Index 3, Offset 0, Mask 0*8
Route-Reflector Client
0 accepted prefixes consume 0 bytes
Prefix advertised 1, suppressed 0, Withdrawn 0
Number of NLPIs in the update sent: max 1, min 0

r3#sh ip bgp neighbor 192.168.4.4
BGP neighbor is 192.168.4.4, remote AS 100, internal link
BGP version 4, remote router ID 192.168.4.4
BGP state=Established, up for 01:15:51
Last read 00:00:51, hold time is 180, keepalive internal is 60 seconds
Neighbor capabilities:
Route refres: advertised and received(new)
Address family IPv4 Unicast: advertised and received
Address family IPv4 Multicast: advertised and received
Received 97 messages, 0 notifications, 0 in queue
Sent 101 messages, 0 notifications, 0 in queue
Route refresh request: received 0, sent 0
Default minimum time between advertisement runs is 5 seconds

For address family: Ipv4 Unicast
BGP table version 3, neighbor version 3
Index 3, Offset 0, Mask0*8
Route-Reflector Client
0 accepted prefixes consume 0 bytes
Prefix advertised 2, suppressed 0, withdrawn 1
Number of NLRs in the update sent: max 1, min 0

For address family: IPv4 Multicast
BGP table version 2, neighbor version 2
Index 3, Offset 0, Mask 0*8
Route-Reflector Client
0 accepted prefixes consume 0 bytes
Prefix advertised 1, suppressed 0, Withdrawn 0
Number of NLPIs in the update sent: max 1, min 0

Technical Verification For Task E

r3#show ip bgp ipv4 multicast
BGP table version is 2, local router ID is 192.168.3.3
Status odes: s suppressed, d damped, h history, * valid, > best, I internal
Origin codes: I-IGP, e-EGP, ?.incomplete
Network  Next Hop  Metric  LocPrf  Weight  Path
*>172.16.2.0/24  192.168.2.2  0  100  01

Technical Verification For Task F
r3# show ip vrf
Name  Default RD  Interfaces
Red    100:1  Ethernet0/0

r3# show ip route vrf RED
  172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
   C 172.16.136.0/26 is directly connected, Ethernet0/0
   B 172.16.136.0/26[20/0] via 172.16.136.1, 00:41:18
      10.0.0.0/32 is subnetted, 1 subnets
      B 10.0.0.0/32[200/0] via 172.16.35.2, 00:04:35
      192.168.1.0/32 is subnetted, 1 subnets
      B 192.168.1.1[20/0] via 172.16.136.1, 00:43:13

Technical Verification For Task G
r5# show ip vrf
Name  Default RD  Interfaces
Green  100:1  Loopback100

r5# show ip route vrf Green
  172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
   B 172.16.16.0/26[200/0] via 172.16.35.1, 00:39:30
   B 172.16.16.0/28[200/0] via 172.16.35.1, 00:43:28
      10.0.0.0/32 is subnetted, 1 subnets
      C 10.10.10.10 is directly connected, Loopback100
      192.168.1.0/32 is subnetted, 1 subnets
      B 192.168.1.1[200/0] via 172.16.35.1, 00:45:15

Technical Verification For Task H
r5# show tag-switching interfaces
Interface  IP Tunnel  Operational
Serial0/0  YES NO  YES

r3# show tag-switching interfaces
Interface  IP Tunnel  Operational
Serial1/3  YES NO  YES
r3#sh ip route
   172.16.0.0/16 is Variably connected, 4 subnets, 3 masks
   C 172.16.35.1/32 is directly connected, Serial1/3
   C 172.16.35.0/30 is directly connected, Serial1/3
   C 172.16.100.8/29 is directly connected, Serial1/0.2
   C 172.16.100.4/30 is directly connected, Serial1/0.1
   192.168.4.0/32 is subnetted, 1 subnets
   D 192.168.4.4[90/20640000] via 172.16.100.11, 01:42:49, Serial1/0.2
   192.168.5.0/32 is subnetted, 1 subnets
   O 192.168.5.5[110/782] via 172.16.35.2, 00:48:49, Serial1/3
   192.168.3.0/32 is subnetted, 1 subnets
   D 192.168.3.3 is directly connected, Loopback0

r5#show ip route
   172.16.0.0/16 is variably subnetted, 3 subnets, 2 masks
   C 172.16.56.4/30 is directly connected, ATM1/0.32
   C 172.16.35.0/30 is directly connected, Serial0/0
   C 172.16.15.0/28 is directly connected, TokenRing0/0
   192.168.5.0/32 is subnetted, 1 subnets
   C 192.168.5.5 is directly connected, Loopback0
   150.50.0.0/32 is subnetted, 1 subnets
   C 150.5.15.3 is directly connected, Serial0/0
   192.168.3.0/32 is subnetted, 1 subnets
   O 192.168.3.3[110/49] via 172.16.35.1, 00:49:43, Serial0/0

Technical Verification For Task I

r5#show ip bgp summary
BGP router identifier 192.168.5.5, local AS number 100
BGP table version is 1, main routing table version 1

<table>
<thead>
<tr>
<th>Neighbor</th>
<th>V</th>
<th>AS MsgRcvd</th>
<th>MsgSent</th>
<th>TblVer</th>
<th>InQ</th>
<th>OutQ</th>
<th>UP/Down</th>
<th>State/PfxRcd</th>
</tr>
</thead>
<tbody>
<tr>
<td>172.16.35.1</td>
<td>4</td>
<td>100</td>
<td>101</td>
<td>96</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>01:24:08</td>
</tr>
</tbody>
</table>

r3#show ip bgp summary
BGP router identifier 192.168.5.5, local AS number 100
BGP table version is 1, main routing table version 3

<table>
<thead>
<tr>
<th>Neighbor</th>
<th>V</th>
<th>AS MsgRcvd</th>
<th>MsgSent</th>
<th>TblVer</th>
<th>InQ</th>
<th>OutQ</th>
<th>UP/Down</th>
<th>State/PfxRcd</th>
</tr>
</thead>
<tbody>
<tr>
<td>172.16.35.2</td>
<td>4</td>
<td>100</td>
<td>96</td>
<td>101</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>01:28:13</td>
</tr>
</tbody>
</table>
### Technical Verification For Task J

**r3#show ip bgp vpn4 all**

BGP table version is 16, local router ID is 192.168.3.3

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*&gt;i10.10.10.10/32</td>
<td>172.16.35.2</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>?</td>
</tr>
<tr>
<td>*&gt; 172.16.15.0/28</td>
<td>172.16.136.1</td>
<td>0</td>
<td>0</td>
<td>10000</td>
<td>i</td>
</tr>
<tr>
<td>*&gt; 172.16.136.0/26</td>
<td>172.16.136.1</td>
<td>0</td>
<td>0</td>
<td>10000</td>
<td>i</td>
</tr>
<tr>
<td>*&gt; 192.168.1.1/32</td>
<td>172.16.136.1</td>
<td>0</td>
<td>0</td>
<td>10000</td>
<td>i</td>
</tr>
</tbody>
</table>

**r5#show ip bgp vpnv4 all**

BGP table version is 17, local router ID is 192.168.5.5

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*&gt;i10.10.10.10/32</td>
<td>0.0.0.0</td>
<td>0</td>
<td>32768</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>*&gt; 172.16.15.0/28</td>
<td>172.16.35.1</td>
<td>0</td>
<td>0</td>
<td>10000</td>
<td>i</td>
</tr>
<tr>
<td>*&gt; 172.16.136.0/26</td>
<td>172.16.35.1</td>
<td>0</td>
<td>0</td>
<td>10000</td>
<td>i</td>
</tr>
<tr>
<td>*&gt; 192.168.1.1/32</td>
<td>172.16.35.1</td>
<td>0</td>
<td>0</td>
<td>10000</td>
<td>i</td>
</tr>
</tbody>
</table>

**r5#show ip route vrf Green**

172.16.0/16 is variably subnetted, 2 subnets, 2 masks
B 172.16.136.0/26[200/0] via 172.16.35.1, 00:47:32
B 172.16.15.0/28[200/0] via 172.16.35.1, 00:51:30
  10.0.0.0/32 is subnetted, 1 subnets
C 10.10.10.10. is directly connected, Loopback100
B 192.168.1.0/32 is subnetted, 1 subnets
B 192.168.1.1[200/0] via 172.16.35.1, 00:53:17

**r3#sh ip route vrf Red**

172.16.0/16 is variably subnetted, 2 subnets, 2 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
B 172.16.15.0/28[20/0] via 172.16.35.1, 00:51:30
  10.0.0.0/32 is subnetted, 1 subnets
B 10.10.10.10[200/0] via 172.16.35.2, 00:51:49

---

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192.168.1.0/32 is subnetted, 1 subnets
B 192.168.1.1[20/0] via 172.16.136.1, 00:54:27

r1#ping 10.10.10.10

Type escape sequence to abrot.
Sending 5, 100-byte ICMP Echos to 10.10.10.10, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max=32/33/36 ms

r1#trace 10.10.10.10

Type escape sequence to abroat.
Tracing the route to 10.10.10.10
1 172.16.136.3 4 msec 4 msec 4 msec
2 10.10.10.10[AS 100] 16 msec* 16msec

The routing tables of all routers are included here. The legend normally provided in router output has been deleted.

Router 1

r1#show ip route
172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
C 172.16.15.0/28 is directly connected, TokenRing0/0
10.0.0.0/32 is subnetted, 1 subnets
B 10.10.10.10[20/0] via 172.16.136.3, 00:53:09
192.168.1.0/32 is subnetted, Loopback0

r1#show ip bgp
BGP table version is 17, local router ID is 192.168.1.1
Status codes: s suppressed, d damped, h history, *valid, > best, i-internal

Network Next Hop Metric LocPrf Weight Path
Router Distinguisher: 100:1 (default for vrf Red)
*>10.10.10.10/32 172.16.136.3 0 100 ?
*> 172.16.15.0/28 0.0.0.0 0 32768 i
*> 172.16.136.0/26 0.0.0.0 0 32768 i
*> 192.168.1.1/32 0.0.0.0 0 32768 I

Router 2

r2#show ip route
172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
C  172.16.2.0/24 is directly connected, TokenRing0/0
D  172.16.100.8/29[90/21024000] via 172.16.100.5, 01:52:06, Serial1/0.1
C  172.16.100.4/30 is directly connected, Serial1/0.1
D  192.168.4.4[90/211520000] via 172.16.100.5, 00:52:04, Serial1/0.1
C  192.168.2.2 is directly connected, Loopback0
D  192.168.3.3[90/1889792] via 172.16.100.5, 01:53:07, Serial1/0.1

r2#show ip bgp ipv4 multicast

BGP table version is 2, local router ID is 192.168.2.2
Status odes: s suppressed, d damped, h history, * valid, > best, I internal
Origin codes: I-IGP, e-EGP, ?-incomplete

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>*&gt;i172.16.2.0/24</td>
<td>0.0.0.0</td>
<td>0</td>
<td>23768</td>
<td>i</td>
<td></td>
</tr>
</tbody>
</table>

Router 3

R3#sh ip route

172.16.0.0/16 is Variably connected, 4 subnets, 3 masks
C  172.16.35.1/32 is directly connected, Serial1/3
C  172.16.35.0/30 is directly connected, Serial1/3
C  172.16.100.192.168.4.0/32 is subnetted, 1 subnets
D  192.168.4.4[90/20640000] via 172.16.100.11, 01:42:49, Serial1/0.2
D  192.168.5.5[110/782] via 172.16.35.2, 00:48:49, Serial1/3
D  192.168.2.2[90/20640000] via 172.16.100.6, 01:43:51, Serial1/0.1
D  192.168.3.3 is directly connected, Loopback0

r3#show ip bgp ipv4 multicast

BGP table version is 2, local router ID is 192.168.3.3
Status odes: s suppressed, d damped, h history, * valid, > best, I internal
Origin codes: I-IGP, e-EGP, ?-incomplete

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
</table>

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r3#show ip bgp vpn4 vrf Red
BGP table version is 16, local router ID is 192.168.3.3
Status codes: s suppressed, d damped, h history, *valid, > best, i-internal

<table>
<thead>
<tr>
<th>Network</th>
<th>Next Hop</th>
<th>Metric</th>
<th>LocPrf</th>
<th>Weight</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.10.10.10/32</td>
<td>172.16.35.2</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>?</td>
</tr>
<tr>
<td>172.16.136.0/26</td>
<td>172.16.136.1</td>
<td>0</td>
<td>0</td>
<td>10000</td>
<td>i</td>
</tr>
<tr>
<td>172.16.136.0/26</td>
<td>172.16.136.1</td>
<td>0</td>
<td>0</td>
<td>10000</td>
<td>i</td>
</tr>
<tr>
<td>192.168.1.1/32</td>
<td>172.16.136.1</td>
<td>0</td>
<td>0</td>
<td>10000</td>
<td>I</td>
</tr>
</tbody>
</table>

r3#sh ip route vrf Red
172.16.0/16 is variably subnetted, 2 subnets, 2 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
B 172.16.15.0/28[20/0] via 172.16.136.1, 01:00:00
  10.0.0.0/32 is subnetted, 1 subnets
    B 10.10.10.10[200/0] via 172.16.35.2, 00:59:17
    192.168.100.32 is subnetted, 1 subnets
    B 192.168.1.1[20/0] via 172.16.136.1, 01:01:55

Router 4

172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C 172.16.100.8/29 is directly connected, Serial0/0.1
D 172.16.100.4/30[90/21024000] via 172.16.100.9, 01:58:24, Serial0/0.1
  192.168.4.0/32 is subnetted, 1 subnets
C 192.168.4.4 is directly connected, Loopback0
  10.0.0.0/22 is subnetted, 1 subnets
C 10.1.4.0 is directly connected, ethernet0/0
  192.168.2.0/32 is subnetted, 1 subnets
D 192.168.2.2[90/21152000] via 172.16.100.9, 01:58:24, Serial0/0.1
  192.168.3.0/32 is subnetted, 1 subnets
D 192.168.3.3[90/2297856] via 172.16.100.9, 01:58:25, Serial0/0.1

r4#show ip bgp ipv4 multicast
BGP table version is 2, local router ID is 192.168.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i internal
Origin codes: I-IGP, e-EGP, ?-incomplete
Network | Next Hop | Metric | LocPrf | Weight | Path
---|---|---|---|---|---
*>i172.16.2.0/24 | 192.168.2.2 | 0 | 100 | 0 | I

Router 5

172.16.0.0/16 is variably subnetted, 3 subnets, 2 masks
C 172.16.56.4/30 is directly connected, ATM1/0.32
C 172.16.35.0/30 is directly connected, Serial0/0
C 172.16.15.0/28 is directly connected, TokenRing0/0
192.168.5.0/32 is subnetted, 1 subnets
C 192.168.5.5 is directly connected, Loopback0
150.50.0.0/32 is subnetted, 1 subnets
C 150.5.15.3 is directly connected, Serial0/0
192.168.3.0/32 is subnetted, 1 subnets
O 192.168.3.3[110/49] via 172.16.35.1, 01:01:01, Serial0/0

r5#show ip bgp vpnv4 all
BGP table version is 17, local router ID is 192.168.5.5
Status codes: s suppressed, d damped, h history, *valid, > best, i-internal

Network | Next Hop | Metric | LocPrf | Weight | Path
---|---|---|---|---|---
Router Distinguisher: 100:1 (default for vrf Red)
*>i10.10.10.10/32 | 0.0.0.0 | 0 | 32768 | ?
*> 172.16.15.0/28 | 172.16.35.1 | 0 | 0 | 10000 | i
*> 172.16.136.0/26 | 172.16.35.1 | 0 | 0 | 10000 | i
*> 192.168.1.1/32 | 172.16.35.1 | 0 | 0 | 10000 | I

r5#show ip route vrf Green
172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
B 172.16.136.0/26[200/0] via 172.16.35.1, 00:55:27
B 172.16.15.0/28[200/0] via 172.16.35.1, 00:59:26
10.0.0.0/32 is subnetted, 1 subnets
C 10.10.10.10 is directly connected, 1 subnets
B 192.168.1.1[200/0] via 172.16.35.1, 01:01:12

Configuration Verification

Only relevant portions of the configuration have been included.

Router 1

r1#sh run
interface Loopback0

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ip address 192.168.1.1 255.255.255.255
!
interface Ethernet0/0
ip address 172.16.136.1 255.255.255.192
half-duplex
!
interface TokenRing0/0
ip address 172.16.15.1 255.255.255.240
ring-speed 16
router bgp 10000
no synchronization
bgp log-neighbor-changes
network 172.16.15.0 mask 255.255.255.24
network 172.16.136.0 mask 255.255.255.192
network 192.168.1.1 mask 255.255.255.255
neighbor 172.16.136.3 remote-as 100
no auto-summary

Router 2

r2#sh run

interface Loopback0
ip address 192.168.2.2 255.255.255.255
interface TokenRing0/0
ip address 172.16.2.2 255.255.255.0
ring-speed 16
!
interface Serial1/0
no ip address
encapsulation frame-relay
no frame-relay inverse-arp
!
interface Serial1/0.1 point-to-point
ip address 172.16.100.6 255.255.255.252
frame-relay interface-dlci 233
router eigrp 100
network 172.16.100.4.0.0.03
network 192.168.2.2.0.0.0.0
no auto-summary
no eigrp log-neighbor-changes
!
router bgp 100
no synchronization
bgp-log-neighbor-changes
neighbor 192.168.3.3 remote-as 100
no auto-summary
!
address-family ipv4 multicast
neighbor 192.168.3.3 activate
network 172.16.2.0 mask 255.255.255.0
exit-address-family

Router 3

r3#sh run
ip vrf Red
rd 100:1
route-target export 100:1
route-target import 100:1
route-target import 100:2
ip cef

interface Loopback0
ip address 192.168.3.3 255.255.255.255
half-duplex

interface Serial1/0
no ip address
encapsulation frame-relay
no fair-queue
no frame-relay inverse-arp
!
interface Serial1/0.1 point-to-point
ip address 172.16.100.5 255.255.255.252
ip ospf priority 255
frame-relay interface-dlci 332
!
interface Serial1/0.2 point-to-point
ip address 172.16.100.9 255.255.255.248
ip ospf network point-to-point
frame-relay interface-dlci 344

router eigrp 100
network 172.16.100.4.0.0.0.0
network 172.16.100.8.0.0.0.7
network 172.16.136.0.0.0.63
network 192.168.3.3.0.0.0.0

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no auto-summary
no eigrp log-neighbor-changes
!
router ospf 100
log-adjacency-changes
network 172.16.35.0.0.0.0.3 area 0
network 192.168.3.3.0.0.0.0 area 0

router bgp 100
no synchronization
bgp log-neighbor-changes
neighbor 172.16.35.2 remote-as 100
neighbor 192.168.2.2 update-as 100
neighbor 192.168.2.2 update-source Loopback0
neighbor 192.168.2.2 route-reflector-client
neighbor 192.168.4.4 remote-as 100
neighbor 192.168.4.4 update-source Loopback0
neighbor 192.168.4.4 route-reflector-client
no auto-summary
!
address-family ipv4 vrf Red
neighbor 172.16.136.1 remote-as 10000
neighbor 172.16.136.1 activate
no auto-summary
no synchronization
exit-address-family
!
address-family ipv4 multicast
neighbor 192.168.2.2 activate
neighbor 192.168.2.2 route-reflector-client
neighbor 192.168.4.4 activate
neighbor 192.168.4.4 route-reflector-client
exit auto-summary
exit-address-family

address-family vpnv4
neighbor 172.16.35.2 activate
neighbor 172.16.35.2 send-community extended
no auto-summary
exit

Router 4

r4#sh run
interface Loopback0
ip address 192.168.4.4 255.255.255.255
!
interface Ethernet0/0
ip address 10.1.4.4 255.255.252.0
half-duplex
!
interface Serial0/0
no ip address
encapsulation frame-relay
no frame-relay inverse-arp
!
interface Serial0/0.1 point-to-point
ip address 172.16.100.11 255.255.255.248
fram-relay interface-dlci 443

router eigrp 100
network 172.16.100.0.0.0.7
network 192.168.4.0.0.0.0
no auto-summary
no eigrp-neighbor-changes
!
router bgp 100
no synchroniation
bgp log-neighbor-changes
neighbor 192.168.3.3 remote-as 100
no auto-summary
!
address-family ipv4 multicast
neighbor 192.168.3.3 activate
exit-address-family

**Router 5**

r5#sh run

ip vrf Red
rd 100:1
route-target export 100:2
route-target import 100:2
route-target import 100:1
ip cef

interface Loopback0
ip address 192.168.5.5 255.255.255.255
!
interface Loopback100
ip vrf forwarding Green
ip address 10.10.10.10 255.255.255.255

interface Serial0/0
ip address 172.16.35.2 255.255.255.252
encapsulation ppp
tag-switching ip
no fair-queue

router bgp 100
log-adjacency-changes
network 172.16.35.0.0.0.0.3 area 0
network 192.168.5.0.0.0.0.0 area 0

router bgp 100
no synchronization
bgp log-neighbor-changes
neighbor 172.16.35.1 remote-as 100
no auto-address-family

address-family-vpnv4
neighbor 172.16.35.1 activate
neighbor 172.16.35.1 send-community extended
no auto-summary
exit-address-family
Lab Preparation Scenario - Advanced MPLS

Topics Covered
- Tag Switching
- MP-BGP
- VRF Configuration
- VRFF IGP’s (BGP)

Difficulty Level: CCIE
Average Completion Time: 2 to 4 hours

Standard Topology

Standard TCP/IP Addressing and SPID Information

**R1 (3620)**
- Loop0 192.168.1.1/24 Loopback
- E/0/0 172.16.136.1/26 Ethernet Segment to Catalyst 3/1
- T0/0 172.16.15.1/28 Token ring Segment to 3920
- S1/1 172.16.31.1/30 Serial to R3
- S1/0 unassigned Frame-relay

**R2 (3620)**
- Loop0 192.168.2.2/24 Loopback
- T0/0 172.16.2.2/24 Token Ring segment to 3920
BRI0/0  172.16.230.2/24  BRI to R3
S1/1  172.16.32.2/24  Serial to R3
S1/0  unassigned  Frame-relay

R3 (2610)
Loop0  192.168.2.2/24  Loopback
E0/0  172.16.136.3/26  Ethernet Segment to Catalyst 3/3
BRI0/0  172.16.230.3/24  ISDN to R2
S1/3  172.16.35.1/30  Serial to R5
S1/2  172.16.32.3/24  Serial to R2
S1/1  172.16.31.2/30  Serial to R1
S1/0  unassigned  Frame-relay

R3 (2610)
Loop0  192.168.4.4/24  Loopback
E0/0  10.1.4.4/22  Ethernet Segment to Catalyst 3/5
S0/0  unassigned  Frame-relay

R5 (3620)
Loop0  192.168.5.5/24  Loopback
E0/0  172.16.136.5/26  Ethernet Segment to Catalyst 3/5
T0/0  172.16.15.5/28  Token Ring segment to 3920
S0/0  172.16.35.2/30  Serial link to R3
A1/0  172.16.56.5/30  ATM-R6

R6 (3640)
Loop0  192.168.6.6/24  Loopback
FA0/0  172.16.136.6/26  Ethernet segment-R2
E2/0  10.2.6.6/23  Ethernet segment-BB2
A1/0  172.16.56.6/30  ATM-R5

ISDN Information
Switch Type  Basic-NI 1

R2
SPI1:  42255501210101
SPI2:  42255501220101

R3
SPI1:  42255501310101
SPI2:  42255501320101

Technical Tasks
A. Configure the frame-relay cloud with R3 as the hub and R2, and R4 as spokes. Use point-
to-point interfaces between R3-R2 and R3-R4. Configure R3-R4 in subnet 172.16.100.8/29. configure R3-R2 in the subnet 172.16.100.4/30.
B. Configure R3 and R5 as PE routers.
C. Configure the PPP link between R3 and R5 for Tag-Switching. Use the loopback interfaces as the Tag-Switching Identifier.

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D. Configure R3 and R5 using OSPF. OSPF will be the protocol in the MPLS make sure that you include the loopbacks in the OSPF process. Use Area 0 for this OSPF area. Log adjacencies changes.
E. Configure MP-BGP on R3 and R5. Use AS 100. Each router should peer with the others loopbacks.
F. Configure a VPN named VPNA between R3 and R1. Use100:100. Advertise the loopback of R1.
G. Configure a VPN named VPNB and VPNC. VPNA will use BGP AS 65100. Advertise the loopback of R2.
H. Configure a VPN named VPNC between R# and R$. Use 100:300 as the route descriptor. VPNA should have access VPNB and VPNC. VPNC will use BGP AS 65300. Advertise the loopback of R4.
I. Configure a VPN named VPNX between R5 and R6. Use 100:999 as the route descriptor. VPNX should have access VPNB only. VPNX will use BGP AS 65200. Advertise the loopback of R1 and the backbone connection to BB2.

All subnets/interfaces that participate in routing must be reachable from all routers.

Instructor’s Comments and Technical Tips
A. configure standard Frame-Relay Connections. Use point-to-point sub-interfaces.
B. PE routers run MP-BGP. The first step is to configure CEF then you must enable tag-switching on the links between the PE’s. you must configure BGP and the address families for VPNv4.
C. Use the tag-switching ip command. This command must be enable to both sides of the link.
D. MPLS requires an IGP in the core. OSPF and ISIS are both supported as core IGP protocols. Remember to add a network statement for the loopback interfaces as they are needed for BGP and MPLS identification.
E. When you configure MP-BGP you must first configure BGP. You must activate the VPNv4 connection and configure BGP to send extended communities.
F. The route-target and the router descriptors do not have to be the same. Route-target must be used to select which routes you choose to import and export. In this lab you must select the route targets to import only from routers and VPNs that you need. If you discomfiture Router targets you must may import routes that you do not want in your VPN.
G. N/A
H. N/A
I. Use the as-override command to accept the routers from R2. Without this command R6 will ignore any routes from AS65200 because it contains it’s own AS number in the path.

Technical Verification

*Technical Verification For Task A*
R2#sh frame-relay map
Serial1/0.1 (up): point-to-point dlci, dlci 233(0*E9, 0*3890), broadcast
  Status defined, active
r3#sh frame-relay map
Serial1/0.1 (up): point-to-point dlci, dlci 344(0*158,0*5480), broadcast
  Status defined, active
Serial1/0.1 (up): point-to-point dlci, dlci 332(0*14C,0*50C0), broadcast
  Status defined, active
r4#sh frame-relay map
Serial0/0.1 (up): point-to-point dlci, dlci 433(0*1BB,0*6CB0), broadcast
  Status defined, active

Technical Verification For Task B

r3#sh ip cef
Prefix    Next Hop     Interface
0.0.0.0/32 receive
172.16.35.0/30 attached Serial1/3
172.16.35.0/32 receive
172.16.35.1/32 receive Serial1/3
172.16.35.3/32 receive
192.168.3.3/32 receive
192.168.5.5/32 172.16.35.2 Serial1/3
224.0.0.0/4    drop
224.0.0.0/24 receive
255.255.255.255/32 receive

r5#sh ip cef
Prefix    Next Hop     Interface
0.0.0.0/32 receive
172.16.35.0/30 attached Serial0/0
172.16.35.0/30 receive
172.16.35.2/32 receive Serial0/0
172.16.35.3/32 receive
192.16.35.3/32 receive
192.16.35.5/32 172.16.35.1 Serial0/0
224.0.0.0/4    drop
224.0.0.0/24 receive
255.255.255.255/32 receive

Technical Verification For Task C

r3#sh tag-switching interfaces
r5#sh tag-switching interfaces
Interface IP Tunnel Operational
Serial1/3 Yes No Yes

r3#sh tag-switching tdp neighbor
Peer TDP ident: 192.168.5.5:0; Local TDP Ident 192.168.3.3:0
TCP connection: 192.168.5.5.11004-192.168.3.3.711
State: Oper; PIEs sent/rcvd: 24/25; ; Downstream
Up time: 00:17:46
TDP discovery sources:
Serial1/3
Addresses bound to peer TDP Ident:
192.168.5.5 172.16.35.2

r5#sh tag-switching tdp nei
Peer TDP Ident: 192.168.3.3:0; Local TDP Ident 192.168.5.5:0
TCP connection: 192.168.3.3.711-192.168.5.5.11004
State: Oper; PIEs sent/rcvd: 19/20; ; Downstream
Up time: 00:18:15
TDP discovery sources:
Serial1/3
Addresses bound to peer TDP Ident:
192.168.3.3 172.16.35.1

r3#show tag-switching forwarding-table
Local Outgoing Prefix Bytes tag Outgoing Next Hop
Tag tag or VC or Tunnel Id switched interface
16 Aggregate 172.16.136.0/26[V] \ 0
17 Aggregate 172.16.100.4/30[V] \ 0
18 Untagged 192.168.2.2/32[V] 0 Sel/0.1 point2point
19 Aggregate 172.16.100.8/29[V] \ 0
20 Untagged 192.168.4.4/32[V] 0 Sel/3 point2point
22 Pop tag 192.168.5.5/32 0 Sel/3 point2point
23 Untagged 192.16.1.1/32[V] 0 Et0/0 172.16.136.1

r5#show tag-switching forwarding-table
Local Outgoing Prefix Bytes tag Outgoing Next Hop
Tag tag or VC or Tunnel Id switched interface
602 Aggregate 172.16.56.4/30[V] 0
603 Untagged 192.168.6.6/32[V] 0 AT1/0.32 172.16.56.6
Technical Verification For Task D

r3#show ip ospf
Routing Process “ospf 1” with ID 192.168.3.3 and Domain ID 0.0.0.1
Supports only single TOS(TOS0) routers
Supports opaque LSA
SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
Number of external LSA 0. Checksum Sum0*0
Number of opaque AS LSA 0. Checksum Sum0*0
Number of Debitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
External flood list length 0
Area BACKBONE(0)
  Number of interfaces in this area is 2
  Area has no authentication
  SPF algorithm excluded 3 times
  Area ranges are
  Number of LSA 2. Checksum Sum 0*18C0D
  Number of opaque link LSA 0. Checksum Sum 0*0
  NumberDCbitless LSA 0
  Number of indication LSA 0
  Number of DoNotAge LSA 0
  Flood list length 0

r5#show ip OSPF
Routing Process “ospf 1” with ID 192.168.3.3 and Domain ID 0.0.0.1
Supports only single TOS(TOS0) routers
Supports opaque LSA
SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
Number of external LSA 0. Checksum Sum0*0
Number of opaque AS LSA 0. Checksum Sum0*0
Number of Debitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
External flood list length 0
Area BACKBONE(0)
  Number of interfaces in this area is 2
  Area has no authentication
  SPF algorithm excluded 4 times
  Area ranges are

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Number of LSA 2. Checksum Sum 0*18C0D
Number of opaque link LSA 0. Checksum Sum 0*0
Number DC bitless LSA 0
Number of indication LSA 0
Number of DoNotAge LSA 0
Flood list length 0

Technical Verification For Task E

r3#sh ip bgp neighbor 192.168.5.5
BGP neighbor is 192.168.5.5, remote AS 100, internal link
BGP version 4, remote router ID 192.168.5.5
BGP state=Established, up for 01:28:16
Last read 00:00:16, hold time is 180, keepalive internal is 60 seconds
Neighbor capabilities:
Route refresh: advertised and received (new)
Address family IPv4 Unicast: advertised and received
Address family VPNv4 Multicast: advertised and received
Received 82 messages, 0 notifications, 0 in queue
Sent 101 messages, 0 notifications, 0 in queue
Route refresh request: received 0, sent 0
Default minimum time between advertisement runs is 5 seconds

For address family: IVPN4 Unicast
BGP table version 1, neighbor version 1
Index 1, Offset 0, Mask 0*2
0 accepted prefixes consume 0 bytes
Prefix advertised 0, suppressed 0, withdrawn 1
Number of NLRIs in the update sent: max 1, min 0

For address family: VPNv4 Unicast
BGP table version 36, neighbor version 36
Index 4, Offset 0, Mask ox10
Community attribute sent to this neighbor
2 accepted prefixes consume 120 bytes
Prefix advertised 8, suppressed 0, withdrawn 1
Number of NLRIs in the update sent: max 1, min 0

Connections established 1; dropped 0
Last reset never
Connection state is ESTAB, i/O status: 1, unread input bytes: 0
Local host: 192.168.3.3, Local port: 11005
Foreign host: 192.168.5.5, Foreign port: 179

Enqueued packets for retransmit: 0, input: 0 mis-ordered: 0(0 bytes)
### Event Timers (current time is 0*9F9CE4A):

<table>
<thead>
<tr>
<th>Timer</th>
<th>Status</th>
<th>Wakeups</th>
<th>Next</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrans</td>
<td>39</td>
<td>2</td>
<td>0*0</td>
</tr>
<tr>
<td>Timerwait</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>AckHold</td>
<td>31</td>
<td>12</td>
<td>0*0</td>
</tr>
<tr>
<td>SendWnd</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>KeepAlive</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>GiveUp</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>PmtuAger</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>DeadWait</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
</tbody>
</table>

iss: 2956513634  snduna: 2956515051  sndnxt: 2956515051  sndwnd: 16080
irs: 1326927567  rcvnxt: 1326928377  rcvwnd: 16118  delrcvwnd: 266

SRTT: 298 ms, RTTO: 319 ms, RTV: 21 ms, KRRT: 0 ms
MinRTT: 20 ms, maxRTT: 300ms, ACK hold: 200ms
Flags: passive open, nagle, gen tcbs

Datagrams (max data segment is 536 bytes):
Rcvd: 57 (out of order: 0), with data: 31, total data bytes: 809
Sent: 52 (retransmit: 2), with data: 36, total data bytes: 1416

r5#sh ip bgp neighbors is 192.168.3.3
BGP neighbor is 192.168.3.3, remote AS 100, internal link
BGP version 4, remote router ID 192.168.3.3
BGP state=Established, up for 00:30:35
Last read 00:00:34, hold time is 180, keepalive internal is 60 seconds
Neighbor capabilities:
Route refresh: advertised and received(new)
Address family IPv4 Unicast: advertised and received
Address family VPNv4 Multicast: advertised and received
Received 42 messages, 0 notifications, 0 in queue
Sent 35 messages, 0 notifications, 0 in queue
Route refresh request: received 0, sent 0
Default minimum time between advertisement runs is 5 seconds

For address family: IPv4 Unicast
BGP table version 1, neighbor version 1
Index 1, Offset 0, Mask0*2
0 accepted prefixes consume 0 bytes
Prefix advertised 2, suppressed 0, withdrawn 1
Number of NLRIs in the update sent: max 0, min 0

For address family: VPNv4 Unicast

---

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BGP table version 9, neighbor version 9
Index 2, Offset 0, Mask 0*4
Route-Reflector Client
2 accepted prefixes consume 120 bytes
Prefix advertised 13, suppressed 0, Withdrawn 1
Number of NLPIs in the update sent: max 4, min 0

Connections established 1; dropped 0
Last reset never
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Local host: 192.168.5.5, Local port: 179
Foreign host: 192.168.3.3, Foreign port: 11005

Enqueued packets for retransmit: 0, input: 0 mis-ordered: 0(0 bytes)
Event Timers (current time is 0*9FD74D0):

<table>
<thead>
<tr>
<th>Timer</th>
<th>Status</th>
<th>Wakeups</th>
<th>Next</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrans</td>
<td>37</td>
<td>2</td>
<td>0*0</td>
</tr>
<tr>
<td>Timerwait</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>AckHold</td>
<td>39</td>
<td>25</td>
<td>0*0</td>
</tr>
<tr>
<td>SendWnd</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>KeepAlive</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>GiveUp</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>PmtuAger</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>DeadWait</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
</tbody>
</table>

iss: 132927567 snduna: 1326928434 sndnxt: 1326928434 sndwnd: 16061
irs: 2956513634 rcvnxt: 29565108 rcvwnd: 16023 delrcvwnd: 361

SRTT: 297 ms, RTTO: 325 ms, RTV: 28 ms, KRTT: 0 ms
MinRTT: 16 ms, maxRTT: 300ms, ACK hold: 200ms
Flags: passive open, nagle, gen tcbs
Datagrams (max data segment is 536 bytes):
Rcvd: 160 (out of order: 0), with data: 39, total data bytes: 1473
Sent: 64 (retransmit: 2), with data: 34, total data bytes: 866

Technical Verification For Task F, G and H

r3#sh ip bgp neighbor
BGP neighbor is 172.16.100.6vrf VPNB, remote AS 65200, external link
BGP version 4, remote router ID 192.168.2.2
BGP state=Established, up for 00:10:29

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Last read 00:00:28, hold time is 180, keepalive internal is 60 seconds
Neighbor capabilities:
Route refresh: advertised and received (new)
Address family IPv4 Unicast: advertised and received
Received 14 messages, 0 notifications, 0 in queue
Sent 20 messages, 0 notifications, 0 in queue
Route refresh request: received 0, sent 0
Default minimum time between advertisement runs is 30 seconds

For address family: VPNv4 Unicast
Translation address family IPv4 Unicast for VRF VPNB
BGP table version 36, neighbor version 36
Index 2, Offset 0, Mask 0*4
1 accepted prefixes consume 60 bytes
Prefix advertised 7, suppressed 0, withdrawn 1
Number of NLRIs in the update sent: max 0, min 0

Connections established 1; dropped 0
Last reset never
Connection state is ESTAB, i/O status: 1, unread input bytes: 0
Local host: 172.16.100.5, Local port: 179
Foreign host: 172.16.100.6, Foreign port: 11000

Enqueued packets for retransmit: 0, input: 0 mis-ordered: 0(0 bytes)
Event Timers (current time is 0*9F4BFDF):

<table>
<thead>
<tr>
<th>Timer</th>
<th>Status</th>
<th>Wakeups</th>
<th>Next</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrans</td>
<td>14</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>Timerwait</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>AckHold</td>
<td>14</td>
<td>8</td>
<td>0*0</td>
</tr>
<tr>
<td>SendWnd</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>KeepAlive</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>GiveUp</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>PmtuAger</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>DeadWait</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
</tbody>
</table>

iss: 327159314 snduna: 327159923 sndnxt: 327159923 sndwnd: 15776
irs: 1252268830 rcvnxt: 1252269176 rcvwnd: 16058 delrcvwnd: 345

SRTT: 259 ms, RTTO: 579 ms, RTV: 320 ms, KRTT: 0 ms
MinRTT: 8 ms, maxRTT: 300ms, ACK hold: 200ms
Flags: passive open, nagle, gen tcbs

Datagrams (max data segment is 460 bytes):
Rcvd: 20 (out of order: 0), with data: 14, total data bytes: 627
Sent: 24 (retransmit: 0), with data: 14, total data bytes: 627

BGP neighbor is 172.16.100.11, remote AS 65300, internal link
BGP version 4, remote router ID 192.168.4.4
BGP state=Established, up for 01:30:11
Last read 00:00:10, hold time is 180, keepalive internal is 60 seconds
Neighbor capabilities:
Route refresh: advertised and received (new)
Address family IPv4 Unicast: advertised and received
Received 34 messages, 0 notifications, 0 in queue
Sent 40 messages, 0 notifications, 0 in queue
Route refresh request: received 0, sent 0
Default minimum time between advertisement runs is 30 seconds

For address family: VPNv4 Unicast
Translates address family IPv4 Unicast for VRF VPNC
BGP table version 36, neighbor version 36
Index 1, Offset 0, Mask 0*2
1 accepted prefixes consume 60 bytes
Prefix advertised 6, suppressed 0, withdrawn 1
Number of NLRIs in the update sent: max 0, min 0

Connections established 1; dropped 0
Last reset never
Connection state is ESTAB, i/O status: 1, unread input bytes: 0
Local host: 172.16.100.9, Local port: 11001
Foreign host: 172.16.100.11, Foreign port: 179

Enqueued packets for retransmit: 0, input: 0 mis-ordered: 0(0 bytes)
Event Timers (current time is 0*9F5B86F):

<table>
<thead>
<tr>
<th>Timer</th>
<th>Status</th>
<th>Wakeups</th>
<th>Next</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrans</td>
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<tr>
<td>Timerwait</td>
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<td>AckHold</td>
<td>34</td>
<td>16</td>
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<tr>
<td>SendWnd</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>KeepAlive</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>GiveUp</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>PmtuAger</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>DeadWait</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
</tbody>
</table>

iss: 427824235 snduna: 427825206 sndnxt: 427825206 sndwnd: 15414
irs: 3788376725 rcvnxt: 3788377432 rcvwnd: 15678 delrcvwnd: 706

SRTT: 298 ms, RTTO: 314 ms, RTV: 16 ms, KRTT: 0 ms
MinRTT: 12 ms, maxRTT: 300ms, ACK hold: 200ms
Flags: passive open, nagle, gen tcbs

Datagrams (max data segment is 1460 bytes):
Rcvd: 56 (out of order: 0), with data: 35, total data bytes: 725
Sent: 56(retransmit: 1), with data: 38, total data bytes: 989

BGP neighbor is 172.16.136.1, remote AS 65100, internal link
BGP version 4, remote router ID 192.168.1.1
BGP state=Established, up for 00:22:52
Last read 00:00:59, hold time is 180,keepalive internal is 60 seconds
Neighbor capabilities:
Route refresh: advertised and received (new)
Address family IPv4 Unicast: advertised and received
Received 38 messages, 0 notifications, 0 in queue
Sent 46 messages, 0 notifications, 0 in queue
Route refresh request: received 0, sent 0
Default minimum time between advertisement runs is 30 seconds

For address family: VPNv4 Unicast
Translate address family Ip4 Unicast for VRF VPNA
BGP table version 36, neighbor version 36
Index 3, Offset 0, Mask0*8
1 accepted prefixes consume 60 bytes
Prefix advertised 9, suppressed 0, withdrawn 0
Number of NLRIs in the update sent: max 1, min 0

Connections established 2; dropped 1
Last reset 00:24:07, due to peer closed the session
Connection state is ESTAB, i/O status: 1, unread input bytes: 0
Local host: 172.16.136.3, Local port: 179
Foreign host: 172.16.136.1, Foreign port: 11003

Enqueued packets for retransmit: 0, input: 0 mis-ordered: 0(0 bytes)
Event Timers (current time is 0*9F6A784):

<table>
<thead>
<tr>
<th>Timer</th>
<th>Status</th>
<th>Wakeups</th>
<th>Next</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrans</td>
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<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>Timerwait</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>AckHold</td>
<td>27</td>
<td>10</td>
<td>0*0</td>
</tr>
<tr>
<td>SendWnd</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>KeepAlive</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>GiveUp</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>PmtuAger</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>DeadWait</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
</tbody>
</table>
iss: 3446085663 snduna: 3446086425 sndnxt: 3446086425 sndwnd: 15623
irs: 943577652 rcvnxt: 943578226 rcvwnd: 15811 delrcvwnd: 573

SRTT: 293 ms, RTTO: 352 ms, RTV: 59 ms, KRTT: 0 ms
MinRTT: 0 ms, maxRTT: 300ms, ACK hold: 200ms
Flags: passive open, nagle, gen tcbs

Datagrams (max data segment is 1460bytes):
Rcvd: 44 (out of order: 0), with data: 27, total data bytes: 573
Sent: 38 (retransmit: 1), with data: 27, total data bytes: 761

BGP neighbor is 192.168.5.5, remote AS 100, internal link
BGP version 4, remote router ID 192.168.5.5
BGP state=Established, up for 01:25:37
Last read 00:00:37, hold time is 180, keepalive internal is 60 seconds
Neighbor capabilities:
Route refresh: advertised and received (new)
Address family IPv4 Unicast: advertised and received
Address family VPNv4 Multicast: advertised and received
Received 30 messages, 0 notifications, 0 in queue
Sent 37 messages, 0 notifications, 0 in queue
Route refresh request: received 0, sent 0
Default minimum time between advertisement runs is 5 seconds

For address family: IPv4 Unicast
BGP table version 1, neighbor version 1
Index 1, Offset 0, Mask 0*2
0 accepted prefixes consume 0 bytes
Prefix advertised 2, suppressed 0, withdrawn 1
Number of NLRIs in the update sent: max 0, min 0

For address family: VPNv4 Unicast
BGP table version 36, neighbor version 36
Index 4, Offset 0, Mask 0*10
Route-Reflector Client
2 accepted prefixes consume 120 bytes
Prefix advertised 8, suppressed 0, Withdrawn 1
Number of NLRIs in the update sent: max 1, min 0

Connections established 1; dropped 0
Last reset never
Connection state is ESTAB, i/O status: 1, unread input bytes: 0

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Local host: 192.168.3.3, Local port: 11005
Foreign host: 192.168.5.5, Foreign port: 179

Enqueued packets for retransmit: 0, input: 0 mis-ordered: 0(0 bytes)
Event Timers (current time is 0*472AFE):

<table>
<thead>
<tr>
<th>Timer</th>
<th>Status</th>
<th>Wakeups</th>
<th>Next</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrans</td>
<td>37</td>
<td>2</td>
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<tr>
<td>Timerwait</td>
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<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>AckHold</td>
<td>29</td>
<td>10</td>
<td>0*0</td>
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<tr>
<td>SendWnd</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>KeepAlive</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>GiveUp</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>PmtuAger</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>DeadWait</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
</tbody>
</table>

iss: 2956513634 snduna: 2956515013 sndnxt: 2956515013 sndwnd: 16118
irs: 1326927567 rcvnxt: 1326928339 rcvwnd: 16156 delrcvwnd: 228

SRTT: 297 ms, RTTO: 325 ms, RTV: 28 ms, KRTT: 0 ms
MinRTT: 20 ms, maxRTT: 300ms, ACK hold: 200ms
Flags: passive open, nagle, gen tcbs

Datagrams (max data segment is 536 bytes):
Rcvd: 53 (out of order: 0), with data: 29, total data bytes: 771
Sent: 48 (retransmit: 2), with data: 34, total data bytes: 1378

**Technical Verification For Task I**

r5#show ip bgp neighbor
BGP neighbor is 172.16.56.6, remote AS 65200, internal link
BGP version 4, remote router ID 192.168.6.6
BGP state=Established, up for 01:50:16
Last read 00:00:16, hold time is 180, keepalive internal is 60 seconds
Neighbor capabilities:
Route refresh: advertised and received (new)
Address family IPv4 Unicast: advertised and received
Received 54 messages, 0 notifications, 0 in queue
Sent 57 messages, 0 notifications, 0 in queue
Route refresh request: received 0, sent 0
Default minimum time between advertisement runs is 30 seconds

For address family: VPNv4 Unicast
Translate address family IPv4 Unicast for VRF VPNX

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BGP table version 9, neighbor version 9
Index 1, Offset 0, Mask0*2
1 accepted prefixes consume 60 bytes
Prefix advertised 4, suppressed 0, withdrawn 1
Number of NLRIs in the update sent: max 0, min 0

Connections established 1; dropped 0
Last reset never
Connection state is ESTAB, i/O status: 1, unread input bytes: 0
Local host: 172.16.56.5, Local port: 179
Foreign host: 172.16.56.6, Foreign port: 11000

Enqueued packets for retransmit: 0, input: 0 mis-ordered: 0(0 bytes)
Event Timers (current time is 0*A0D7920):

<table>
<thead>
<tr>
<th>Timer</th>
<th>Status</th>
<th>Wakeups</th>
<th>Next</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrans</td>
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<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>Timerwait</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>AckHold</td>
<td>54</td>
<td>26</td>
<td>0*0</td>
</tr>
<tr>
<td>SendWnd</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>KeepAlive</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>GiveUp</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>PmtuAger</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>DeadWait</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
</tbody>
</table>

iss: 657627338 snduna: 657628572 sndnxt: 657628572 sndwnd: 15151
irs: 3442780949 rcvnxt: 3442782032 rcvwnd: 15302 delrcvwnd: 1082

SRTT: 300 ms, RTTO: 303 ms, RTV: 3 ms, KRTT: 0 ms
MinRTT: 4 ms, maxRTT: 300ms, ACK hold: 200ms
Flags: passive open, nagle, gen tcbs

Datagrams (max data segment is 4430 bytes):
Rcvd: 88 (out of order: 0), with data: 54, total data bytes: 1082
Sent: 84 (retransmit: 0), with data: 57, total data bytes: 1233

BGP neighbor is 192.168.3.3, remote AS 100, internal link
BGP version 4, remote router ID 192.168.3.3
BGP state=Established, up for 01:49:05
Last read 00:00:04, hold time is 180, keepalive internal is 60 seconds
Neighbor capabilities:
Route refresh: advertised and received (new)
Address family IPv4 Unicast: advertised and received
Address family VPNv4 Multicast: advertised and received
Received 61 messages, 0 notifications, 0 in queue
Sent 54 messages, 0 notifications, 0 in queue
Route refresh request: received 0, sent 0
Default minimum time between advertisement runs is 5 seconds

For address family: IPv4 Unicast
BGP table version 1, neighbor version 1
Index 1, Offset 0, Mask 0*2
0 accepted prefixes consume 0 bytes
Prefix advertised 0, suppressed 0, withdrawn 0
Number of NLRIs in the update sent: max 0, min 0

For address family: VPNv4 Unicast
BGP table version 9, neighbor version 9
Index 2, Offset 0, Mask 0*4
Route-Reflector Client
2 accepted prefixes consume 120 bytes
Prefix advertised 2, suppressed 0, Withdrawn 0
Number of NLRIs in the update sent: max 2, min 0

Connections established 1; dropped 0
Last reset never
Connection state is ESTAB, i/O status: 1, unread input bytes: 0
Local host: 192.168.5.5, Local port: 179
Foreign host: 192.168.3.3, Foreign port: 11005

Enqueued packets for retransmit: 0, input: 0 mis-ordered: 0(0 bytes)
Event Timers (current time is 0*A0E7860):

<table>
<thead>
<tr>
<th>Timer</th>
<th>Status</th>
<th>Wakeups</th>
<th>Next</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrans</td>
<td>55</td>
<td>2</td>
<td>0*0</td>
</tr>
<tr>
<td>Timerwait</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>AckHold</td>
<td>57</td>
<td>38</td>
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<tr>
<td>SendWnd</td>
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</tr>
<tr>
<td>KeepAlive</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>GiveUp</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>PmtuAger</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
<tr>
<td>DeadWait</td>
<td>0</td>
<td>0</td>
<td>0*0</td>
</tr>
</tbody>
</table>

iss: 1326927567 snduna: 1326928776 sndnxt: 1326928776 sndwnd: 16270
irs: 2956513634 rcvnxt: 2956515450 rcvwnd: 16232 delrcvwnd: 152

SRTT: 300 ms, RTTO: 303 ms, RTV: 3 ms, KRTT: 0 ms
MinRTT: 16 ms, maxRTT: 300 ms, ACK hold: 200 ms
Flags: passive open, nagle, gen tcbs

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Datagrams (max data segment is 536 bytes):
Rcvd: 86 (out of order: 0), with data: 58, total data bytes: 1834
Sent: 98 (retransmit: 2), with data: 53, total data bytes: 1227

The routing tables of all router are included here. The legend normally in router output has been deleted.

Router 1

r1#show ip route
    172.16.0.0/16 is variably subnetsed, 3 subnets, 3 masks
    C 172.16.136.0/26 is directly connected, Ethernet0/0
    B 172.16.100.8/29[20/0] via 172.16.136.3, 00:50:39
    B 172.16.100.4/30[20/0] via 172.136.3, 00:50:39
    192.168.4.0/32 is subnetted, 1 subnets
    B 192.168.4.4[20/0] via 172.16.136.3, 00:50:39
    C 192.168.1.1 is directly connected, Loopback0
    192.168.2.0/32 is subnetted, 1 subnets
    B 192.168.2.2[20/0] via 172.16.136.3, 00:39:38

Router 2

r2#show ip route
    172.16.0.0/16 is variably subnetsed, 4 subnets, 3 masks
    B 172.16.136.0/26[20/0] via 172.16.100.5, 00:40:49
    B 172.16.56.4/30[20/0] via 172.16.100.5, 00:40:49
    B 172.16.100.8/29[20/0] via 172.16.100.5, 00:40:49
    C 172.16.100.4/30 is directly connected, Serial1/0.1
    192.168.4.0/32 is subnetted, 1 subnets
    B 192.168.4.4[20/0] via 172.16.100.5, 00:40:49
    B 192.168.1.0/32 is subnetted, 1 subnets
    B 192.168.1.1[20/0] via 172.16.100.5, 00:40:49
    B 192.168.2.0/32 is subnetted, 1 subnets
    C 192.168.2.2 is directly connected, Loopback0

Router 3

r3#show ip route
172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C  172.16.35.1/32 is directly connected, Serial1/3
C  172.16.35.0/30 is directly connected, Serial1/3
192.16.5.0/32 is subnetworked, 1 subnets
O  192.168.5.5[110/782] via 172.16.35.2, 00:54:02, Serial1/3
C  192.168.3.0/32 is subnetworked, 1 subnets
C  192.168.3.3 is directly connected, Loopback0

**Router 4**

r4#show ip route

172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
B  172.16.136.0/29[20/0] via 172.16.100.9, 01:00:53
C  172.16.100.8/29 is directly connected, Serial0/0.1
B  172.16.100.4/30[20/0] via 172.16.100.9, 01:00:53
192.168.4.0/32 is subnetworked, 1 subnets
C  192.168.4.4 is directly connected, Loopback0
192.168.1.0/32 is subnetworked, 1 subnets
B  192.168.1.1[20/0] via 172.16.100.9, 00:52:44
192.168.2.0/32 is subnetworked, 1 subnets
B  192.168.2.2[20/0] via 172.16.100.9, 00:41:44

**Router 5**

r5#show ip route

172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C  172.16.35.1/32 is directly connected, Serial0/0
C  172.16.35.0/30 is directly connected, serial0/0
192.168.5.0/32 is subnetworked, 1 subnets
C  192.168.5.5 is directly connected, Loopback0
192.168.3.0/32 is subnetworked, 1 subnets
C  192.168.3.3[110/49] via 172.16.35.1, 00:54:46, serial0/0

**Router 6**

r6#sh ip route

172.16.0.0/30 is subnetworked, 2 subnets
C  172.16.56.4 is directly connected, ATM1/0.32
B  172.16.100.4[20/0] via 172.16.56.5, 00:54:46
192.168.6.0/32 is subnetworked, 1 subnets
C  192.168.6.6 is directly connected, Loopback0

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192.168.2.0/32 is subnetted, 1 subnets

B 192.168.2.2[20/0] via 172.16.56.5, 00:42:38

Configuration Verification

*Only relevant portions of the configuration have been included.*

**Router 1**

```
 r1#sh run
 interface Loopback0
  ip address 192.168.1.1 255.255.255.255
  
 interface Ethernet0/0
  ip address 172.16.136.1 255.255.255.192
  half-duplex

 router bgp 65100
  bgp log-neighbor-changes
  network 192.168.1.1 mask 255.255.255.255
  neighbor 172.16.136.3 remote-as 100
```

**Router 2**

```
 r2#sh run
 interface Loopback0
  ip address 192.168.2.2 255.255.255.255

  interface Serial1/0
  no ip address encapsulation frame-relay
  no frame-relay inverse-arp
  
  interface serial1/0.1 point-to-point
  ip address 172.16.100.6 255.255.255.252
  frame-relay interface-dlci 223
  router bgp 65200
  bgp log-neighbor-changes
  network 192.168.2.2 mask 255.255.255.255
  neighbor 172.16.100. remote-as 100
```

**Router 3**

```
 r3#sh run

  ip vrf VPNA
  description VPNA
  rd 100:100
```

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route-target export 100:1
route-target import 100:2
route-target import 100:3
!
ip vrf VPNB
description VPNB
rd 100:200
route-target export 100:2
route-target import 100:1
route-target import 100:3
route-target import 100:999
!
ip vrf VPNC
description VPNC
rd 100:300
route-target export 100:3
route-target import 100:1
route-target import 100:2

ip cef
tag-switching tdp router-id Loopback0

interface Loopback0
ip address 192.168.3.3 255.255.255.255
!
interface Ethernet0/0
ip vrf forwarding VPNA
ip address 172.16.136.3 255.255.255.192
half-duplex

interface serial1/0
no ip address
encapsulation frame-relay
no fair-queue
no frame-relay inverse-arp
!
interface Serial1/0.1 point-to-point
ip vrf forwarding VPNB
ip address 172.16.100.5 255.255.255.252
ip ospf priority 255
frame-relay interface-dlci 332

interface serial1/0.2 point-to-point
ip vrf forwarding VPNC

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ip address 172.16.100.9 255.255.255.248
ip ospf network point-to-point
frame-relay interface-dlci 344

interface Serial1/3
ip address 172.16.35.1 255.255.255.252
encapsulation ppp
tag-switching ip
clockrate 64000

router ospf 1
log-adjacency-changes
passive-interface Loopback0
network 172.16.35.0.0.0.0 area 0
network 192.168.3.3.0.0.0.0 area 0

router bgp 100
bgp log-neighbor-changes
neighbor 192.168.5.5 remote-as 100
neighbor 192.168.5.5 update-source Loopback0

address-family ipv4 VPNC
redistribute connected
neighbor 172.16.100.11 remote-as 65300
neighbor 172.16.100.11 activate
no auto-summary
no synchronization
exit-address-family

address-family ipv4 vrf VPNB
redistribute connected
neighbor 172.16.100.6 remote-as 65200
neighbor 172.16.100.6 activate
no auto-summary
no synchronization
exit-address-family

address-family ipv4 vrf VPNA
redistribute connected
neighbor 172.16.136.1 remote-as 65100
neighbor 172.16.136.1 activate
no auto-summary
no synchronization
exit-address-family
Router 4
r4#sh run

interface Loopback0
ip address 192.4.4 255.255.255.255

interface Serial0/0
no ip address
encapsulation frame-relay
no frame-relay inverse-arp
!
interface Serial0/0.1 point-to-point
ip address 172.16.100.11 255.255.255.248
frame-relay interface-dlci 443

Router 5
r5#sh run

ip vrf VPNX
description VPNX
rd 100:999
route-target export 100:999
route-target import 100:2

ip cef
tag-switching tdp router-id Loopback0

interface Loopback0
ip address 192.168.5.5 255.255.255.255

interface Serial0/0
ip address 192.16.35.2 255.255.255.252
encapsulation ppp
tag-switching ip
no fair-queue

interface ATM1/0
no ip address
no atm-keepalive
!
interface ATM1/0.32 multipoint
ip vrf forwarding VPNX
ip address 172.16.56.5 255.255.255.252

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ip ospf network point-to-point
pvc 0/32
protocol ip 172.16.56.6 broadcast
capsulation aal5mux ip

router ospf 1
log-adjacency-changes
passive-interface Loopback0
network 172.16.35.0.0.0.0.3 area 0
network 192.168.5.5.0.0.0.0 area
!
router bgp 100
bgp log-neighbor-changes
neighbor 192.168.3.3 remote-as 100
neighbor 192.168.3.3 update-source Loopback0

address-family ipv4 vrf VPNX
redistribute connected
neighbor 172.16.56.6 remote-as 65200
neighbor 172.16.56.6 activate
no auto-summary
no synchronization
exit-address-family
!
address-family vpnv4
neighbor 192.168.3.3 activate
neighbor 192.168.3.3 send-community both

Router 6
r6#sh run
interface Loopback0
ip address 192.168.6.6 255.255.255.255
no ip directed-broadcast

interface ATM1/0
no ip address
no ip directed-broadcast
no atm imli-keepalive
!
interface ATM1/0.32 multipoint
ip address 172.16.56.6 255.255.255.252
no ip directed-broadcast
ip ospf network point-to-point
pvc 0/32
Protocol ip 172.16.56.5 broadcast
Encapsulation aal5mux ip

Interface Ethernet2/0
Ip address 10.26.6 255.255.254.0
No ip directed-broadcast

Router bgp 100
Bgp-log-neighbor-changes
Network 10.2.6.0 mask 255.255.254.0
Network 192.168.6.6 mask 255.255.255.255
Neighbor 172.16.56.5 remote-as 100
Neighbor 172.16.56.5 allows-in 2

LA1010

Ls10#sh run
Interface ATM0/0/1
No ip address
No ip directed-broadcast
No atm-ilmi-keepalive
Atm pvc 0 32 interface ATM0/0/0 0 32
Lab Preparation Scenario - Committed Access Rate (CAR)

Topics Covered

- Rate Limiting
- Taken Bucket
- Access Lists
- Settings QoS Values and Diff-Serv

Standard Topology

Standard TCP/IP Addressing and SPID Information

**R1 (3620)**

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address/Netmask</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.1.1/24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E/0/0</td>
<td>172.16.136.1/26</td>
<td>Ethernet Segment to Catalyst 3/1</td>
</tr>
<tr>
<td>T0/0</td>
<td>172.16.15.1/28</td>
<td>Token ring Segment to 3920</td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.31.1/30</td>
<td>Serial to R3</td>
</tr>
<tr>
<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

**R2 (3620)**

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address/Netmask</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.2.2/24</td>
<td>Loopback</td>
</tr>
</tbody>
</table>

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### CCIE LAB

<table>
<thead>
<tr>
<th>T0/0</th>
<th>172.16.2.2/24</th>
<th>Token Ring segment to 3920</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR1/0</td>
<td>172.16.230.2/24</td>
<td>BRI to R3</td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.32.2/24</td>
<td>Serial to R3</td>
</tr>
<tr>
<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

**R3 (2610)**

<table>
<thead>
<tr>
<th>Loop0</th>
<th>192.168.2.2/24</th>
<th>Loopback</th>
</tr>
</thead>
<tbody>
<tr>
<td>E0/0</td>
<td>172.16.136.3/26</td>
<td>Ethernet Segment to Catalyst 3/3</td>
</tr>
<tr>
<td>BR1/0</td>
<td>172.16.230.3/24</td>
<td>ISDN toR2</td>
</tr>
<tr>
<td>S1/3</td>
<td>172.16.35.1/30</td>
<td>Serial to R5</td>
</tr>
<tr>
<td>S1/2</td>
<td>172.16.32.3/24</td>
<td>Serial to R2</td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.31.2/30</td>
<td>Serial to R1</td>
</tr>
<tr>
<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

**R4 (2610)**

<table>
<thead>
<tr>
<th>Loop0</th>
<th>192.168.4.4/24</th>
<th>Loopback</th>
</tr>
</thead>
<tbody>
<tr>
<td>E0/0</td>
<td>10.1.4.4/22</td>
<td>Ethernet Segment to Catalyst 3/5</td>
</tr>
<tr>
<td>S0/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

**R5 (3620)**

<table>
<thead>
<tr>
<th>Loop0</th>
<th>192.168.5.5/24</th>
<th>Loopback</th>
</tr>
</thead>
<tbody>
<tr>
<td>E0/0</td>
<td>172.16.136.5/26</td>
<td>Ethernet Segment to Catalyst 3/5</td>
</tr>
<tr>
<td>T0/0</td>
<td>172.16.15.5/28</td>
<td>Token Ring segment to 3920</td>
</tr>
<tr>
<td>S0/0</td>
<td>172.16.35.2/30</td>
<td>Serial link to R3</td>
</tr>
<tr>
<td>A1/0</td>
<td>172.16.56.5/30</td>
<td>ATM-R6</td>
</tr>
</tbody>
</table>

**R6 (3640)**

<table>
<thead>
<tr>
<th>Loop0</th>
<th>192.168.6.6/24</th>
<th>Loopback</th>
</tr>
</thead>
<tbody>
<tr>
<td>FA0/0</td>
<td>172.16.136.6/26</td>
<td>Ethernet segment-R2</td>
</tr>
<tr>
<td>E2/0</td>
<td>10.2.6.6/23</td>
<td>Ethernet segment-BB2</td>
</tr>
<tr>
<td>A1/0</td>
<td>172.16.56.6/30</td>
<td>ATM-R5</td>
</tr>
</tbody>
</table>

**ISDN Information**

<table>
<thead>
<tr>
<th>Switch Type</th>
<th>Basic-NI 1</th>
</tr>
</thead>
</table>

**R2**

<table>
<thead>
<tr>
<th>SPID1:</th>
<th>422555012101</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPID2:</td>
<td>422555012201</td>
</tr>
</tbody>
</table>

**R3**

<table>
<thead>
<tr>
<th>SPID1:</th>
<th>422555013101</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPID2:</td>
<td>422555013201</td>
</tr>
</tbody>
</table>

**Technical Tasks**

A. Configure the addressing from the list above. In this Lab you will use PPP link from R3 and R5 and the Ethernet Link from R1 to R3. You should also configure the appreciate loopback on each of these routers.

B. Configure EIGRP on R1, R3 and R5. Use 100. All interfaces on R1, R3 and R5 must be reachable from all other routers. Test this by pinging all the loopbacks.
C. Configure in S1/3 on R3 to limit ICMP traffic from the loopback on R5 to the loopback on R1 to 8000 Bits per second. Transmit all packets that match and drop all packets that exceed. Configure a second statement that would permit any udp traffic from any source and destination with 16000 Bits Per second, transmit all packets that conform and drop any that exceed.

D. Configure R5 so that any egress traffic from S0/0 will not exceed 32000 Bits Per second. Use 1.5 seconds for the tc value in the Normal Burst and two times the Normal Burst value for Excess Burst.

E. Configure Ethernet 0/0 on R3 to limit the following. Any traffic from the MAC address of R1’s Ethernet0/0 should be limited to 8MB. Configure any web traffic R3 to 5 MB, configure any tftp traffic to 2MB and configure any traffic with a prudence of 5 to 1MB.

All subnets/interfaces that particularly in routing must be reachable from all routers.

Instructor’s comments and Technical Tips

A. N/A
B. Don’t forget to include a network statement for the loopback interfaces.
C. When you configure CAR remember that the bandwidth is in bits and the burst values are configure in bytes.
D. If you use multiple statements on an interface it will drop out when it matches a statement. If you want to inspect using multiple statement you should use the continue command instead of the transmit command.
E. When you match a mac-address you must use the access-list-rate-limit command.

Technical Verification

Task A and B

r1#sh ip route
Codes: C- connected, S- static, I- Igrp, 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, E- EGP
    i-ISIS, L1- 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

   172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
C   172.16.136.0/26 is directly connected, Ethernet0/0
D   172.16.35.2/32[90/20537600] via 172.16.136.3, 01:17:23, Ethernet0/0
D   172.16.35.0/30[90/20537600] via 172.16.136.3, 01:17:23, Ethernet0/0
   192.168.5.0/32 is subnetted, 1 subnets
D   192.168.5.5[90/20665600] via 172.16.136.3, 01:17:19, Ethernet0/0
   192.168.1.0/32 is subnetted, 1 subnets

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r1#sh in e0/0
Ethernet0/0 is up, line protocol is up
    Hardware is AmdP2, address is 0002.1651.eb61 (bia 0002.1651.eb61)
    Internet address 172.16.136.1/26
    MTU 1500 bytes, BW 10000Kbit, DLY 1000 usec,
        Reliability 255/255, txload 1/255, rxload 1/255
    Encapsulation ARPA, loopback not set
    Keepalive set (10 sec)
    ARP type: ARPA, ARP Timeout 04:00:00
    Last input 00:00:02, output 00:00:03, output hang never
    Last clearing of “show interface” counters never
    Queueing strategy: fifo
    Output queue: 0/40, 0 drops; input queue 0/75, 0 drops
    5 minute input rate 0 bits/sec, 0 packets/sec
    5 minute output rate 0 bits/sec, 0 packets/sec
        63667 packets input, 5143277 bytes, 0 no buffer
        Received 1811 broadcasts, 0 runts, 0 giants, 0 throttles
        0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
        0 input packets with dribble condition detected
        66392 packets output, 21859152 bytes, 0 underruns(1/0/0)
        0 output errors, 1 collisions, 3 interface resets
        0 babbles, 0 late collision, 6 deferred
        0 lost carrier, 0 no carrier
        0 output buffer failures, 0 output buffers swapped out

r3#sh ip route
Codes: C- connected, S- static, I- Igrp, 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, E- EGP
    i-IS-IS, L1- 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

    172.16.0/16 is variably subnetted, 3 subnets, 3 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
C 172.16.136.2/32 is directly connected, Serial1/3
C 172.16.135.0/30 is directly connected, serial1/3
192.168.5.0/32 is subnetted, 1 subnets
D 192.168.5.5[90/20640000] via 172.16.35.2, 01:17:39, Serial1/3
192.168.1.0/32 is subnetted, 1 subnets
D 192.168.1.1[90/409600] via 172.16.136.1, 01:18:15, Ethernet0/0
192.168.3.0/32 is subnetted, 1 subnets
C 192.168.3.3 is directly connected, Loopback0

r3#sh in e0/0
Ethernet0/0 is up, line protocol is up
   Hardware is AmdP2, address is 0002.b92a.c920 (bia 0002.b92a.c920)
   Internet address 172.16.136.3/26
   MTU 1500 bytes, BW 10000Kbit, DLY 1000 usec,
       Reliability 255/255, txload 1/255, rxload 1/255
   Encapsulation ARPA, loopback not set
   Keepalive set (10 sec)
   ARP type: ARPA, ARP Timeout 04:00:00
   Last input 00:00:01, output 00:00:03, output hang never
   Last clearing of “show interface” counters never
   Queueing strategy: fifo
   Output queue: 0/40, 0 drops; input queue 0/75, 0 drops
   5 minute input rate 0 bits/sec, 0 packets/sec
   5 minute output rate 0 bits/sec, 0 packets/sec
       65869 packets input, 21773164 bytes, 0 no buffer
       Received 18921 broadcasts, 0 runs, 0 giants, 0 throttles
       0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
       0 input packets with dribble condition detected
       64569 packets output, 5264804 bytes, 0 underruns(0/0/0)
       0 output errors, 0 collisions, 2 interface resets
       0 babbles, 0 late collision, 5 deferred
       0 lost carrier, 0 no carrier
       0 output buffer failures, 0 output buffers swapped out

r3#sh in e0/0
Ethernet0/0 is up, line protocol is up
   Hardware is AmdP2, address is 0002.b92a.c920 (bia 0002.b92a.c920)
   Internet address 172.16.136.3/26
   MTU 1500 bytes, BW 10000Kbit, DLY 1000 usec,
       Reliability 255/255, txload 1/255, rxload 1/255
   Encapsulation ARPA, loopback not set
   Keepalive set (10 sec)
   ARP type: ARPA, ARP Timeout 04:00:00
   Last input 00:00:01, output 00:00:03, output hang never
   Last clearing of “show interface” counters never
   Queueing strategy: fifo
Output queue: 0/40, 0 drops; input queue 0/75, 0 drops
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
 65869 packets input, 21773164 bytes, 0 no buffer
Received 18921 broadcasts, 0 runts, 0 giants, 0 throttles
 0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
 0 input packets with dribble condition detected
64569 packets output, 5264804 bytes, 0 underruns(1/0/0)
 0 output errors, 0 collisions, 2 interface resets
 0 babbles, 0 late collision, 5 deferred
 0 lost carrier, 0 no carrier
 0 output buffer failures, 0 output buffers swapped out

r5#sh ip route
Codes: C- connected, S- static, I- Igrp, 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, E- EGP
i-IS-IS, L1- 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

    172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
 D  172.16.136.0/26 [90/1787392] via 172.16.35.1, 01:28:03, Serial0/0
 C   172.16.35.1/32 is directly connected, Serial0/0
 C  172.16.35.0/30 is directly connected, Serial0/0
  192.168.5.0/30 is subnetted, 1 subnets
 C     192.168.5.5 is directly connected, Loopback0
 C  192.168.1.0/32 is subnetted, 1 subnets
 D    192.168.1.1 [90/1915392] via 172.16.35.1, 01:28:03, Serial0/0
    192.168.3.0/32 is subnetted, 1 subnets
 D    192.168.3.3 [90/1889792] via 172.16.35.1, 01:28:04, Serial0/0

r5#sh in s0/0
Serial0/0 is up, line protocol is up
  Hardware is QUICC Serial
   Internet address 172.16.35.2/30
    MTU 1500 bytes, BW 2048Kbit, DLY 20000 usec,
     Reliability 255/255, txload 1/255, rxload 1/255
   Encapsulation PPP, loopback not set
   Keepalive set (10 sec)
   LCP Open
   Open: IPCP, CDPCP
Last input 00:00:02, output 00:00:02, output hang never
Last clearing of “show interface” counters 01:29:50
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: weighted fair
Output queue: 0/1000/64/0 (size/max total/threshold/drops)
Conversations 0/1/256 (active/max active/max total)
Reserved Conversations 0/0 (allocated/max allocated)
Available bandwidth 1536 kilobits/sec
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
23751 packets input, 2433115 bytes, 0 no buffer
Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
23754 packets output, 2433697 bytes, 0 underruns
0 output errors, 0 collisions, 2 interface resets
0 babbles, 0 late collision, 5 deferred
0 lost carrier, 0 no carrier
0 output buffer failures, 0 output buffers swapped out
0 carrier transitions
DCP=up DSR=up DTR=up RTS=up CTS=up

Task C
r5#sh in s0/0 rate-limit
Serial0/0
Output
Matches: all traffic
params: 32000 bps, 6000 limit, 12000 extended limit
conformed 11591 packets, 4350635 bytes; action: transmit
exceeded 259 packets, 115334 bytes; action: drop
last packet: 228ms ago, current burst: 1004 bytes
last cleared 00:23:43 ago, conformed 24000 bps, exceeded 0 bps

Task D
r3#sh access-lists
rate-limit access list 125
  0002.1651.EB61
Extended IP access list 100
  Permit icmp host 192.168.5.5 host 192.168.1.1 (1798 matches)
Extended IP access list 101
  Permit udp any any
Extended IP access list 150
  Permit tcp any any eq www (2 matches)
Extended IP access list 151
  Permit udp any any eq tftp (2 matches)
Extended IP access list 152
   Permit ip any any precedence critical

r3#sh interface s1/3 rate-limit
Serial1/3
Input
   Matches: access-group 100
      params: 8000 bps, 1500 limit, 3000 extended limit
         conformed 1734 packets, 180336 bytes; action: transmit
         exceeded 64 packets, 6656 bytes; action: drop
      last packet: 7717524ms ago, current burst: 1839 bytes
      last cleared 02:46:27 ago, conformed 0 bps, exceeded 0 bps
   Matches: access-group 101
      params: 16000 bps, 2000 limit, 4000 extended limit
         conformed 0 packets, 0 bytes; action: transmit
         exceeded 0 packets, 0 bytes; action: drop
      last packet: 10882492ms ago, current burst: 0 bytes
      last cleared 02:46:27 ago, conformed 0 bps, exceeded 0 bps

Task E

r3#sh access-lists
pat-e-limit access list 125
    0002.1651.EB61
Extended IP access list 100
   Permit icmp host 192.168.5.5 host 192.168.1.1 (1798 matches)
Extended IP access list 101
   Permit udp any any
Extended IP access list 150
   Permit tcp any any eq www (2 matches)
Extended IP access list 151
   Permit udp any any eq tftp (2 matches)
Extended IP access list 152
   Permit ip any any precedence critical

r3#sh interfaces e0/0 rate-limit
Ethernet0/0
Input
   Matches: access-group 150
      params: 5000000 bps, 937500 limit, 1875000 extended limit
         conformed 2 packets, 116 bytes; action: transmit
         exceeded 0 packets, 0 bytes; action: drop
      last packet: 9359460ms ago, current burst: 0 bytes
      last cleared 02:47:44 ago, conformed 0 bps, exceeded 0 bps
matches: access-group 151
  params: 2000000 bps, 250000 limit, 500000 extended limit
  conformed 2 packets, 116 bytes; action: transmit
  exceeded 0 packets, 120 bytes; action: drop
  last packet: 5468545ms ago, current burst: 0 bytes
  last cleared 02:46:31 ago, conformed 0 bps, exceeded 0 bps
matches: access-group 152
  params: 1000000 bps, 250000 limit, 500000 extended limit
  conformed 0 packets, 0 bytes; action: transmit
  exceeded 0 packets, 0 bytes; action: drop
  last packet: 11547358ms ago, current burst: 0 bytes
  last cleared 02:45:41 ago, conformed 0 bps, exceeded 0 bps
matches: access-group rate-list 125
  params: 8000000 bps, 150000 limit, 300000 extended limit
  conformed 3 packets, 222 bytes; action: transmit
  exceeded 0 packets, 0 bytes; action: drop
  last packet: 3265ms ago, current burst: 0 bytes
  last cleared 00:00:16 ago, conformed 0 bps, exceeded 0 bps

Configuration Verification
Only relevant of the configuration have been included.

Router 1
  Interface Loopback0
  Ip address 192.168.1.1 255.255.255.255
  !
  interface Ethernet0/0
  ip address 172.16.136.1 255.255.255.192
  half-duplex
  
  router eigrp 100
  network 172.16.0.0
  network 192.168.1.0
  no auto-summary
  no eigrp log-neighbor-changes

Router 3
  Interface Loopback0
  Ip address 192.3.3 255.255.255.255
  !
  interface Ethernet0/0
  ip address 172.16.136.3 255.255.255.192
  rate-limit input access-group 150 5000000 937500 1875000 conform-action transmit exceed-action drop

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rate-limit input access-group 151 2000000 250000 500000 conform-action transmit exceed-action drop
rate-limit input access-group 152 1000000 125000 250000 conform-action transmit exceed-action drop
rate-limit input access-group rate-limit 125 8000000 1500000 3000000 conform-action transmit exceed-action drop
half-duplex

interface Serial1/3
ip address 172.16.35.1 255.255.255.252
rate-limit input access-group 100 8000 1500 3000 conform-action transmit exceed-action drop
rate-limit input access-group 101 16000 2000 4000 conform-action transmit exceed-action drop
encapsulation ppp
clockrate 64000

! router eigrp 100
network 172.16.0.0
network 192.168.3.0
no auto-summary
no eigrp log-neighbor-changes

! ip kerberos source any
ip classless
no ip http server

! access-list 100 permit icmp host 192.168.5.5 host 192.168.1.1
access-list 101 permit udp any any
access-list 150 permit tcp any any eq www
access-list 151 permit udp any any tftp
access-list 152 permit ip any any precedence critical
access-list rate-limit 125 0002.1651.eb61

Router 5

Interface Loopback0
Ip address 192.168.5.5 255.255.255.255

! interface Ethernet0/0
no ip address
shutdown
half-duplex

! interface Serial0/0
ip address 172.16.35.2 255.255.255.252
rate-limit output 32000 6000 12000 conform-action transmit exceed-action drop
encapsulation ppp

router eigrp 100
network 172.16.0.0
network 192.168.5.0
no auto-summary
no eigrp log-neighbor-changes
Lab Preparation Scenario - Congestion Avoidance

Topics Covered

- Random Detect
- Weighted Random Detect
- Weighted Fair Queue

Difficulty Level: CCIE
Average Completion Time: 2 to 3 Hours

Standard Topology

Standard TCP/IP Addressing and SPID Information

**R1 (3620)**
- Loop0 192.168.1.1/24 Loopback
- E/0/0 172.16.136.1/26 Ethernet Segment to Catalyst 3/1
- T0/0 172.16.15.1/28 Token ring Segment to 3920
- S1/1 172.16.31.1/30 Serial to R3
- S1/0 unassigned Frame-relay

**R2 (3620)**
- Loop0 192.168.2.2/24 Loopback

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### CCIE LAB

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address/Netmask</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>T0/0</td>
<td>172.16.2.2/24</td>
<td>Token Ring segment to 3920</td>
</tr>
<tr>
<td>BR10/0</td>
<td>172.16.230.2/24</td>
<td>BRI to R3</td>
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<td>S1/1</td>
<td>172.16.32.2/24</td>
<td>Serial to R3</td>
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<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
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</tbody>
</table>

**R3 (2610)**
- Loop0: 192.168.2.2/24  Loopback
- E0/0: 172.16.136.3/26  Ethernet Segment to Catalyst 3/3
- BR10/0: 172.16.230.3/24  ISDN to R2
- S1/3: 172.16.35.1/30  Serial to R5
- S1/2: 172.16.32.3/24  Serial to R2
- S1/1: 172.16.31.2/30  Serial to R1
- S1/0: unassigned  Frame-relay

**R4 (2610)**
- Loop0: 192.168.4.4/24  Loopback
- E0/0: 10.1.4.4/22  Ethernet Segment to Catalyst 3/5
- S0/0: unassigned  Frame-relay

**R5 (3620)**
- Loop0: 192.168.5.5/24  Loopback
- E0/0: 172.16.136.5/26  Ethernet Segment to Catalyst 3/5
- T0/0: 172.16.15.5/28  Token Ring segment to 3920
- S0/0: 172.16.35.2/30  Serial link to R3
- A1/0: 172.16.56.5/30  ATM-R6

**R6 (3640)**
- Loop0: 192.168.6.6/24  Loopback
- FA0/0: 172.16.136.6/26  Ethernet segment-R2
- E2/0: 10.2.6.6/23  Ethernet segment-BB2
- A1/0: 172.16.56.6/30  ATM-R5

#### ISDN Information
- Switch Type: Basic-NI 1

#### R2
- SPID1: 42255501210101
- SPID2: 42255501220101

#### R3
- SPID1: 42255501310101
- SPID2: 42255501320101

#### Technical Tasks

A. Configure the IP of the interface between R1, R3 and R5. Configure random detect on the interface between R5-R3

B. Configure Weighted Random Early Detect on S1/3 on R5 and S0/0 on R3. Configure Precedence 0 to for a minimum threshold of 100 packets and a maximum threshold of 200 packets. Configure Precedence 5 for a minimum threshold of 100 packets and a maximum threshold of 300 packets.

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C. Configure the E0/0 on R3 to support Random Detect. Configure the weight used for queue depth to 11.
D. Configure WFQ on R1 E0/0. Configure the interface to randomly drop any www packets, the reserved bandwidth should be 40 percent. Configure the default class to reserve the remaining 35% but do not enable RED.

All subnets/interface that participate in routing must be reached from all routers.

Instructor’s Comments and Technical Tips
A. Use the random-detect command on the interface. This now becomes the default queuing for that interface.
B. In this case we will be using Precedence to mark the packet drop probability. Typically this would be configured in the core of the network and packets would have been marked at the edge.
C. Configure the class-map and policy map first. The bandwidth can be expressed as a number or as a percent. By default are only able to reserve 75 percent of the total of the interface.

Technical Verification

Task A
r1#sh in e0/0
Ethernet0/0 is up, line protocol is up
Hardware is Amdp2, address is 0002.1651.eb61 (bia 0002.1651.eb61)
Internet address 172.16.136.1/26
MTU 1500 bytes, BW 10000Kbit, DLY 1000 usec,
   Reliability 255/255, txload 1/255, rxload 1/255
Encapsulation ARPA, loopback not set
Keepalive set (10 sec)
ARP type: ARPA, ARP Timeout 04:00:00
Last input 00:00:02, output 00:00:03, output hang never
Last clearing of “show interface” counters never
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queuing strategy: weighted fair
Output queue: 0/1000/64/0 (size/max total/threshold/drops)
   Conversations 0/0/256 (active/max active/max total)
   Reserved Conversations 2/2 (allocated/max allocated)
Available bandwidth 75000 kilobits/sec
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
   79594 packets input, 10709277 bytes, 0 no buffer
   Received 7402 broadcasts, 0 runts, 0 giants, 0 throttles
   0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
   0 input packets with dribble condition detected
   99684 packets output, 28632745 bytes, 0 underruns(2/2/0)
   0 output errors, 4 collisions, 4 interface resets
0 babbles, 0 late collision, 16 deferred
0 lost carrier buffer failures, 0 output buffers swapped out

**Task B**
r3#sh queuing interface s1/3

Interface Serial1/3 queuing strategy: random early detection (WRED)
Exp-weight-constant: 9 (1/512)
Mean queue depth: 0

<table>
<thead>
<tr>
<th>Class (Prec)</th>
<th>Random drop pkts/bytes</th>
<th>Tail drop pkts/bytes</th>
<th>Minimum threshold</th>
<th>Maximum threshold</th>
<th>Mark probability</th>
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**Task C**
r3#sh queuing interface e0/0

Interface Ethernet0/0 queuing strategy: random early detection (WRED)
Exp-weight-constant: 11 (1/2048)
Mean queue depth: 0

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Task D
R1#sh class-map
Class Map match-all WRED (id 2)
Match access-group 150

Class Map match-any class-default (id 0)
Match any
R1#sh policy-map WRED
Policy Map WRED
Class WRED
Weighted Fair Queuing
  Bandwidth 40(%) Exponential weight 9
  Class  min-threshold  max-threshold  mark-probability
  0    -            -            1/10
  1    -            -            1/10
  2    -            -            1/10
  3    -            -            1/10
  4    -            -            1/10
  5    -            -            1/10
  6    -            -            1/10
  7    -            -            1/10
rsvp -            -            1/10
Class class-default
Weighted Fair Queuing
  Bandwidth 35 (%) Max Threshold 64 (packets)

Configuration Verification

Only relevant portions of the configuration have been included.

Router 1
  Class-map match- all WRED
  Match access-group 150
  !
  !
policy-map WRED
class WRED
bandwidth percent 40
random-detect
class class-default
bandwidth percent 35

interface Ethernet0/0
ip address 172.16.136.1 255.255.255.192
half-duplex
service-policy output WRED

access-list 150 permit tcp any eq www

interface Ethernet0/0
ip address 172.16.136.1 255.255.255.192
half-duplex
random-detect

Router 3
Interface Ethernet0/0
Ip address 172.16.136.3 255.255.255.192
Half-duplex
Random-detect exponential-weighting-constant 11

Interface Serial1/3
Bandwidth 64000
Ip address 172.16.35.1 255.225.255.252
Encapsulation ppp
Random-detect
Random-detect precedence 0 300 600 10
Random-detect precedence 5 300 600 10
Clockrate 64000

Router 5
Interface Serial0/0
Ip address 172.16.35.2 255.255.255.252
Encapsulation ppp
Random-detect
Lab Preparation Scenario - Traffic Classification (QoS)

Topics Covered
- Access lists
- Setting QoS values- TOS and DIFF-Serv

Difficulty Level: CCIE

Average Completion Time: 2 to 3 Hours

Standard Topology

Standard TCP/IP Addressing and SPID Information

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<thead>
<tr>
<th>Interface</th>
<th>Address</th>
<th>Description</th>
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<td>Loopback</td>
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<td>Token ring Segment to 3920</td>
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<td>Frame-relay</td>
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R2 (3620)
Loop0  192.168.2.2/24    Loopback
T0/0   172.16.2.2/24    Token Ring segment to 3920
BRI0/0 172.16.230.2/24  BRI to R3
S1/1   172.16.32.2/24  Serial to R3
S1/0   unassigned      Frame-relay

R3 (2610)
Loop0  192.168.2.2/24    Loopback
E0/0   172.16.136.3/26  Ethernet Segment to Catalyst 3/3
BRI0/0 172.16.230.3/24  ISDN to R2
S1/3   172.16.35.1/30  Serial to R5
S1/2   172.16.32.3/24  Serial to R2
S1/1   172.16.31.2/30  Serial to R1
S1/0   unassigned      Frame-relay

R4 (2610)
Loop0  192.168.4.4/24    Loopback
E0/0   10.1.4.4/22      Ethernet Segment to Catalyst 3/5
S0/0   unassigned      Frame-relay

R5 (3620)
Loop0  192.168.5.5/24    Loopback
E0/0   172.16.136.5/26  Ethernet Segment to Catalyst 3/5
T0/0   172.16.15.5/28   Token Ring segment to 3920
S0/0   172.16.35.2/30  Serial link to R3
A1/0   172.16.56.5/30  ATM-R6

R6 (3640)
Loop0  192.168.6.6/24    Loopback
FA0/0  172.16.136.6/26  Ethernet segment-R2
E2/0   10.2.6.6/23      Ethernet segment-BB2
A1/0   172.16.56.6/30  ATM-R5

ISDN Information
Switch Type  Basic-NI 1

R2
SPID1:   42255501210101
SPID2:   42255501220101

R3
SPID1:   42255501310101
SPID2:   42255501320101

Technical Tasks

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A. Configure the addressing from list above. In this lab you will use the PPP link from R3 to R5 and the Ethernet Link from R1 to R3. You should also configure the appropriate loopbacks on each of these routers.
B. Configure EIGRP on R1, R3 and R5. Use AS 100. All interface on R1, R3 and R5 must be reachable from all other routers. Test this by pinging all the loopbacks.
C. Configure R1 to for Policy Based Routing. You will have to create three policies. The first policy should permit EIGRP from this router to any host and should also permit SMTP from any host to 192.168.5.5, this policy when matched should have a precedence of 5.
D. Configure a second policy on R1 that will allow any Telnet traffic from R1 to 192.168.3.3 to have a Precedence value of 3.
E. Configure a third policy on R1 that will allow any TFTP traffic from R1 to 192.168.5.5 to have a precedence of 1.
F. Configure a default policy on R1 that will mark any packets that didn’t match the other policies with a Precedence of 0.
G. Configure R3 to classify Packets using Rate-Limiting. Classify WWW traffic passing through this router with a Precedence of 5. Classify any POP3 or LPD traffic with a Precedence of 3 and all other traffic should have a Precedence of 0.
H. Configure R5 using Modular QoS. Create two class maps, one class map to match ICMP packets and one packets to a Precedence of 3, use the equivalent DSCP values for the traceroute packets.

Instructor’s Comments and Technical Tips

A. Remember to add the clock rate to the DCE interface.
B. Use EIGRP 100 on all routers. Include a network statement for each loopback.
C. Use a route-map and access-lists to complete this task. Ensure your access-list will match the proper source and destination addresses. You must apply the policy based routing by using the ip policy command on the interface and the ip local policy to apply the policy that is generated on this router.
D. N/A.
E. N/A.
F. N/A.
G. When you use rate-limiting for this lab you can set your speed to the line rate. If you use multiple rate-limiting commands you must be careful of how you use continue command. The continue command will be used if you want to inspect multiple statement in a sequence.
H. When using the Modular QoS commands you must create a class map and a policy map. The class map is used when to an interface.

Technical Verification

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Task A and B

r1#sho ip route
Codes: C- connected, S- static, I- Igrp, 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, E- EGP
i-IS-IS, L1- 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
   172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
       C 172.16.136.0/26 is directly connected, Ethernet0/0
       D 172.16.35.2/32[90/20537600] via 172.16.136.3, 01:17:23, Ethernet0/0
       D 172.16.35.0/30[90/20537600] via 172.16.136.3, 01:17:23, Ethernet0/0
       192.168.5.0/32 is subnetted, 1 subnets
           D 192.168.5.5[90/20665600] via 172.16.136.3, 01:17:19, Ethenernet0/0
           192.168.1.0/32 is subnetted, 1 subnets
           C 192.168.1.1 is directly connected, Loopback0
           192.168.3.0/32 is subnetted, 1 subnets
           D 192.168.3.3[90/409600] via 172.16.136.3, 01:17:56, Ethernet0/0

r1#sh in e0/0
Ethernet0/0 is up, line protocol is up
     Hardware is AmdP2, address is 0002.1651.eb61 (bia 0002.1651.eb61)
     Internet address 172.16.136.1/26
     MTU 1500 bytes, BW 10000Kbit, DLY 1000 usec,
         Reliability 255/255, txload 1/255, rxload 1/255
     Encapsulation ARPA, loopback not set
     Keepalive set (10 sec)
     ARP type: ARPA, ARP Timeout 04:00:00
     Last input 00:00:02, output 00:00:03, output hang never
     Last clearing of “show interface” counters never
     Queuing strategy: fifo
     Output queue: 0/40, 0 drops; input queue 0/75, 0 drops
     5 minute input rate 0 bits/sec, 0 packets/sec
     5 minute output rate 0 bits/sec, 0 packets/sec
         63667 packets input, 5143277 bytes, 0 no buffer
         Received 1811broadcasts, 0 runts, 0 giants, 0 throttles
         0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
         0 input packets with dribble condition detected
         66392 packets output, 21859152 bytes, 0 underruns(1/0/0)
         0 output errors, 1 collisions, 3 interface resets
0 babbles, 0 late collision, 6 deferred
0 lost carrier, 0 no carrier
0 output buffer failures, 0 output buffers swapped out

r3#sh ip route
Codes: C- connected, S- static, I- Igrp, 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, E- EGP
i-IS-IS, L1- 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

    172.16.0/16 is variably subnetted, 3 subnets, 3 masks
    C 172.16.136.0/26 is directly connected, Ethnernet0/0
    C 172.16.136.2/32 is directly connected, Serial1/3
    C 172.16.135.0/30 is directly connected, serial1/3
    192.168.5.0/32 is subnetted, 1 subnets
    D 192.168.5.5[90/20640000] via 172.16.35.2, 01:17:39, Serial1/3
    192.168.1.0/32 is subnetted, 1 subnets
    D 192.168.1.1[90/409600] via 172.16.136.1, 01:18:15, Ethernet0/0
    192.168.3.0/32 is subnetted, 1 subnets
    C 192.168.3.3 is directly connected, Loopback0

r3#sh in e0/0
Ethernet0/0 is up, line protocol is up
Hardware is AmdP2, address is 0002.b92a.c920 (bia 0002.b92a.c920)
Internet address 172.16.136.3/26
MTU 1500 bytes, BW 10000Kbit, DLY 1000 usec,
 reliability 255/255, txload 1/255, rxload 1/255
Encapsulation ARPA, loopback not set
Keepalive set (10 sec)
ARP type: ARPA, ARP Timeout 04:00:00
Last input 00:00:01, output 00:00:03, output hang never
Last clearing of “show interface” counters never
Queueing strategy: fifo
Output queue: 0/40, 0 drops; input queue 0/75, 0 drops
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
  65369packets input, 21773164bytes, 0 no buffer
Received 18921broadcasts, 0 runts, 0 giants, 0 throttles
  0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
0 input packets with dribble condition detected
64569 packets output, 5264804 bytes, 0 underruns(0/0/0)
0 output errors, 0 collisions, 2 interface resets
0 babbles, 0 late collision, 5 deferred
0 lost carrier, 0 no carrier
0 output buffer failures, 0 output buffers swapped out

r3#sh in e0/0
Ethernet0/0 is up, line protocol is up
Hardware is AmdP2, address is 0002.b92a.c920 (bia 0002.b92a.c920)
Internet address 172.16.136.3/26
MTU 1500 bytes, BW 10000Kbit, DLY 1000 usec,
    Reliability 255/255, txload 1/255, rxload 1/255
Encapsulation ARPA, loopback not set
Keepalive set (10 sec)
ARP type: ARPA, ARP Timeout 04:00:00
Last input 00:00:01, output 00:00:03, output hang never
Last clearing of “show interface” counters never
Queuing strategy: fifo
Output queue: 0/40, 0 drops; input queue 0/75, 0 drops
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
65869packets input, 21773164 bytes, 0 no buffer
Received 18921broadcasts, 0 runts, 0 giants, 0 throttles
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
0 input packets with dribble condition detected
64569packets output, 5264804 bytes, 0 underruns(1/0/0)
0 output errors, 0 collisions, 2 interface resets
0 babbles, 0 late collision, 5 deferred
0 lost carrier, 0 no carrier
0 output buffer failures, 0 output buffers swapped out

r5#sh ip route
Codes: C- connected, S- static, I- Igrp, 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, E- EGP
i-IS-IS, 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

172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
D 172.16.136.0/26[90/1787392] via 172.16.35.1, 01:28:03, Serial0/0
C 172.16.35.1/32 is directly connected, Serial0/0
C  172.16.35.0/30 is directly connected, Serial0/0
    192.168.5.0/30 is subnetted, 1 subnets
C  192.168.5.5 is directly connected, Loopback0
    192.168.1.0/32 is subnetted, 1 subnets
D  192.168.1.1[90/1915392] via 172.16.35.1, 01:28:03, Serial0/0
    192.168.3.0/32 is subnetted, 1 subnets
D  192.168.3.3[90/1889792] via 172.16.35.1, 01:28:04, Serial0/0

r5#sh in s0/0
Serial0/0 is up, line protocol is up
  Hardware is QUICC Serial
  Internet address 172.16.35.2/30
  MTU 1500 bytes, BW 2048Kbit, DLY 20000 usec,
      Reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, loopback not set
  Keepalive set (10 sec)
  LCP Open
  Open: IPCP, CDPCP
  Last input 00:00:02, output 00:00:02, output hang never
  Last clearing of “show interface” counters 01:29:50
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queuing strategy: weighted fair
  Output queue: 0/1000/64/0 (size/max total/threshold/drops)
      Conversations 0/1/256 (active/max active/max total)
      Reserved Conversations 0/0 (allocated/max allocated)
      Available bandwidth 1536 kilobits/sec
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  23751 packets input, 2433115 bytes, 0 no buffer
  Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
  0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
  23754 packets output, 2433697 bytes, 0 underruns
  0 output errors, 0 collisions, 2 interface resets
  0 babbles, 0 late collision, 5 deferred
  0 lost carrier, 0 no carrier
  0 output buffer failures, 0 output buffers swapped out
  0 carrier transitions
  DCP=up DSR=up DTR=up RTS=up CTS=up

Task C

r1#sh route-map
route-map MarkTraffic, permit, sequence 10
Match clauses:
ip address (access-lists): 100
Set clauses:
  ip precedence critical
Policy routing matches: 2 packets, 134 bytes
route-map MarkTraffic, permit, sequence 20
Match clauses:
  ip address (access-lists): 101
Set clauses:
  ip precedence flash
Policy routing matches: 11 packets, 496 bytes
route-map MarkTraffic, permit, sequence 30
Match clauses:
  ip address (access-lists): 102
Set clauses:
  ip precedence priority
Policy routing matches: 1 packets, 45 bytes
route-map MarkTraffic, permit, sequence 40
Match clauses:
  ip address (access-lists): 103
Set clauses:
  ip precedence routing
Policy routing matches: 32777 packets, 9318901 bytes

Task D

r1#sh route-map
route-map MarkTraffic, permit, sequence 10
Match clauses:
  ip address (access-lists): 100
Set clauses:
  ip precedence critical
Policy routing matches: 2 packets, 134 bytes
route-map MarkTraffic, permit, sequence 20
Match clauses:
  ip address (access-lists): 101
Set clauses:
  ip precedence flash
Policy routing matches: 11 packets, 496 bytes
route-map MarkTraffic, permit, sequence 30
Match clauses:
  ip address (access-lists): 102
Set clauses:
  ip precedence priority
Policy routing matches: 1 packets, 45 bytes
route-map MarkTraffic, permit, sequence 40
Match clauses:
  ip address (access-lists): 103
Set clauses:
  ip precedence routing
Policy routing matches: 32777 packets, 9318901 bytes

Task E

r1#sh route-map
route-map MarkTraffic, permit, sequence 10
Match clauses:
  ip address (access-lists): 100
Set clauses:
  ip precedence critical
Policy routing matches: 2 packets, 134 bytes
route-map MarkTraffic, permit, sequence 20
Match clauses:
  ip address (access-lists): 101
Set clauses:
  ip precedence flash
Policy routing matches: 11 packets, 496 bytes
route-map MarkTraffic, permit, sequence 30
Match clauses:
  ip address (access-lists): 102
Set clauses:
  ip precedence priority
Policy routing matches: 1 packets, 45 bytes
route-map MarkTraffic, permit, sequence 40
Match clauses:
  ip address (access-lists): 103
Set clauses:
  ip precedence routing
Policy routing matches: 32777 packets, 9318901 byte

Task F

r1#sh route-map
route-map MarkTraffic, permit, sequence 10
Match clauses:
  ip address (access-lists): 100
Set clauses:
  ip precedence critical
Policy routing matches: 2 packets, 134 bytes
route-map MarkTraffic, permit, sequence 20  
Match clauses:  
ip address (access-lists): 101  
Set clauses:  
ip precedence flash  
Policy routing matches: 11 packets, 496 bytes  
route-map MarkTraffic, permit, sequence 30  
Match clauses:  
ip address (access-lists): 102  
Set clauses:  
ip precedence priority  
Policy routing matches: 1 packets, 45 bytes  
route-map MarkTraffic, permit, sequence 40  
Match clauses:  
ip address (access-lists): 103  
Set clauses:  
ip precedence routing  
Policy routing matches: 32777 packets, 9318901 bytes

Task G

r3#sh interfaces e0/0 rate-limit  
Ethernet0/0  
Input  
matches: access-group 100  
params: 10000000 bps, 1875000 limit, 3!750000 extended limit  
conformed 20 packets, 1200 bytes; action: set-pre-transmit 5  
exceeded 0 packets, 0 bytes; action: drop  
last packet: 486521 ms ago, current burst: 0 bytes  
last cleared 00:59:25 ago, conformed 0 bps, exceeded 0 bps  
matches: access-group 101  
params: 10000000 bps, 1875000 limit, 3750000 extended limit  
conformed 0 packets, 0 bytes; action: set-pre-transmit 3  
exceeded 0 packets, 0 bytes; action: drop  
last packet: 3799328 ms ago, current burst: 0 bytes  
last cleared 00:59:25 ago, conformed 0 bps, exceeded 0 bps  
matches: access-group 102  
params: 10000000 bps, 1875000 limit, 3750000 extended limit  
conformed 32721 packets, 9469064 bytes; action: set-pre-transmit 5  
exceeded 0 packets, 0 bytes; action: drop  
last packet: 128 ms ago, current burst: 0 bytes  
last cleared 00:59:25 ago, conformed 0 bps, exceeded 0 bps

Task H

r5#sh policy-map interface s0/0
Serial0/0
   Service-policy output: SetTos (1215)
Class-map: traceroute (match-all) (1217/3)
   15 packets, 861 bytes
   5 minute offered rate 0 bps, drop rate 0 bps
   Match: access-group 101 (1221)
   Qos Set
   ip dscp 24
      Packets marked 0
Class-map: ping (match-all) (1225/2)
   20137 packets, 7000348 bytes
   5 minute offered rate 31000 bps, drop rate 0 bps
   Match: access-group 101 (1229)
   Qos Set
      ip precedence 5
         Packets marked 0
Class-map: class-default (match-all) (1233/0)
   819 packets, 71051 bytes
   5 minute offered rate 0 bps, drop rate 0 bps
   Match: any (1237)

Configuration Verification

Only relevant portions of the configuration have been included.

Router 1

    interface Loopback0
    ip address 192.168.1.1 255.255.255.255
    !
    interface Ethernet0/0
    ip address 172.16.136.1 255.255.255.192
    ip policy route-map Traffic
       half-duplex

    router eigrp 100
    network 172.16.0.0
    network 192.168.1.0
    no auto-summary
    no eigrp log-neighbor-changes

    ip local policy route-map MarkTraffic
access-list 100 permit eigrp any any
access-list 100 permit tcp any host 192.168.5.5 eq smtp
access-list 101 permit tcp any host 192.168.3.3 eq telnet
access-list 102 permit udp any host 192.168.5.5 eq tftp
access-list 103 permit ip any any

route-map MarkTraffic permit 10
match ip address 100
set ip precedence critical
!
route-map MarkTraffic permit 20
match ip address 101
set ip precedence flash
!
route-map MarkTraffic permit 30
match ip address 102
set ip precedence priority
!
route-map MarkTraffic permit 40
match ip address 103
set ip precedence routine

Router 3
 Interface Loopback0
 Ip address 192.168.3.3 255.255.255.255
!
interface Ethernet0/0
 ip address 172.16.136.3 255.255.255.192
 rate-limit input access-group 100 10000000 1875000 3750000 conform-action set-transmit 5 exceed-action drop
 rate-limit input access-group 101 10000000 1875000 3750000 conform-action set-transmit 3 exceed-action drop
 rate-limit input access-group 102 10000000 1875000 3750000 conform-action set-transmit 0 exceed-action drop
 half-duplex

interface Serial1/3
 ip address 172.16.35.1 255.255.255.252
 encapsulation ppp
 clockrate 64000
!
router eigrp 100
network 172.16.0.0
network 192.168.3.0
no auto-summary
no eigrp log-neighbor-changes
!
access-list 100 permit tcp any any eq www
access-list 101 permit tcp any any eq pop3
access-list 102 permit tcp any any eq lpd
access-list 102 permit ip any any

**Router 5**

ip cef
class-map match-all ping
match access-group 100
class-map match-all traceroute
match access-group 101
!
!
policy-map SetTos
clas traceroute
set ip dscp 24
class ping
set ip precedence 5

interface Loopback0
ip address 192.168.5.5 255.255.255.255
!
interface serial0/0
ip address 172.16.35.2 255.255.255.252
encapsulation ppp

router 100
network 172.16.0.0
network 192.168.5.0
no auto-summary
no eigrp log-neighbor-changes

access-list 100 permit any any
access-list 101 permit any any
Lab Preparation Scenario - Traffic Policing

Topics Covered
- Traffic policing

Difficulty Level: CCIE

Average Completion Time: 2 to 3 Hours

Standard Topology

Standard TCP/IP Addressing and SPID Information

**R1 (3620)**
- Loop0: 192.168.1.1/24 Loopback
- E/0/0: 172.16.136.1/26 Ethernet Segment to Catalyst 3/1
- T/0/0: 172.16.15.1/28 Token ring Segment to 3920
- S1/1: 172.16.31.1/30 Serial to R3
- S1/0: unassigned Frame-relay

**R2 (3620)**
Loop0 192.168.2.2/24  Loopback
T0/0  172.16.2.2/24  Token Ring segment to 3920
BR1/0  172.16.230.2/24  BRI to R3
S1/1  172.16.32.2/24  Serial to R3
S1/0  unassigned  Frame-relay

R3 (2610)
Loop0 192.168.2.2/24  Loopback
E0/0  172.16.136.3/26  Ethernet Segment to Catalyst 3/3
BR1/0  172.16.230.3/24  ISDN to R2
S1/3  172.16.35.1/30  Serial to R5
S1/2  172.16.32.3/24  Serial to R2
S1/1  172.16.31.2/30  Serial to R1
S1/0  unassigned  Frame-relay

R4 (2610)
Loop0 192.168.4.4/24  Loopback
E0/0  10.1.4.4/22  Ethernet Segment to BB1
S0/0  unassigned  Frame-relay

R5 (3620)
Loop0 192.168.5.5/24  Loopback
E0/0  172.16.136.5/26  Ethernet Segment to Catalyst 3/5
T0/0  172.16.15.5/28  Token Ring segment to 3920
S0/0  172.16.35.2/30  Serial link to R3
A1/0  172.16.56.5/30  ATM-R6

R6 (3640)
Loop0 192.168.6.6/24  Loopback
FA0/0  172.16.136.6/26  Ethernet segment-R2
E2/0  10.2.6.6/23  Ethernet segment-BB2
A1/0  172.16.56.6/30  ATM-R5

ISDN Information
Switch Type Basic-NI 1

R2
SPID1: 42255501210101
SPID2: 42255501220101

R3
SPID1: 42255501310101
SPID2: 42255501320101

Technical Tasks
A. Configure the addressing from the list above. In this lab you will use the PPP link from R3 to R5 and the Ethernet Link from R1 to R3. You should also configure the appropriate loopback on each of these routers.
B. Configure EIGRP on R1, R3 and R5. Use AS 100. All interfaces on R1, R3 and R5 must be reachable from all other routers. Test this by pinging all the loopbacks.

C. Configure policing on R1 with the following values. Web traffic to any destination can transmit 100Kbits/sec with a burst size of 3000 bytes and an excess burst of 3000 bytes. Email traffic (POP3 and SMTP) can transmit at a maximum speed of 20Kbits/sec with a burst size of 3750 bytes and an excess burst size of 7500 bytes, any packets that exceed the limit will re-marked with a precedence of 3 before transmission, this statement should use the two token bucket method where all excess traffic is dropped. Configure a third statement to police any FTP traffic where the maximum rate is 8000 bits/sec and the token bucked size is 1500 bytes for the Normal and Excess burst, any traffic that exceeds should be re-transmitted with a diffServ Code point of 20.

D. Configure R3 to Policy the following ingress on S1/3. Create three Classes: Gold, Silver and Bronze. Gold Traffic should consist of EIGRP only, police this to 30 kbits/sec, any excess traffic should be marked with a precedence of 3. Silver Traffic should consist of FTP only, police this at 20 kbits/sec, any excess traffic with a precedence of 1. Bronze traffic will consist of Telnet only, police this at 8 kbits/sec. Create two token buckets for the telnet traffic and ensure that both buckets will drop any excess traffic. You are not permitted to use any access lists to complete this task.

All subnets/interfaces that participate in routing must be reachable from all routers.

Instructor’s Comments and Technical Tips

A. Remember to add the clock rate to the DCE interface.

B. Use EIGRP 100 on all routers. Include a network statement for each loopback.

C. You must configure Modular QoS for policing. You must create map first then the policy map. Policing can be configured for egress traffic. Use the service policy {input/output} statement to apply the policy to an interface.

D. When you create a two token bucket queue you must use the violate-action command.

Technical Verification

Task A and B

r1#sho ip route
Codes: C- connected, S- static, I- Igrp, 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, E- EGP
i-IS-IS, L1- IS-IS level-1 ,L2 – IS-IS level2, ia-IS-IS inter area
*-candidate default, U-per-user static route, o-ODR

Leading the way in IT testing and certification tools, www.testking.com
P-periodic downloaded static route

Gateway of last resort is not set
  172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
C  172.16.136.0/26 is directly connected, Ethernet0/0
D  172.16.35.2/32[90/20537600] via 172.16.136.3, 01:17:23, Ethernet0/0
D  172.16.35.0/30[90/20537600] via 172.16.136.3, 01:17:23, Ethernet0/0
D  192.168.5.0/32 is subnetted, 1 subnets
D  192.168.5.5[90/20665600] via 172.16.136.3, 01:17:19, Ethernet0/0
C  192.168.1.1 is directly connected, Loopback0
  192.168.3.0/32 is subnetted, 1 subnets
D  192.168.3.3[90/409600] via 172.16.136.3, 01:17:56, Ethernet0/0

r1#sh in e0/0
Ethernet0/0 is up, line protocol is up
  Hardware is AmdP2, address is 0002.1651.eb61 (bia 0002.1651.eb61)
  Internet address 172.16.136.1/26
  MTU 1500 bytes, BW 10000Kbit, DLY 1000 usec,
    Reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:02, output 00:00:03, output hang never
  Last clearing of “show interface” counters never
  Queuing strategy: fifo
  Output queue: 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
    63667 packets input, 5143277 bytes, 0 no buffer
    Received 1811 broadcasts, 0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
    0 input packets with dribble condition detected
    66392 packets output, 21859152 bytes, 0 underruns(1/0/0)
    0 output errors, 1 collisions, 3 interface resets
    0 babbles, 0 late collision, 6 deferred
    0 lost carrier, 0 no carrier
    0 output buffer failures, 0 output buffers swapped out

r3#sh ip route
Codes: C- connected, S- static, I- Igrp, 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, E- EGP
Gateway of last resort is not set

172.16.0/16 is variably subnetted, 3 subnets, 3 masks
C  172.16.136.0/26 is directly connected, Ethernet0/0
C  172.16.136.2/32 is directly connected, Serial1/3
C  172.16.135.0/30 is directly connected, serial1/3
192.168.5.0/32 is subinetted, 1 subnets
D  192.168.5.5[90/20640000] via 172.16.35.2, 01:17:39, Serial1/3
D  192.168.1.1[90/409600] via 172.16.136.1, 01:18:15, Ethernet0/0
C  192.168.3.0/32 is subinetted, 1 subnets
C  192.168.3.3 is directly connected, Loopback0

r3#sh in e0/0
Ethernet0/0 is up, line protocol is up
  Hardware is AmdP2, address is 0002.b92a.c920 (bia 0002.b92a.c920)
  Internet address 172.16.136.3/26
  MTU 1500 bytes, BW 10000Kbit, DLY 1000 usec,
     Reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:01, output 00:00:03, output hang never
  Last clearing of “show interface” counters never
  Queuing strategy: fifo
  Output queue: 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     65869packets input, 21773164bytes, 0 no buffer
     Received 18921broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     0 input packets with dribble condition detected
     64569 packets output, 5264804 bytes, 0 underruns(0/0/0)
     0 output errors, 0 collisions, 2 interface resets
     0 babbles, 0 late collision, 5 deferred
     0 lost carrier, 0 no carrier
     0 output buffer failures, 0 output buffers swapped out
r3#sh in e0/0
Ethernet0/0 is up, line protocol is up
Hardware is AmdP2, address is 0002.b92a.c920 (bia 0002.b92a.c920)
Internet address 172.16.136.3/26
MTU 1500 bytes, BW 10000Kbit, DLY 1000 usec,
    Reliability 255/255, txload 1/255, rxload 1/255
Encapsulation ARPA, loopback not set
Keepalive set (10 sec)
ARP type: ARPA, ARP Timeout 04:00:00
Last input 00:00:01, output 00:00:03, output hang never
Last clearing of “show interface” counters never
Queueing strategy: fifo
Output queue: 0/40, 0 drops; input queue 0/75, 0 drops
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
    65869packets input, 21773164 bytes, 0 no buffer
    Received 18921broadcasts, 0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
    0 input packets with dribble condition detected
    64569packets output, 5264804 bytes, 0 underruns(1/0/0)
    0 output errors, 0 collisions, 2 interface resets
    0 babbles, 0 late collision, 5 deferred
    0 lost carrier, 0 no carrier
    0 output buffer failures, 0 output buffers swapped out
r5#sh ip route
Codes: C- connected, S- static, I- Igrp, 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, E- EGP
i-IS-IS, L1- 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

172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
D 172.16.136.0/26[90/1787392] via 172.16.35.1, 01:28:03, Serial0/0
C 172.16.35.1/32 is directly connected, Serial0/0
C 172.16.35.0/30 is directly connected, Serial0/0
192.168.5.0/30 is subnetted, 1 subnets
C 192.168.5.5 is directly connected, Loopback0
192.168.1.0/32 is subnetted, 1 subnets
D 192.168.1.1[90/1915392] via 172.16.35.1, 01:28:03, Serial0/0
D 192.168.3.0/32 is subnetted, 1 subnets
D 192.168.3.3[90/1889792] via 172.16.35.1, 01:28:04, Serial0/0

r5#sh in s0/0
Serial0/0 is up, line protocol is up
Hardware is QUICC Serial
Internet address 172.16.35.2/30
MTU 1500 bytes, BW 2048Kbit, DLY 20000 usec,
   Reliability 255/255, txload 1/255, rxload 1/255
Encapsulation PPP, loopback not set
Keepalive set (10 sec)
LCP Open
Open: IPCP, CDPCP
Last input 00:00:02, output 00:00:02, output hang never
Last clearing of “show interface” counters 01:29:50
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queuing strategy: weighted fair
Output queue: 0/1000/64/0 (size/max total/threshold/drops)
   Conversations 0/1/256 (active/max active/max total)
   Reserved Conversations 0/0 (allocated/max allocated)
   Available bandwidth 1536 kilobits/sec
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
23751 packets input, 2433115 bytes, 0 no buffer
Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
23754 packets output, 2433697 bytes, 0 underruns
0 output errors, 0 collisions, 2 interface resets
0 babbles, 0 late collision, 5 deferred
0 lost carrier, 0 no carrier
0 output buffer failures, 0 output buffers swapped out
0 carrier transitions
DCP=up DSR=up DTR=up RTS=up CTS=up

Task C

r1#show policy-map interface e0/0
Ethernet0/0

Service-policy output: Police (1421)

Class-map: Web (match-all) (1423/3)
   10 packets, 600 bytes
5 minute offered rate 0 bps, drop rate 0 bps
Match: access-group 100 (1427)
Police:
   100000 bps, 3000 limit, 3000 extended limit
   conformed 10 packets, 600 bytes; action: transmit
   exceeded 0 packets, 0 bytes; action: drop

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conformed 0 bps, exceed 0 bps, exceed 0 bps violate 0 bps
Class-map: MAIL (match-all) (1431/2)
   2 packets, 120 bytes
   5 minute offered rate 0 bps, drop rate 0 bps
   Match: access-group 101 (1435)
   Police:
   200000 bps, 3750 limit, 7500 extended limit
   conformed 2 packets, 120 bytes; action: transmit
   exceeded 0 packets, 0 bytes; action: set-prec-transmit 3
   conformed 0 bps, exceed 0 bps, exceed 0 bps violate 0 bps
Class-map: FTP (match-all) (1439/3)
   31 packets, 1860 bytes
   5 minute offered rate 0 bps, drop rate 0 bps
   Match: access-group 102 (1443)
   Police:
   8000 bps, 1500 limit, 1500 extended limit
   conformed 31 packets, 1860 bytes; action: transmit
   exceeded 0 packets, 0 bytes; action: drop
   conformed 0 bps, exceed 0 bps violate 0 bps
Class-map: class-default (match-all) (1447/0)
   18968 packets, 2492018 bytes
   5 minute offered rate 0 bps, drop rate 0 bps
   Match: any (1451)

r1# show access-lists
Extended IP access list 100
   permit tcp any eq www (10 matches)
Extended IP access list 101
   permit tcp any any eq smtp (1 match)
   permit tcp any any eq pop3 (1 match)
Extended IP access list 102
   permit tcp any any eq ftp (19 matches)
   permit tcp any any eq ftp-data (12 matches)

Task D

r3# show policy-map interface S1/3
Serial1/3

Service-policy input: TOS (1531)
Class-map: Gold (match-all) (1533/2)
   782 packets, 50048 bytes
   5 minute offered rate 0 bps, drop rate 0 bps
   Match: protocol eigrp (1537)
   Police:
300000 bps, 1500 limit, 1500 extended limit
conformed 782 packets, 50048 bytes; action: transmit
exceeded 0 packets, 0 bytes; action: set-prec-transmit 3
conformed 0 bps, exceed 0 bps, exceed 0 bps violate 0 bps
Class-map: Silver (match-all) (541/4)
  20 packets, 884 bytes
  5 minute offered rate 0 bps, drop rate 0 bps
  Match: protocol ftp (1545)
  Police:
  20000 bps, 1500 limit, 1500 extended limit
  conformed 20 packets, 884 bytes; action: transmit
  exceeded 0 packets, 0 bytes; action: set-prec-transmit 1
  conformed 0 bps, exceed 0 bps, exceed 0 bps violate 0 bps
Class-map: Bronze (match-all) (1549/3)
  5046 packets, 1153584 bytes
  5 minute offered rate 0 bps, drop rate 0 bps
  Match: protocol telnet (1553)
  Police:
  8000 bps, 1500 limit, 1500 extended limit
  conformed 3814 packets, 520140 bytes; action: transmit
  exceeded 17 packets, 1892 bytes; action: drop
  violated 1215 packets, 631552 bytes; action: drop
  conformed 0 bps, exceed 0 bps, exceed 0 bps violate 0 bps
Class-map: class-default (match-all) (1557/0)
  1604 packets, 102176 bytes
  5 minute offered rate 0 bps, drop rate 0 bps
  Match: any (1561)

Configuration Verification

Only relevant portions of the configuration have been included.

Router 1

Class-map match-all MAIL
  Match access-group 101
Class-map match-all FTP
  Match access-group 102
Class-map match-all Web
  Match access-group 100
!
!
policy-map Police
class Web
    police 100000 3000 3000 conform-action transmit exceed-action drop
class MAIL
    police 20000 3750 7500 conform-action transmit exceed-action set-prec-transmit 3 violate-action drop
class FTP
    police 8000 1500 1500 conform-action transmit exceed-action drop

interface Loopback0
ip address 192.168.1.1 255.255.255.255
!
interface Ethernet0/0
ip address 172.16.136.1 255.255.255.192
half-duplex
service-policy output Police

router eigrp 100
network 172.16.0.0
network 192.168.1.0
no auto-summary
no eigrp log-neighbor-changes

access-list 100 permit tcp any any eq www
access-list 101 permit tcp any any eq smtp
access-list 101 permit tcp any any eq pop3
access-list 102 permit tcp any any eq ftp
access-list 102 permit tcp any any eq ftp-data

Router 3

Class-map match-all gold
Match protocol eigrp
Class-map match-all Bronze
Match protocol telnet
Class-map match-all Silver
Match protocol ftp
!
!
policy-map TOS
class Gold
    police 3000 1500 1500 conform-action transmit exceed-action set-prec-transmit 3
class Silver
    police 20000 1500 1500 conform-action transmit exceed-action set-prec-transmit 1
class Bronze
    police 8000 1500 1500 conform-action transmit exceed-action drop violate-action drop
interface Loopback0
ip address 192.168.3.3 255.255.255.255
!
interface Ethernet0/0
ip address 172.16.35.1 255.255.255.252
encapsulation ppp
clockrate 64000
!
routerr eigrp 100
network 172.16.0.0
network 192.168.3.0
no auto-summary
no eigrp log-neighbor-changes

**Router 5**

Interface Loopback0
ip address 192.168.5.5 255.255.255.255
!
interface Ethernet0/0
no ip address
shutdown
half-duplex
!
interface Serial0/0
ip address 172.16.35.2 255.255.255.252
encapsulation ppp

router eigrp 100
network 172.16.0.0
network 192.168.5.0
no auto-summary
no eigrp log-neighbor-changes
Lab Preparation Scenario: Extended Access Control Lists (ACLS’s)

Topics Covered
- Frame Relay
- OSPF
- OSPF Virtual Link
- OSPF Network Type
- Access-list
- ICMP
- WWW
- SMTP
- Bit Boundaries

Difficulty Level: CCIE™
Average completion Time: 2 to 3 Hours

Standard TCP/IP Addressing and SPID Information

R1 (3620)
<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.1.1/24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E/0/0</td>
<td>172.16.136.1/26</td>
<td>Ethernet Segment to Catalyst 3/1</td>
</tr>
<tr>
<td>T0/0</td>
<td>172.16.15.1/28</td>
<td>Token ring Segment to 3920</td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.31.1/30</td>
<td>Serial to R3</td>
</tr>
<tr>
<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

R2 (3620)
<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.2.2/24</td>
<td>Loopback</td>
</tr>
<tr>
<td>T0/0</td>
<td>172.16.2.2/24</td>
<td>Token Ring segment to 3920</td>
</tr>
<tr>
<td>BRI0/0</td>
<td>172.16.230.2/24</td>
<td>BRI to R3</td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.32.2/24</td>
<td>Serial to R3</td>
</tr>
<tr>
<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>

R3 (2610)
<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop0</td>
<td>192.168.2.2/24</td>
<td>Loopback</td>
</tr>
<tr>
<td>E0/0</td>
<td>172.16.136.3/26</td>
<td>Ethernet Segment to Catalyst 3/3</td>
</tr>
<tr>
<td>BRI0/0</td>
<td>172.16.230.3/24</td>
<td>ISDN toR2</td>
</tr>
<tr>
<td>S1/3</td>
<td>172.16.35.1/30</td>
<td>Serial to R5</td>
</tr>
<tr>
<td>S1/2</td>
<td>172.16.32.3/24</td>
<td>Serial to R2</td>
</tr>
<tr>
<td>S1/1</td>
<td>172.16.31.2/30</td>
<td>Serial to R1</td>
</tr>
<tr>
<td>S1/0</td>
<td>unassigned</td>
<td>Frame-relay</td>
</tr>
</tbody>
</table>
R3 (2610)
Loop0  192.168.4.4/24  Loopback
E0/0  10.1.4.4/22  Ethernet Segment to Catalyst 3/5
S0/0  Unassigned  Frame-relay

R5 (3620)
Loop0  192.168.5.5/24  Loopback
E0/0  172.16.136.5/26  Ethernet Segment to Catalyst 3/5
T0/0  172.16.15.5/28  Token Ring segment to 3920
S0/0  172.16.35.2/30  Serial link to R3
A1/0  172.16.56.5/30  ATM-R6

R6 (3640)
Loop0  192.168.6.6/24  Loopback
FA0/0  172.16.136.6/26  Ethernet segment-R2
E2/0  10.2.6.6/23  Ethernet segment-BB2
A1/0  172.16.56.6/30  ATM-R5

ISDN Information
Switch Type  Basic-NI 1

R2
SPID1:  42255501210101
SPID2:  42255501220101

R3
SPID1:  42255501310101
SPID2:  42255501320101

Technical Tasks

A.  Configuration the Frame relay so R2 AND R4 to connect via DLCI 244 and 442 Configure the IP addressing for 172.16.24.0/29 using the router as the last octet. Use no other DLCI’s. Do not use sub-interfaces.

B.  Configuration OSPF with R1 E1/0, R3 E1/0, R5 E1/0 and R6 FA1/0 and E2/0 in Area 0. R3 serial ½, R2 Serial 1/1 and To0/0 in area 2. R3 Serial 1/1 and R2 S1/0 and R4 S0/0 in area 7.

C.  Insert a default route into OSPF on R4 so all routers can access Eth0/0. Do not use the IP route command.

D.  Assume R3 is the gateway to the Internet. On R3 create an access-list allowing any IP address to access server 172.16.136.254 for web traffic only. Allow only SMTP traffic to server 172.16.136.253. Allow users inside to access any www server and to received ICMP replies.

E.  On R2 create an incoming access-list on serial 1/0 denying any IP traffic coming from the following subnets: 204.17.33.0, 204.17.37.0 204.17.14.0, 204.17.45.0, 204.17.161.0, 204.17.165.0, 204.17.173.0, 205.17.37.0, 205.17.45.0, 221.17.37.0, 221.17.45.0. Use as few statements as possible.
Instructor’s Comments and Technical Tips

A. N/A.

B. Use a virtual link to connect area 7. Change the network type of the Frame Relay interface.

C. Use a command under the routing process.

D. Use the established verb as well as selecting the individual port numbers.

E. Create the access-list paying particular attention to the bit boundaries.

Technical Verification

Technical Verification For task A

```
r2#sho frame map
Serial1/0 (up): ip 172.16.24.4 dlci 244(0*F4, 0*3C40), static, broadcast, CISCO, status defined, active
```

```
r2#
```

```
r4#sho frame map
Serial1/0 (up): ip 172.16.24.2 dlci 244(0*1BA, 0*6CA0), static, broadcast, CISCO, status defined, active
```

```
r4#
```

Technical Verification For Task B

```
r1#sho ip route
```

Technical Verification For Task C

```
r1#sho ip route
```

Codes: C- connected, S- static, I- IGRP, R- RIP, M- mobile, B- BGP O- 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, E- EGP I-IS-IS, L1- 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 172.16.136.3 to network 0.0.0.0

172.16.0/16 is variably subnetted, 6 subnets, 5 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
O IA 172.16.32.0/24[110/791] via 172.16.136.3, 00:00:49, Ethernet0/0
C 172.16.31.0/30 is directly connected, Serial1/1
O IA 172.16.24.0/29[110/839] via 172.16.136.3, 00:00:49, Ethernet0/0
C 172.16.15.0/28 is directly connected, TokenRing0/0
O IA 172.16.2.0/24[110/797] via 172.16.136.3, 00:00:49, Ethernet0/0
10.0.0.0/23 is subnetted, 1 subnets
O 10.26.0[110/20] via 172.16.136.6, 00:04:23, Ethernet0/0
C 192.168.1.0/24 o directly connected, Loopback0
O*E2 0.0.0.0/0[110/1] via 172.16.136.3, 00:00:50, Ethernet0/0

r1#

r2#sho ip route
Codes: C- connected, S- static, I- IGRP, R- RIP, M- mobile, B- BGP O- 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, E- EGP I_IS-IS, L1- 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 172.16.24.4 to network 0.0.0.0
  172.16.0.0/16 is variably subnetted, 5 subnets, 4 masks
O 172.16.136.0/26[110/58] via 172.16.32.3, 00:04:24, Serial1/1
C 172.16.32.0/24 is directly connected, Serial1/1
O IA 172.16.31.0/30[110/829] via 172.16.32.3, 00:00:50, Serial1/1
C 172.16.24.0/29 is directly connected, Serial1/0
C 172.16.2.0/24 is directly connected, Tokenring0/0
10.0.0.0/23 is subnetted, 1 subnets
O 10.2.6.0[110/68] via 172.16.32.3, 00:04:24, Serial1/1
C 192.168.2.0/24 is directly connected, Loopback0
O*E2 0.0.0.0/0[110/1] via 172.16.24.4, 00:00:51, Serial1/0
r2#

r3#sho ip route
Codes: C- connected, S- static, I- IGRP, R- RIP, M- mobile, B- BGP O- 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, E- EGP I_IS-IS, L1- 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 172.16.32.2 to network 0.0.0.0
  172.16.0.0/16 is variably subnetted, 5 subnets, 4 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
C 172.16.32.0/24 is directly connected, Serial1/2
C 172.16.31.0/30 is directly connected, Serial1/1
O IA 172.16.24.0/29[110/829] via 172.16.32.2, 00:00:50, Serial1/2
O 172.16.2.0/24[110/787] via 172.16.32.2, 00:04:39, serial1/2
10.0.0.0/23 is subnetted, 1 subnets
O 10.2.6.0[110/20] via 172.16.136.6, 00:04:29, Ethernet0/0
C 192.168.3.0/24 is directly connected, Loopback0
O*E2 0.0.0.0/0[110/1] via 172.16.32.2, 00:00:51, Serial1/2

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Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 5 subnets, 4 masks
O IA 172.16.136.0/26 [110/122] via 172.16.24.2, 00:01:11, serial0/0
O IA 172.16.32.0/24 [110/112] via 172.16.24.2, 00:01:11, Serial0/0
O IA 172.16.31.0/30 [110/893] via 172.16.24.2, 00:01:11, Serial0/0
C 172.16.24.0/29 is directly connected, Serial0/0
O IA 172.16.2.0/24 [110/70] via 172.16.24.2, 00:01:11, Serial0/0
C 192.168.4.0/24 is directly connected, 2 subnets, 2 masks
  10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O IA 10.2.6.0/23 [110/132] via 172.16.24.2, 00:01:12, Serial0/0
C 10.1.4.0/22 is directly connected, Ethernet0/0
r4#

Gateway of last resort is 172.16.136.3 to network 0.0.0.0

172.16.0.0/16 is variably subnetted, 6 subnets, 5 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
O IA 172.16.32.0/24 [110/791] via 172.16.136.3, 00:01:12, Ethernet0/0
O IA 172.16.31.0/30 [110/791] via 172.16.136.3, 00:01:12, Ethernet0/0
O IA 172.16.24.0/29 [110/839] via 172.16.136.3, 00:01:12, Ethernet0/0
C 172.16.15.0/28 is directly connected, TokenRing0/0
O IA 172.16.2.0/24 [110/797] via 172.16.136.3, 00:01:12, Ethernet0/0
C 192.168.5.0/24 is directly connected, Loopback0
  10.0.0.0/23 is subnetted, 1 subnets
O 10.2.6.0 [110/20] via 172.16.136.6, 00:04:46, Ethernet0/0
O*E2 0.0.0.0/0 [110/1] via 172.16.136.3, 00:01:13, Ethernet0/0
r5#
r6#sho ip route
Codes: C- connected, S- static, I- IGRP, R- RIP, M- mobile, B- BGP O- 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, E- EGP L IS-IS, L1- 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 172.16.136.3 to network 0.0.0.0

172.16.0.0/16 is variably subnetted, 5 subnets, 4 masks
C 172.16.136.0/26 is directly connected, FastEthernet0/0
O IA 172.16.32.0/24[110/782] via 172.16.136.3, 00:01:17, FastEthernet0/0
O IA 172.16.31.0/30[110/782] via 172.16.136.3, 00:01:17, FastEthernet0/0
O IA 172.16.24.0/29[110/830] via 172.16.136.3, 00:01:17, FastEthernet0/0
O IA 172.16.2.0/24[110/788] via 172.16.136.3, 00:01:17, FastEthernet0/0

10.0.0.0/23 is subnetted, 1 subnets
C 10.2.6.0 is directly connected, Ethernet2/0
C 192.168.6.0/24 is directly connected, Loopback0
O*E2 0.0.0.0/0[110/1] via 172.16.136.3, 00:01:17, FastEthernet0/0
r6#

Technical Verification For Task D

r3#sho access-list
Extended IP access list 100
permit ospf any any (1491 matches)
permit tcp any host 172.16.136.254 eq www
permit tcp any host 172.16.136.253 eq www
permit tcp any any eq www established
permit icmp any any echo-reply (44 matches)

r3#

r3#sho ip int ser ½

Serial1/2 is up, line protocol is up
Internet address is 172.16.32.3/24
Broadcast address is 255.255.255.255
Address determined by setup command
MTU is 1500 bytes
Helper address is not set
Directed broadcast forwarding is disabled
Multicast reserved groups joined: 224.0.0.5 244.0.0.6
Outgoing access list is not set

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Inbound access list is 100
Proxy ARP is enabled
Security level is default
Split horizon is enabled
ICMP redirects are always sent
ICMP unreachables are always sent
ICMP mask replies are never sent

IP fast switching is enabled
IP fast switching on the same interface is enabled
IP Flow switching is disabled
IP Feature Fast switching turbo vector
IP multicast fast switching is enabled
IP multicast distributed fast switching is disabled
IP route-cache flags are Fast
Router Discovery is disabled

IP output packet accounting is disabled
IP access violation accounting is disabled
TCP/IP header compression is disabled
RTP/IP header compression is disabled
Probe proxy name replies are disabled
Policy routing is disabled
Network address translation is disabled
WCCP Redirect outbound is disabled
WCCP Redirect inbound is disabled
WCCP Redirect inbound is disabled
BGP Policy Mapping is disabled

Technical Verification For Task E

```
r2#sho access-list
Extended IP access list 101
deny ip 204.17.33.0 0.0.140.255 any (24 matches)
deny ip 205.17.37.0 16.0.8.255 any (20 matches)
permit ip any any (57 matches)
r2#
```

```
r2#sho ip int ser 1/0
Serial 1/0 is up, line protocol is up
```

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Internet address is 172.16.32.3/24
Broadcast address is 255.255.255.255
Address determined by setup command
MTU is 1500 bytes
Helper address is not set
Directed broadcast forwarding is disabled
Multicast reserved groups joined: 224.0.0.5 244.0.0.6
Outgoing access list is not set

Inbound access list is 101
Proxy ARP is enabled
Security level is default
Split horizon is enabled
ICMP redirects are always sent
ICMP unreachables are always sent
ICMP mask replies are never sent

IP fast switching is enabled
IP fast switching on the same interface is enabled
IP Flow switching is disabled
IP Feature Fast switching turbo vector
IP multicast fast switching is enabled
IP multicast distributed fast switching is disabled
IP route-cache flags are Fast
Router Discovery is disabled

IP output packet accounting is disabled
IP access violation accounting is disabled
TCP/IP header compression is disabled
RTP/IP header compression is disabled
Probe proxy name replies are disabled
Policy routing is disabled
Network address translation is disabled
WCCP Redirect outbound is disabled
WCCP Redirect inbound is disabled
WCCP Redirect inbound is disabled
BGP Policy Mapping is disabled
IP multicast multiplayer switching is disabled

r2#

Configuration Verification
Only relevant portions of the configuration have been included.
Router 1

```bash
r1#sh run
!
hostname r1
!
interface Loopback0
ip address 192.168.1.1 255.255.255.0
!
interface TokenRing0/0
ip address 172.16.15.1 255.255.255.240
ring-speed 16
!
interface Serial1/0
no ip address
encapsulation frame-relay
shutdown
!
interface Serial1/1
ip address 172.16.31.1 255.255.255.252
!
router ospf 1
log-adjacency-changes
network 172.16.31.0.0.0.0.3 area 1
network 172.16.136.0.0.0.0.63 area 0
!
end
r1#
```

Router 2

```bash
r2#sh run
!
!
hostname r2
!
!
!
interface Loopback0
ip address 192.168.2.2 255.255.255.0
!
interface BRI0/0
no ip address
shutdown
```
! interface Ethernet0/0
no ip address
shutdown
half-duplex
!
interface Tokenring0/0
ip address 172.16.2.2 255.255.255.0
ring-speed 16
!
interface serial1/0
ip address 172.16.24.2 255.255.255.248
ip access-group 101 in
encapsulation frame-relay
ip ospf network point-to-point
frame-relay map ip 172.16.24.4 244 broadcast
no frame-relay inverse-arp
!
interface Serial1/1
ip address 172.16.32.2 255.255.255.0
!
routerr ospf 1
log-adjacency-changes
area 2 virtual-link 192.168.3.3
network 172.16.2.0 0.0.0.255 area 2
network 172.16.24.0 0.0.0.7 area 7
network 172.16.32.0 0.0.0.255 area 2
!
!
access-list 101 deny ip 204.17.33.0 0.0.140.255 any
access-list 101 deny ip 205.17.37.0 16.0.8.255 any
access-list 101 deny ip any any
!
!
end
r2#

Router 3

r3#sh run

!
!
hostname r3
!

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! interface Loopback0
ip address 192.168.3.3 255.255.255.0
!
interface Ethernet0/0
ip address 172.16.136.3 255.255.255.192
half-duplex
!
interface BRI0/0
no ip address
shutdown
!
interface Serial1/0
no ip address
encapsulation frame-relay
shutdown
!
interface Serial1/1
ip address 172.16.31.2 255.255.255.252
clockrate 64000
!
interface Serial1/2
ip address 172.16.32.3 255.255.255.0
ip access-group 100 in
clockrate 64000
!
interface Serial1/3
ip address 172.16.35.1 255.255.255.252
shutdown
clockrate 64000
!
router ospf 1
log-adjacency-changes
area 2 virtual-link 192.168.2.2
network 172.16.31.0 0.0.0.3 area 1
network 172.16.32.0 0.0.0.255 area 2
network 172.16.136.0 0.0.0.63 area 0
!
access-list 100 permit ospf any any
access-list 100 permit tcp any host 172.16.136.254 eq www
access-list 100 permit tcp any host 172.16.136.253 eq smtp
access-list 100 permit tcp any any eq www established
access-list 100 permit icmp any any echo-reply
!
r3#

Router 4

r4#sh run

! hostname r4
interface Loopback0
ip address 192.168.4.4 255.255.255.0
interface Ethernet0/0
ip address 10.1.4.4 255.255.255.248
encapsulation frame-relay
ip ospf network point-to-point
frame-relay map ip 172.16.24.2 442 broadcast
no frame-relay inverse-arp
interface Serial0/1
no ip address
shutdown
router ospf 1
log-adjacency-changes
network 172.16.24.0 0.0.0.7 area 7
default-information originate always
end
r4#

Router 5

r5#sh run

! hostname r5
interface Loopback0
ip address 192.168.5.5 255.255.255.0
interface Ethernet0/0
ip address 172.16.136.5 255.255.255.192
half-duplex
!
interface Serial0/0
ip address 172.16.35.2 255.255.255.252
!
interface TokenRing0/0
ip address 172.16.15.5 255.255.255.240
ring-speed 16
!
interface Serial0/1
no ip address
shutdown
no atm imli-keepalive
!
router ospf 1
log-adjacency-changes
network 172.16.136.0 0.0.0.63 area 0
!
end
r5#

Router 6
r6#sh run
!
hostname r6
!
interface Loopback0
ip address 192.168.6.6 255.255.255.0
no ip directed-broadcast
duplex auto
speed auto
!
interface ATM1/0

no ip address
no ip directed-broadcast
shutdown
no atm imli-keepalive
!
interface Ethernet2/0
ip address 10.2.6.6 255.255.254.0
no ip directed-broadcast
!
router ospf 1
network 10.2.6.0 0.0.1.255 area 0
network 172.16.136.0 0.0.0.63 area 0
!
password cisco

login
!
end
Lab Preparation Scenario: Extended Access Control Lists II (ACL’s)

Topics Covered
- Frame Relay
- Frame Relay Map
- Frame Relay Inverse-arp
- OSPF
- OSPF network type
- OSPF virtual-link
- Reflexive Access-list
- Reflexive timers

Difficulty Level: CCIE™
Average completion Time: 2 Hours

Standard TCP/IP Addressing and SPID Information

R1 (3620)
Loop0  192.168.1.1/24  Loopback
E/0/0  172.16.136.1/26  Ethernet Segment to Catalyst 3/1
T0/0  172.16.15.1/28  Token ring Segment to 3920
S1/1  172.16.31.1/30  Serial to R3
S1/0  unassigned  Frame-relay

R2 (3620)
Loop0  192.168.2.2/24  Loopback
T0/0  172.16.2.2/24  Token Ring segment to 3920
BRI0/0  172.16.230.2/24  BRI to R3
S1/1  172.16.32.2/24  Serial to R3
S1/0  unassigned  Frame-relay

R3 (2610)
Loop0  192.168.2.2/24  Loopback
E0/0  172.16.136.3/26  Ethernet Segment to Catalyst 3/3
BRI0/0  172.16.230.3/24  ISDN toR2
S1/3  172.16.35.1/30  Serial to R5
S1/2  172.16.32.3/24  Serial to R2
S1/1  172.16.31.2/30  Serial to R1
S1/0  unassigned  Frame-relay

R3 (2610)
**CCIE LAB**

Loop0  192.168.4.4/24  Loopback  
E0/0  10.1.4.4/22  Ethernet Segment to Catalyst 3/5  
S0/0  Unassigned  Frame-relay  

**R5 (3620)**  
Loop0  192.168.5.5/24  Loopback  
E0/0  172.16.136.5/26  Ethernet Segment to Catalyst 3/5  
T0/0  172.16.15.5/28  Token Ring segment to 3920  
S0/0  172.16.35.2/30  Serial link to R3  
A1/0  172.16.56.5/30  ATM-R6  

**R6 (3640)**  
Loop0  192.168.6.6/24  Looback  
FA0/0  172.16.136.6/26  Ethernet segment-R2  
E2/0  10.2.6.6/23  Ethernet segment-BB2  
A1/0  172.16.56.6/30  ATM-R5  

**ISDN Information**  
**Switch Type**  Basic-NI 1  

**R2**  
**SPID1:**  42255501210101  
**SPID2:**  42255501220101  

**R3**  
**SPID1:**  42255501310101  
**SPID2:**  42255501320101  

**Technical Tasks**  

A. Configure the Frame Relay so R2 AND R4 to connect via DLCI 244 and 442 Configure the IP addressing for 172.16.24.0/29 using the router number as the last octet. Do not use any other DLC’s. Use no sub-interfaces.

B. Configure OSPF with R1 E1/0, R3 E1/0, R5 E1/0 and R6 Fa1/0 in Area 0. R3 Serial ½, R2 Serial 1/1 and To0/0 in area 2. R3 serial 1/1 and R1 Serial 1/1 in area 1. Configure R4 S0/0 and R2 S1/0 in area 2. Configure R4 Eth0/0 in area 4. Make sure all routers can ping R4 Eth0/0 interface. Do not configure OSPF on links between R5 and R3 and R1.

C. Assume the Frame Connection from R2 to R4 is the internet. Create an access-list that will dynamically and temporarily create session filtering entries allowing inside users full TCP access to the outside and allow inside user to do ICMP to the outside.

D. Access R4 via telnet from R5.

E. Access R5 via telnet from R4 (this should fail).

F. Ping R4 from R5 (this should complete). Ping R5 from R4. (this should fail).

**Instructor’s Comments and technical tips**  

A. N/A.

B. See OSPF labs if necessary.
C. Use a reflexive access-list. Reflexive access-list must be a named access-list. When first created only the inbound and outbound filters will show ip.

D. Configure r2 so the TCP entries time out after 180 seconds. Do not affect the ICMP entries.

E. The access-list should block the connection because it was not established from the inside.

F. The access-list again allows the inside established connection to complete but blocks the outside initiated traffic.

Technical Verification

Technical Verification For Task A

r2#sho frame-relay map
Serial1/0 (up): ip 172.16.24.4 dlci 244(0*F4, 0*3C40), static, broadcast, CISCO, status defined, active

r4#sho frame-relay map
Serial0/0 (up): ip 172.16.24.2 dlci 442(0*1BA, 0*6Ca0), static, broadcast, CISCO, status defined, active

Technical Verification For Task B

r1#show ip ospf neig
Neighbor  Pri  State  Dead Time  Address  Interface
192.168.3.3  1  FULL/DROTHER  00:00:35  172.16.136.3  Ethernet0/0
192.168.6.6  1  FULL/DROTHER  00:00:35  172.16.136.3  Ethernet0/0
192.168.5.5  1  FULL/BDR  00:00:38  172.16.136.5  Ethernet0/0

r2#show ip ospf neig
Neighbor  Pri  State  Dead Time  Address  Interface
192.168.4.4  1  FULL/-  00:00:39  172.16.24.4  Serial1/0
192.168.3.3  1  FULL/-  00:00:39  172.16.32.3  Serial1/1

r3#show ip ospf neig
Neighbor  Pri  State  Dead Time  Address  Interface
192.168.6.6  1  2WAY/DROTHER  00:00:35  172.16.136.6  Ethernet0/0
192.168.1.1  1  FULL/DR  00:00:34  172.16.136.1  Ethernet0/0
192.168.5.5  1  FULL/BDR  00:00:38  172.16.136.5  Ethernet0/0
192.168.2.2  1  FULL/-  00:00:33  172.16.32.3  Serial1/2

r4#show ip ospf neig
Neighbor  Pri  State  Dead Time  Address  Interface
192.168.2.2  1  FULL/-  00:00:33  172.16.24.2  Serial0/0
r5#show ip ospf neig
Neighbor Pri State Dead Time Address Interface
192.168.3.3 1 FULL/DROTHER 00:00:34 172.16.136.3 Ethernet0/0
192.168.6.6 1 FULL/DROTHER 00:00:34 172.16.136.6 Ethernet0/0
192.168.1.1 1 FULL/BDR 00:00:33 172.16.136.1 Ethernet0/0
r5#

r6#show ip ospf neig
Neighbor Pri State Dead Time Address Interface
192.168.3.3 1 2WAY/DROTHER 00:00:31 172.16.136.3 Ethernet0/0
192.168.1.1 1 FULL/DR 00:00:30 172.16.136.1 Ethernet0/0
192.168.5.5 1 FULL/BDR 00:00:34 172.16.136.5 Ethernet0/0
r6#

Technical Verification For Task C, D, E&F

r2#sho ip access-list
Reflexive IP access list icmptraffic
  permit icmp host 10.1.4.5 host 172.16.136.5 (5 matches) (time left 223)
  permit icmp host 10.1.4.4 host 172.16.136.5 (10 matches) (time left 149)
Extended IP access list inbound
  permit ospf any any (31 matches)
  evaluate tcptraffic
  evaluate icmptraffic
Extended IP access list outbound
  permit tcp any any reflect tcptraffic
  permit udp any any
  permit icmp any any reflect icmptraffic
Reflexive IP access list tcptraffic
  Permit tcp host 10.1.4.4 eq telnet host 172.16.136.5 eq 11001 (85 matches) (time left 289)
r2#

Configuration Verification

Only relevant portions of the configuration have been included.

Router 1

r1#sh run
hostname r1
!
!
interface Loopback0
ip address 192.168.1.1255.255.255.0
!
interface Ethernet0/0
ip address 172.16.136.1 255.255.255.192
half duplex
!
interface TokenRing0/0
ip address 172.16.51.1 255.255.255.240
ring-speed 16
!
interface Serial1/0
no ip address
encapsulation frame-relay
shutdown
!
interface serial1/1
ip address 172.16.31.1 255.255.255.252
!
router ospf 1
log-adjacency-changes
network 172.16.31.0 0.0.03 area 1
network 172.16.136.0 0.0.0.63 area 0
r1#

Router 2
R2#sh run
!
hostname r2
!
!
!
!
interface Loopback0
ip address 192.168.2.2 255.255.255.0
!
interface BRI0/0
no ip address
shutdown
!
interface Ethernet0/0
no ip address
shutdown
half-duplex
!
interface TokenRing0/0
ip address 172.16.2.2 255.255.255.0
ring-speed 16
!
interface Serial1/0
ip address 172.16.24.2 255.255.255.248
ip access-group inbound in
ip access-group outbound out
encapsulation frame-relay
ip ospf network point-to-point
frame-relay map ip 172.16.24.4 244 broadcast
no frame-relay inverse-arp
!
interface Serial1/1
ip address 172.16.32.2 255.255.255.0
!
router ospf 1
log-adjacency-changes
network 172.16.2.0 0.0.0.255 area 2
network 172.16.24.0 0.0.0.7 area 2
network 172.16.32.0 0.0.0.255 area 2
!
ip kerberos source-interface any
ip classless
no ip http server
!
!
!
ip access-list extended inbound
permit ospf any any
evaluate tcptrafffic
evaluate icmptraffic
!
ip access-list extended outbound
permit tcp any any reflect tcptrafffic
permit udp any any
permit icmp any any reflect icmptraffic
!
!
r2#

Router 3

R3#sh run

!
hostname r3
!
!
!
!
!
!
!
!
!
!
!
!
!
!
!
!
!
interface Loopback0
ip address 192.168.3.3 255.255.255.0
!
interface Ethernet0/0
ip address 172.16.136.3 255.255.255.192
half-duplex
! interface BRI0/0
no ip address
shutdown
!
interface serial1/0
no ip address
encapsulation frame-relay
shutdown
interface Serial1/1 ip address 172.16.31.2 255.255.255.252
clockrate 64000
!
interface serial1/2
ip address 172.16.32.3 255.255.255.0
clockrate 64000
!
interface Serial1/3
ip address 172.16.35.1 255.255.255.252
shutdown
clockrate 64000
!
router ospf 1
log-adjacency-changes
area 2 virtual-link 192.168.4.4
network 172.16.32.0 0.0.0.255 area 2
network 172.16.136.0 0.0.0.63 area 0
!
Router 4
R4#sh run
!
hostname r4
!
!
interface Loopback0
ip address 192.168.4.4 255.255.255.0
!
interface Ethernet0/0
ip address 10.1.4.4 255.255.255.0
!
interface serial0/0
ip address 172.16.24.4 255.255.255.248
encapsulation frame-relay
ip ospf network point-to-point

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frame-relay map ip 172.16.24.2 442 broadcast
no frame-relay inverse-arp
!
interface serial0/1
no ip address
shutdown!
router ospf 1
log-adjacency-changes
area 2 virtual-link 192.168.3.3
network 10.1.4.0 0.0.1255 area 4
network 172.16.24.0 0.0.0.7 area 2
!
!
end
r4#

Router 5

R5#sh run
Hostname r5
!
!
interface Loopback0
ip address 192.168.5.5 255.255.255.0
!
interface Ethernet0/0
ip address 172.16.136.5 255.255.255.192
half-duplex
!
interface serial0/0
ip address 172.16.35.2 255.255.255.252
!
interface TokenRing0/0
ip address 172.16.15.5 255.255.255.240
ring-speed 16
!
interface Serial0/1
no ip address
shutdown
!
interface ATM1/0
no ip address
shutdown
no atm ilmi-keepalive
! router ospf
log-adjacency-changes
network 172.16.136.0 0.0.0.63 area 0
!
r5#

Router 6

R6#sh run
!
hostname r6
!
!
interface Loopback0
ip address 192.168.6.6 255.255.255.0
no ip directed-broadcast!
interface FastEthernet0/0
ip address 172.16.136.6 255.255.255.192
no ip directed-broadcast
duplex auto
speed auto
!
interface ATM1/0
no ip address
no ip directed-broadcast
shutdown
no atm ilmi-keepalive
!
interface Ethernet2/0
ip address 10.2.6.6 255.255.254.0
no ip directed-broadcast
!
router ospf 1
network 172.16.136.0 0.0.0.63 area 0
!
r6#
Lab Preparation Scenario: Extended, Dynamic and Lock-N-Key ACL’s

Topics Covered
- Frame Relay Sub-interface
- OSPF
- EIGRP
- Redistribution
- Dynamic Extended Access-list
- Username/Password
- Lock and Key authentication
- Lock and Key timeout

Difficulty Level: CCIE™
Average completion Time: 1 to 3 Hours

Standard TCP/IP Addressing and SPID Information

R1 (3620)
Loops
- Loop0  192.168.1.1/24  Loopback
- E/0/0  172.16.136.1/26  Ethernet Segment to Catalyst 3/1
- T0/0  172.16.15.1/28  Token ring Segment to 3920
- S1/1  172.16.31.1/30  Serial to R3
- S1/0  unassigned  Frame-relay

R2 (3620)
Loops
- Loop0  192.168.2.2/24  Loopback
- T0/0  172.16.2.2/24  Token Ring segment to 3920
- BRI0/0  172.16.230.2/24  BRI to R3
- S1/1  172.16.32.2/24  Serial to R3
- S1/0  unassigned  Frame-relay

R3 (2610)
Loops
- Loop0  192.168.2.2/24  Loopback
- E0/0  172.16.136.3/26  Ethernet Segment to Catalyst 3/3
- BRIO/0  172.16.230.3/24  ISDN to R2
- S1/3  172.16.35.1/30  Serial to R5
- S1/2  172.16.32.3/24  Serial to R2
- S1/1  172.16.31.2/30  Serial to R1

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Technical Tasks
A. Configure Frame Relay between R4 and R2 using DLCI 442 and 224 respectfully. Use sub-interface. Configure IP address 172.16.24.0/29 using the router number as the fourth octet. Do not use any other DLC’s
B. Configure OSPF on R1, R3 and R6. put all LAN interface in AREA 0 and all WAN interfaces into area 1.
C. Configure EIGRP on R2, R3 and R4.
D. Configure redistribution between OSPF and EIGRP.
E. Configure R3 so a dynamic access-list allows users on R2 TokenRing0/0 full IP access to any device on 172.16.136.0/26 once authenticated with Username testking and password ccie. Do not allow any other access to 172.16.136.0/26. Force entries in the access-list to timeout in three minutes and access to the devices on 172.16.136.0/26 in two minutes.

Instructor’s Comments and Technical Tips
A. N/A.
B. See OSPF Labs if necessary.
C. See EIGRP labs if necessary.
D. Make sure the metrics and subnet parameters are set correctly.
E. Create an extended dynamic access-list. Use command under cty to set timeout value.

Technical Verification

Technical Verification For Task A

```plaintext
r2#sho frame map
Serial 1/0.1 (up): point-to-point dlci, dlci 244(0xF4, 0xC40), broadcast
   Status defined, active
r2#

r3#sho frame map
Serial1/0.1(up): point-to-point dlci 442(0*1BA, 0*6CA0), static,
   broadcast, status defined, active
r4#
```

Technical Verification For Task A

```plaintext
r1#sho ip ospf interf
Ethernet0/0 is up, line protocol is up
Internet address 172.16.136.1/26, Area 0
Process ID 1, Router ID 192.168.1.1, Network type BROADCAST, Cost: 10
Transmit Delay is 1 sec, State DR, Priority 1
Designation router (ID) 192.168.6.6, Interface address 172.16.136.6
Backup designation router (ID) 192.168.5.5, Interface address 172.16.136.5
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:00
Index1/1, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 0, maximum is 1
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor count is 3, Adjacent neighbor count is 2
Adjacent with neighbor 192.168.6.6 (Designated Router
Adjacent with neighbor 192.168.5.5 (Backup Designation Router)
Suppress hello for 0 neighbor(s)
Loopback0 is up, line protocol is up
Internet address 172.16.1.1/30, Area 1
Serial1/1 is up, line protocol is up
Internet address 172.16.31.1/30, Area 1
Process ID 1, Router ID 192.168.1.1, Network type POINT_TO_POINT, Cost: 48
Transmit delay is 1 sec, State POINT_TO_POINT,
Timer intervals configured, Hello 10, Dead 40, Retransmit 5
Hello due in 00:00:07
Index2/3, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 1, maximum is 1
```
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor count is 1, adjacent neighbor counts is 1
Adjacent with neighbor 192.168.3.3
Suppress hello for 0 neighbor(s)
TokenRing0/0 is up, line protocol is up
Internet address 172.16.15.1/28, Area 1
Process ID 1, Router ID 192.168.1.1, network Type BROADCAST, Cost: 6
Transmit delay is 1 sec, State DR, Priority 1
Designed Router (id) 192.168.1.1, Internet address 172.16.15.1
Backup Designation router (id) 192.168.5.5, Interface address 172.16.15.5
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:06
Index ½, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 1, maximum is 4
Last length scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
Adjacent with neighbor 192.168.5.5 (Designation Router)
Suppress hello for 0 neighbor(s)
r1#

r3#sho ip ospf inter
Ethernet0/0 is up, line protocol is up
Internet address 172.16.136.3/26, Area 0
Internet ID 1, Router ID 192.168.3.3, Network Type BROADCAST, Cost: 10
Transmit Delay is 1 sec, State DR, Priority 1
Designation router (ID) 192.168.6.6, Interface address 172.16.136.6
Backup designation router (ID) 192.168.3.3, Interface address 172.16.136.5
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:04
Index1/1, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 2, maximum is 2
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor count is 3, Adjacent neighbor count is 2
Adjacent with neighbor 192.168.6.6 (Designation Router)
Adjacent with neighbor 192.168.5.5 (Router Designation Router)
Suppress hello for 0 neighbor(s)
Serial1/1 is up, line protocol is up
Internet address 172.16.31.2/30, Area 1
Process ID 1, Router ID 192.168.3.3, Network type POINT_TO_POINT, Cost: 781
Transmit delay is 1 sec, State POINT_TO_POINT,
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:00
Index2/3, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 1, maximum is 1
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor count is 1, adjacent neighbor counts is 1
Adjacent with neighbor 192.168.1.1
Suppress hello for 0 neighbor(s)
r2#

r5#sho ip osp inter
Ethernet0/0 is up, line protocol is up
Internet address 172.16.136.5/26, Area 0
Process ID, Router ID 192.168.5.5, Network Type BROADCAST, Cost: 10
Transmit delay is 1 sec, State DROTHER, Priority 1
Designated Router (ID) 192.168.6.6, interface address 172.16.136.6
Backup Designated router (ID) 192.168.5.5, Interface address 172.16.136.5
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:07
Index 2/2, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 1, maximum 4
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 3, Adjacent neighbor count is 3
Adjacent with neighbor 192.168.1.1
Adjacent with neighbor 192.168.3.3
Adjacent with neighbor 192.168.6.6 (Designated Router)
Suppress hello for 0 neighbor(s)
TokenRing0/0 is up, line protocol is up
Internet address 172.16.15.5/28, Area 1
Process ID 1, Router ID 192.168.5.5, Network Type BROADCAST, Cost: 6
Transmit Delay is 1 sec, State BDR, Priority 1
Designated Router (ID) 192.168.1.1, interface address 172.16.15.5
Backup Designated router (ID) 192.168.5.5, Interface address 172.16.15.1
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:09
Index 1/1, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 1, maximum is 3
Last length scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, adjacent neighbor count is 1
Adjacent with neighbor 192.168.1.1 ( Router Designated Router)
Suppress hello for 0 neighbor(s)
r5#

r6#sho ip ospf interf
FastEthernet0/0 is up, line protocol is up
Internet Address 172.16.136.6/26, Area 0
Process ID 1, Router ID 192.168.6.6, Network Type BROADCAST, Cost: 1
Transmit delay is 1 sec, State DR, Priority 1
Designated Router (ID) 192.168.5.5, interface address 172.16.136.6
Backup Designated router (ID) 192.168.3.3, Interface address 172.16.136.5
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:09
Index 1/1, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 2, maximum 2
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 3, Adjacent neighbor count is 3
Adjacent with neighbor 192.168.1.1
Adjacent with neighbor 192.168.3.3
Adjacent with neighbor 192.168.5.5 (Router Designated Router)

Suppress hello for 0 neighbor(s)
Ethernet0/0 is up, line protocol is up
Internet address 10.2.6.6/23, Area 0
Process ID 1, Router ID 192.168.6.6, Network Type BROADCAST, Cost: 10
Transmit Delay is 1 sec, state DR, Priority 1
Designated Router (ID) 192.168.6.6, interface address 10.2.6.6
No backup Designated router on this network
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:02
Index 1/1, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 0, maximum is 0
Last length scan time is 0 msec, maximum is 0 msec
Neighbor Count is 0, adjacent neighbor count is 0
Suppress hello for 0 neighbor(s)
r6#

Technical Verification For Task C
r2#shoip ei ne
IP-EIGRP neighbors for process 1
H Address Interface Hold UP time SRTT RTO Q Seq Type
  (sec)       (ms)  CntNum
1 172.16.24.4 Se1/0.1 12 00:05:29 4 200 0 2
0 172.16.32.3 Se1/0 13 00:05:54 24 200 0 5
r1#

r3#shoip ei ne
IP-EIGRP neighbors for process 1
H Address Interface Hold UP time SRTT RTO Q Seq Type
**Technical Verification For Task D**

Codes: C- connected, S- static, I- IGRP, R- RIP, M- mobile, B- BGP O- 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, E- EGP I-IS-IS, L1- 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

172.16.0.0/16 is variably subnetted, 6 subnets, 5 masks
  C  172.16.16.0/24 is directly connected, Ethernet0/0
  O E2 172.16.16.0/24[110/64] via 172.16.16.3, 00:02:08, Ethernet0/0
  C  172.16.31.0/30 is directly connected, Serial1/1
  O E2 172.16.24.0/29[110/64] via 172.16.16.3, 00:02:08, Ethernet0/0
  C  172.16.15.0/28 is directly connected, TokenRing0/0
  O E2 172.16.2.0/24[110/64] via 172.16.16.3, 00:02:08, Ethernet0/0
  10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
  O  10.26.0/23[110/20] via 172.16.16.6, 00:02:29, Ethernet0/0
  O E2 10.1.4.0/22[110/64] via 172.16.16.3, 00:02:09, Ethernet0/0
  C  192.168.1.0/24 is directly connected, Loopback0

Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 6 subnets, 5 masks
D EX  172.16.16.0/26[170/40514560] via 172.16.32.3, 00:06:42, Serial1/1
Codes: C- connected, S- static, I- IGRP, R- RIP, M- mobile, B- BGP O- 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, E- EGP I-1 IS-IS, L1- 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
172.16.0.0/16 is variably subnetted, 6 subnets, 5 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
C 172.16.32.0/24 is directly connected, Serial1/2
C 172.16.31.0/30 is directly connected, Serial1/1
D 172.16.24.0/29[90/21024000] via 172.16.32.2, 00:13:57, Serial1/2
O 172.16.15.0/28[110/787] via 172.16.32.2, 00:13:57, Serial1/2
D 172.16.2.0/24[90/20528128] via 172.16.32.2, 00:13:57, Serial1/2
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O 10.2.6.0/23[110/20] via 172.16.136.6, 00:02:42, Ethernet0/0
D 10.1.4.0/22[90/21049600] via 172.16.32.2, 00:13:36, Serial1/2
C 192.168.3.0/24 is directly connected, Loopback0
r3#

Codes: C- connected, S- static, I- IGRP, R- RIP, M- mobile, B- BGP O- 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, E- EGP I-1 IS-IS, L1- 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
172.16.0.0/16 is variably subnetted, 6 subnets, 5 masks
D EX 172.16.136.0/26[170/41026560] via 172.16.24.2, 00:06:57, Serial0/0.1
D 172.16.32.0/24[90/2681856] via 172.16.24.2, 00:13:43, Serial0/0.1
D EX 172.16.31.0/30[170/41026560] via 172.16.24.2, 00:06:57, Serial0/0.1
r4#sho ip route

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP, O - 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, E - EGP, I - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, IA - IS-IS inter area, * - candidate default, + - nondefault, D - periodic downloaded static route

Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 6 subnets, 5 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
O E2 172.16.32.0/24 [110/64] via 172.16.136.3, 00:02:39, Ethernet0/0
O 172.16.31.0/30 [110/54] via 172.16.15.1, 00:02:59, TokenRing0/0
O E2 172.16.24.0/29 [110/64] via 172.16.136.3, 00:02:39, Ethernet0/0
C 172.16.15.0/28 is directly connected, TokenRing0/0
O E2 172.16.2.0/24 [110/797] via 172.16.136.3, 00:02:39, Ethernet0/0
C 192.168.5.0/24 is directly connected, Loopback0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O 10.2.6.0/23 [110/41026560] via 172.16.24.2, 00:06:58, Serial0/0.1
C 10.1.4.0/22 is directly connected, Ethernet0/0

r5#

r5#sho ip route

Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 6 subnets, 5 masks
C 172.16.136.0/26 is directly connected, Ethernet0/0
O E2 172.16.32.0/24 [110/64] via 172.16.136.3, 00:02:39, Ethernet0/0
O 172.16.31.0/30 [110/54] via 172.16.15.1, 00:02:59, TokenRing0/0
O E2 172.16.24.0/29 [110/64] via 172.16.136.3, 00:02:39, Ethernet0/0
C 172.16.15.0/28 is directly connected, TokenRing0/0
O E2 172.16.2.0/24 [110/797] via 172.16.136.3, 00:02:39, Ethernet0/0
C 192.168.5.0/24 is directly connected, Loopback0
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O 10.2.6.0/23 [110/41026560] via 172.16.24.2, 00:06:58, Serial0/0.1
O E2 10.1.4.0/22 [110/64] via 172.16.136.3, 00:02:40, Ethernet0/0

r6#

r6#sho ip route

Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 6 subnets, 5 masks
C 172.16.136.0/26 is directly connected, FastEthernet0/0
O E2 172.16.32.0/24 [110/64] via 172.16.136.3, 00:02:56, FastEthernet0/0
O IA 172.16.31.0/30 [110/49] via 172.16.136.1, 00:02:56, FastEthernet0/0

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Technical Verification For Task E

r3#sho access-list
Extended IP access list 101
Permit tcp host 172.16.32.3 eq telnet
Dynamic testking permit ip any 172.16.136.3.0 0.0.0.63
r3#

r2#ping 172.16.136.6
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.136.6, timeout is 2 seconds:
U..U.
Success 5 is 0 percent (0/5)

r2#telnet 172.16.32.3
Trying 172.16.32.3…open

User Access Verification
Password:
[connected to 172.16.32.3 closed by foreign host]

r2#ping 172.16.136.5
Type escape sequence to abort.
Sending 5, 100-bytes ICMP Echos to 172.6.136.5, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/32/32 ms
r2#

r3#sho ip access-list
Extended IP access list 101
Permit tcp any host 172.16.32.3 eq telnet (58 matches)
Dynamic testking permit any 172.16.136.0 0.0.0.63
Permit ip any 172.16.136.0 0.0.0.63 (6 matches) (time left 158)
r3#
Configuration Verification

Only relevant portions of the configuration have been included.

Router 1

r1#sh run
!
hostname r1
!
!
interface Loopback0
ip address 192.168.1.1 255.255.255.0
!
interface Ethernet0/0
ip address 172.16.136.1 255.255.255.192
half-duplex
!
interface TokenRing0/0
ip address 172.16.15.1 255.255.255.240
ring-speed 16
!
interface Serial1/0
no ip address
encapsulation frame-relay
shutdown
!
interface Serial1/1
ip address 172.16.13.1 255.255.255.252
!
router ospf 1
log-adjacency-changes
network 172.16.15.0 0.0.0.255 area 1
network 172.16.13.0 0.0.0.3 area 1
network 172.16.136.0 0.0.0.63 area 0
!
!
end
r1#

Router 2

R2#sh run
!
!
hostname
interface Loopback0
ip address 192.168.2.2 255.255.255.0
!
interface BRI0/0
no ip address
shutdown
!
interface Ethernet0/0
no ip address
shutdown
half-duplex
!
interface TokenRing0/0
ip address 172.16.2.2 255.255.255.0
ring-speed 16
!
interface Serial1/0
no ip address
encapsulation frame-relay
no frame-relay inverse-arp
frame-relay interface-dlci 244
!
interface Serial1/1
ip address 172.16.32.2 255.255.255.0
!
router eigrp 1
network 172.16.0.0
no auto-summary
no eigrp log-neighbor-changes
!
end
r2#

Router 3

R3#sh run
!
!
hostname r3
!
!
username testking password 0 ccie
! interface Loopback0
ip address 172.16.136.3 255.255.255.192
half-duplex
!
interface BRI0/0
no ip address
shutdown
!
interface Serial1/0
no ip address
encapsulation frame-relay
shutdown
!
interface Serial1/1
ip address 172.16.31.2 255.255.255.252
clockrate 64000
!
interface Serial1/2
ip address 172.16.31.2 255.255.255.0
ip access-group 101 in
clockrate 64000
!
interface Serial1/3
ip address 172.16.35.1 255.255.255.252
shutdown
clockrate 64000
!
routing eigrp 1
redistribute ospf metric 64 10 100 1 1500
network 172.16.32.0 0.0.0.255
no auto-summary
no eigrp log-neighbor-changes
!
routing ospf 1
log-adjacency-changes
redistribute eigrp 1 metric 64 subnets
network 172.16.31.0 0.0.0.3 area 1
network 172.16.136.0 0.0.0.63 area 0
!
!
access-list 101 permit tcp any host 172.16.32.3 eq telnet
access-list 101 dynamic testking timeout 120 permit ip any 172.16.136.0 0.0.0.63
!
!  
!  
line vty 0 4  
password cisco  
login local  
autocommand access-enable timeout 3  
!  
end  

r3#  

**Router 4**  

*R4#sh run*  

!  
!  
hostname r4  
!  
!  
interface Loopback0  
ip address 192.168.4.4 255.255.255.0  
!  
interface Ethernet0/0  
ip address 10.1.4.4 255.255.252.0  
half-duplex  
!  
interface Serial0/0  
no ip address  
encapsulation frame-relay  
no frame-relay inverse-arp  
!  
interface Serial0/0.1 point-to-point  
ip address 172.16.24.4 255.255.255.248  
frame-relay interface-dlci 442  
!  
interface Serial0/1  
no ip address  
shutdown  
!  
router eigrp 1  
network 10.0.0.0  
network 172.16.0.0  
no auto-summary  
no eigrp-summary  
no eigrp log-neighbor-changes  
!  

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Router 5

R5#sh run

! hostname r5!
interface Loopback0
ip address 192.168.5.5 255.255.255.0
interface Ethernet0/0
ip address 172.16.136.5 255.255.255.192
half-duplex
interface Serial0/0
ip address 172.16.35.2 255.255.255.252
interface TokenRing0/0
ip address 172.16.15.5 255.255.255.240
ring-speed 16
interface Serial0/1
no ip address
shutdown
interface ATM1/0
no ip address
shutdown
no atm ilmi-keepalive
router ospf 1
log-adjacency-changes
network 172.16.15.0 0.0.0.255 area 1
network 172.16.136.0 0.0.0.63 area 0
end
r5#
Router 6

R6#sh run

! 
hostname r6 
! 
interface Loopback0 
ip address 192.168.6.6 255.255.255.0 
no ip directed-broadcast 
! 
interface FastEthernet0/0 
ip address directed-broadcast 
duplex auto 
speed auto 
! 
interface ATM1/0 
no ip address 
no ip address 
no ip directed-broadcast 
shutdown 
no atm-keepalive 
! 
interface Ethernet2/0 
ip address 10.2.6.6 255.255.254.0 
no ip directed-broadcast 
! 
router ospf 1 
network ospf 1 
network 10.2.6.0 0.0.1.255.255.254.0 
no ip directed-broadcast 
! 
router ospf 1 
network 10.2.6.0 0.01.255 area 0 
network 172.16.136.0 0.0.0.63 area 0 
! 
end
Lab Preparation Scenario: SNMP and HTTP

Topics Covered
- EIGRP
- SNMP
- Router SNMP access-list
- Router SNMP communities
- Switch SNMP communities
- Switch SNMP permit
- HTTP Server
- HTTP Authentication
- HTTP Port
- HTTP access

Difficulty Level: CCIE™
Average completion Time: 2 Hours

Standard TCP/IP Addressing and SPID Information

R1 (3620)
Loop0  192.168.1.1/24  Loopback
E/0/0  172.16.136.1/26  Ethernet Segment to Catalyst 3/1
T0/0  172.16.15.1/28  Token ring Segment to 3920
S1/1  172.16.31.1/30  Serial to R3
S1/0  unassigned  Frame-relay

R2 (3620)
Loop0  192.168.2.2/24  Loopback
T0/0  172.16.2.2/24  Token Ring segment to 3920
BRI0/0  172.16.230.2/24  BRI to R3
S1/1  172.16.32.2/24  Serial to R3
S1/0  unassigned  Frame-relay

R3 (2610)
Loop0  192.168.2.2/24  Loopback
E0/0  172.16.136.3/26  Ethernet Segment to Catalyst 3/3
BRI0/0  172.16.230.3/24  ISDN toR2
S1/3  172.16.35.1/30  Serial to R5
S1/2  172.16.32.3/24  Serial to R2
S1/1  172.16.31.2/30  Serial to R1
S1/0  unassigned  Frame-relay
CCIE LAB

Loop0  192.168.4.4/24  Loopback
E0/0  10.1.4.4/22  Ethernet Segment to Catalyst 3/5
S0/0  Unassigned  Frame-relay

R5 (3620)
Loop0  192.168.5.5/24  Loopback
E0/0  172.16.136.5/26  Ethernet Segment to Catalyst 3/5
T0/0  172.16.15.5/28  Token Ring segment to 3920
S0/0  172.16.35.2/30  Serial link to R3
A1/0  172.16.56.5/30  ATM-R6

R6 (3640)
Loop0  192.168.6.6/24  Loopback
FA0/0  172.16.136.6/26  Ethernet segment-R2
E2/0  10.2.6.6/23  Ethernet segment-BB2
A1/0  172.16.56.6/30  ATM-R5

ISDN Information
Switch Type  Basic-NI 1

R2
SPID1:  42255501210101
SPID2:  42255501220101

R3
SPID1:  42255501310101
SPID2:  42255501320101

Technical Tasks
A.  Configure EIGRP on R1, R2, R3, R5, and R6. R4 will not be used in this LAB. Put all LAN interfaces into EIGRP.
B.  Configure R1 for SNMP community Public for Read only access and SNMP community TESTKING for RW access. Configure the SNMP server of 172.16.136.100. Allow any devices from 172.16.136.0/26 to access the TESTKING community or to TFTP files to the Router.
C.  Configure the Cat5k for IP address 172.6.136.15/26. Configure the SNMP community Public for Read only and the SNMP community TESTKING for Read Write access. Only allow the SNMP server 172.16.136.100 to access the SNMP facilities on the catalyst. Do not allow any other devices to access the Cat expert the SNMP server.
D.  Configure R3 to support HTTP access from 172.16.136.0/26. Configure the router to allow only user TESTKING with password CCIE to access the router using port 81.

Instructor’s Comments and Technical Tips
A.  N/A.
B.  Create an extended IP Access-list with a dynamic access-list.
C.  Use the Set IP Permit command. Make sure you have correctly specified the parameters before enabling.
D. HTTP access to the router sends clear text passwords so it is a poor choice to use over the Internet. To reduce some of the risk associated with HTTP on the router on the use IP HTTP authentication.

Technical Verification

Technical Verification For Task A

```
r2#sh ip int s1/0.1
Serial 1/0.1 is up, line protocol is up

r1#sho ip route
Codes: C- connected, S- static, I- IGRP, R- RIP, M- mobile, B- BGP
O- 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, E- EGP I_IS-IS, L1-
IS-IS level-2, IA-IS-IS inter area*-candidate default, U-per-user static route, o-ODR P-periodic downloaded
istatic route

Gateway of last resort is not set
172.16.0.0/16 is variably subnetted, 6 subnets, 4 masks
C 172.16.132.0/26 is directly connected, Ethernet0/0
D 172.16.32.0/24[90/20537600] via 172.16.136.3, 00:18:25, Ethernet0/0
C 172.16.31.0/30 is directly connected, Serial1/1
C 172.16.15.0/28 is directly connected, TokenRing0/0
D 172.16.2.0/24[90/20553728] via 172.16.136.3, 00:17:55, Ethernet0/0
D 172.16.6.0/24 [90/409600] via 172.16.136.3, 00:19:34, TokenRing0/0
C 192.168.1.0/24[90/409600] via 172.16.136.3, 00:19:04, Ethernet0/0
```
**CCIE LAB**

C 172.16.2.0/24 is directly connected, TokenRing0/0
D 192.168.5.0/24[90/1915392] via 172.16.32.3, 00:18:10, Serial1/1
D 192.168.6.0/24 [90/1915392] via 172.16.32.3, 00:18:11, Serial1/1
D 192.168.1.0/24[90/1915392] via 172.16.32.3, 00:18:11, Serial1/1
C 192.168.2.0/24 is directly connected, Loopback0
D 192.168.3.0/24[90/1889792] via 172.16.32.3, 00:18:11, Serial1/1

```
r3#sho ip route
Codes: C-connected, S-static, I-IGRP, 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, E-EGP I-IS-IS, 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 download static route

Gateway of last resort is not set

    172.16.0.0/16 is variably subnetted, 5 subnets, 4 masks
   C 172.16.136.0/26 is directly connected, Ethernet0/0
   C 172.16.32.0/24 is directly connected, Serial1/2
   C 172.16.31.0/30 is directly connected, Serial1/1
   D 172.16.15.0/28[90/297728] via 172.16.136.1, 00:20:00, Ethernet0/0
   [90/297728] via 172.16.136.5, 00:20:00, Ethernet0/0
   D 172.16.2.0/24[90/20528128] via 172.16.32.2, 00:18:21, Serial1/2
   D 192.168.5.0/24[90/409600] via 172.16.136.5, 00:20:00, Ethernet0/0
   D 192.168.6.0/24[90/409600] via 172.16.136.5, 00:19:28, Ethernet0/0
   D 192.168.1.0/24[90/409600] via 172.16.136.1, 00:20:01, Ethernet0/0
   D 192.168.2.0/24[90/20640000] via 172.16.136.3, 00:18:32, Serial1/2
   C 192.168.3.0/24 is directly connected, Loopback0
r3#
```

```
r5#sho ip route
Codes: C-connected, S-static, I-IGRP, 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, E-EGP I-IS-IS, L1- IS-IS level-1, L2- IS-IS level-2, IA-IS-IS inter area*-candidate default, U-per-user static route, IA-IS-IS inter area P-periodic download static route

Gateway of last resort is not set

    172.16.0.0/16 is variably subnetted, 5 subnets, 4 masks
   C 172.16.136.0/26 is directly connected, Ethernet0/0
   D 172.16.32.0/24[90/20537600] via 172.16.136.3, 00:19:01, Ethernet0/0
   D 172.16.31.0/30[90/1777920] via 172.16.15.1, 00:20:12, TokenRing0/0
   C 172.16.15.0/28 is directly connected, TokenRing0/0
   D 172.16.2.0/24[90/20553728] via 172.16.136.3, 00:18:32, Ethernet0/0
   C 192.168.5.0/24 is directly connected, Loopback0

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r6#sho ip route
Codes: C-connected, S-static, I-IGRP, 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, E-EGP I-IS-IS, L1-IS-IS level-1, L2- IS-IS level2, IA-ISW-IS inter area*-candidate default, U-per-user static route, o-ODR p-periodic downloaded static route.

Gateway of last resort is not set

    172.16.0.0/16 is Variably subnetted, 5subnets, 4 masks
    C 172.16.136.0/26 is directly connected, FastEthernet0/0
    D 172.16.32.0/24
        [90/20514560] via 172.16.136.3, 00:19:17, FastEthernet0/0
    D 172.16.31.0/24
        [90/1764352] via 172.16.136.1, 00:19:54, FastEthernet0/0
    D 172.16.31.0/28 [90/178688] via 172.16.136.5, 00:19:54, FastEthernet0/0
        [90/178688] via 172.16.136.1, 00:19:54, FastEthernet0/0
    D 172.16.2.0/24
        [90/20530688] via 172.16.136.3, 00:18:47, FastEthernet0/0
    D 192.168.5.0/24 [90/156160] via 172.16.136.5, 00:19:54, FastEthernet0/0
        10.0.0.0/23 is subnetted, subnets
        C 10.2.6.0 is directly connected, Ethernet2/0
        C 192.168.6.0/24 is directly connected, Loopback0
    D 192.168.1.0/24 [90/156160] via 172.16.136.1, 00:19:54, FastEthernet0/0
    D 192.168.2.0/24 [90/20642560] via 172.16.136.3, 00:18:46, FastEthernet0/0
    D 192.168.3.0/24 [90/156160] via 172.16.136.3, 00:19:56, FastEthernet0/0

Technical Verification For Task B

snmp-server community public RO 1
snmp-server community TESTKING RO 2
snmp-server host 172.16.136.100 TESTKING
snmp-server tftp-server-list 2

r1#sho access-list
Standard IP access list 1
    permit 172.16.136.0, 100 wildcard bits 0.0.0.255
Standard IP access list 2

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permit 172.16.136.100

r1#

Technical Verification For Task C

Console> (enable) SHO SNMP

RMON:   Disabled
Extended RMON: Extended RMON module is not present
Extended RMON Netflow: Disabled
Extended RMON Vlanmode: Disabled
Extended RMON Vlanagent: Disabled
Memory usage limit for new RMON entries: 85 percent
Traps Enabled:
Port, Module, Chassis, Bridge, Repeater, Vtp, Auth, ippermit, Vmps, config, entity, stpx, sy
Slog, system
Port Traps Enabled: 1/1-2, 3/1-12

Community-Access    Community-String
---------------------  ------ -------------
read-only   public
read-write   private
read-write-all   TESTKING

Trap-Rec-Address Trap-Rec-Community Trap-Rec-Port Trap-Rec-Owner Trap-Rec_Index
-----------  ---------------  -------------------       ---------------  ---------------  ----------------
172.16.136.100   TESTKING  162   CLI   1

Console> (enable)

Console> (enable) sho ip permit

Telnet permit list enabled.
Ssh permit list enabled.
Snmp permit list enabled.
Permit list Mask Access-type
----------- -------- -------------
172.16.136.100                 snmp

Denied IP Address last Accessed Time-Type
-----------

console> (enable)

Technical Verification For Task D

sho run (abbreviated)

ip http server
ip http port 81
ip http access-list-class 1
ip http authentication local
Configuration Verification

Only relevant portions of the configuration have been included.

Router 1

r1#sh run
!hostname r1
!
interface Loopback0
ip address 192.168.1.1 255.255.255.0
!
interface Ethernet0/0
ip address 172.16.136.1 255.255.255.192
half-duplex
!
interface TokenRing0/0
ip address 172.16.15.1 255.255.255.240
ring-speed 16
!
interface Serial1/0
no ip address
encapsulation frame-relay
shutdown
!
interface Serial1/1
ip address 172.16.31.1 255.255.255.252
!
router eigrp 1
network 172.16.0.0
network 192.168.1.0
no auto-summary
no eigrp log-neighbor-changes
!
access-list 1 permit 172.16.136.0 0.0.0.255
access-list 2 permit 172.16.136.100
!
snmp-server community public RO 1
snmp-server community TESTKING RO 2
snmp-server host 172.16.136.100 TESTKING
snmp-server tftp-server-list 2
!
end
r1#
Router 2

R2#sh run

hostname r2
!
!
!
!
interface Loopback0
ip address 192.168.2.2 255.255.255.0
!
interface BRI0/0
no ip address
shutdown
!
interface Ethernet0/0
no ip address
shutdown
half-duplex
!
interface TokenRing0/0
ip address 172.16.2.2 255.255.255.0
ring-speed 16
!
interface Serial1/0
no ip address
encapsulation frame-relay
shutdown
!
interface Serial1/1
ip address 172.16.32.2 255.255.255.0
!
router eigrp 1
network 172.16.0.0
network 192.168.2.0
no auto-summary
no eigrp log-neighbor-changes
!
!
end

r2#

Router 3

R3#sh run

!
hostname r3
!
!
username r3
!
!
username TESTKING password 0 CCIE
!
!
interface Loopback0
ip address 192.168.3.3 255.255.255.0
!
interface Ethernet0/0
ip address 172.16.136.3 255.255.255.192
half-duplex
!
interface BRI0/0
no ip address
shutdown!
Interface Serial1/0
No ip address
Encapsulation frame-relay
Shutdown
!
interface serial1/1
ip address 172.16.31.2 255.255.255.252
clockrate 64000
!
interface Serial1/2
ip address 172.16.32.3 255.255.255.0
clockrate 64000
!
interface Serial1/3
ip address 172.16.35.1 255.255.255.252
shutdown
clockrate 64000
!
router eigrp 1
 network 172.16.0.0
 network 192.168.3.0
 no auto-summary
 no eigrp log-neighbor-changes
!
no http server
ip http port 81
ip http access-class 1
ip http authentication local
!
access-list 1 permit 172.16.136.0 0.0.0.255
!
!
!
end
r3#

**Router 5**

**R5#sh run**

hostname r5
!
!
!
interface Loopback0
ip address 192.168.5.5 255.255.255.0
!
interface Ethernet0/0
ip address 172.16.136.5 255.255.255.192
half-duplex
!
interface Serial0/0
ip address 172.16.136.5 255.255.255.192
half-duplex
!
interface TokenRing0/0
ip address 172.16.15.5 255.255.255.240
ring-speed 16
!
interface serial0/1
no ip address
shutdown
!
interface SerialATM1/0
no ip address
shutdown
no atm ilmi-keepalive
!
router eigrp 1
network 172.16.0.0
network 192.168.5.0
no auto-summary
no eigrp-log-neighbor-changes
!
end
r5#

Router 6

R6#sh run
!
hostname r6
!
!
interface Loopback0
ip address 192.168.6.6 255.255.255.0
no ip directed-broadcast
!
interface FastEthernet0/0
ip address 172.16.136.6 255.255.255.192
no ip directed-broadcast
shutdown
no atm ilmi-keepalive
!
interface Ethernet2/0
ip address 10.2.6.6 255.255.254.0
no ip directed-broadcast
!
router eigrp 1
network 172.16.0.0
network 192.168.6.0
no auto-summary
!
!
end
r6#

Console>(enable) sho run
This command shows non-default configuration only.
Use ‘show config all’ to show both default and non-default configurations.
.............
................
................
Cat 5000

Console> (enable) sh run

 Begin
!
#*****NON-DEFAULT CONFIGURATION*****
!
#time: Mon Feb 25 2002, 19:25:36
!
#version 6.3(4)
!
set option fddi-user-pri enabled
!
#frame distribute method
set port channel all distribution mac both
!
#snmp
set snmp community read-write-all TESTKING
set snmp trap enable module
    set snmp trap enable chassis
    set snmp trap enable bridge
    set snmp trap enable repeater
    set snmp trap enable vtp
    set snmp trap enable auth
    set snmp trap enable ippermit
    set snmp trap enable vmips
    set snmp trap enable entity
    set snmp trap enable config
    set snmp trap enable stpx
    set snmp trap enable syslog
    set snmp trap enable system
set snmp trap 10.2.6.254 testking port 162 owner CLI index 1
!
#ip
set interface sc0 1 172.16.136.15/255.255.255.0 172.16.136.255
!
set ip route0.0.0.0/0.0.0.0 172.16.136.6
!
!
#permit list
set ip permit enable snmp
set ip permit 172.16.136.100 snmp
!
#default port status is enable
CCIE LAB

1
1
#module 1: 2-port 10/100BaseTX Supervisor
set port trap 1/1-2 enable
!
#module 2 empty
!
#module 3: 12-port 10/100BaseTX Ethernet
set port trap 3/1-12 enable
!
#module 4 empty
!
#module 5: 1-port MM OC-ATM
end
Lab Preparation Scenario - Layer 2 ACL’s

Topics Covered
- Frame Relay
- EIGRP
- Mac address filter

Difficulty Level: CCIE™
Average completion Time: 1 Hour

Standard TCP/IP Addressing and SPIID Information

**R1 (3620)**
- Loop0: 192.168.1.1/24 (Loopback)
- E/0/0: 172.16.136.1/26 (Ethernet Segment to Catalyst 3/1)
- T0/0: 172.16.15.1/28 (Token ring Segment to 3920)
- S1/1: 172.16.31.1/30 (Serial to R3)
- S1/0: unassigned (Frame-relay)

**R2 (3620)**
- Loop0: 192.168.2.2/24 (Loopback)
- T0/0: 172.16.2.2/24 (Token Ring segment to 3920)
- BR1/0/0: 172.16.230.2/24 (BRI to R3)
- S1/1: 172.16.32.2/24 (Serial to R3)
- S1/0: unassigned (Frame-relay)

**R3 (2610)**
- Loop0: 192.168.2.2/24 (Loopback)
- E0/0: 172.16.136.3/26 (Ethernet Segment to Catalyst 3/3)
- BR1/0/0: 172.16.230.3/24 (ISDN to R2)
- S1/3: 172.16.35.1/30 (Serial to R5)
- S1/2: 172.16.32.3/24 (Serial to R2)
- S1/1: 172.16.31.2/30 (Serial to R1)
- S1/0: unassigned (Frame-relay)

**R3 (2610)**
- Loop0: 192.168.4.4/24 (Loopback)
- E0/0: 10.1.4.4/22 (Ethernet Segment to Catalyst 3/5)
- S0/0: Unassigned (Frame-relay)

**R5 (3620)**
- Loop0: 192.168.5.5/24 (Loopback)

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Technical Tasks
A. Configure Frame relay on R2 to connect to R4 (DLCI 244). Use sub-interfaces on all the routers using the DLCI’s as the sub-interface number. Configure IP address as follows: R2 172.16.24.2/24 and R4 172.16.24.4/24.
B. Configure EIGRP on all routers putting all addressed into the routing process.
C. Configure R2 TokenRing0/0 to deny any bridging of Token-ring packets from MAC 1000.5A00.00001000.5AFF.FFFF and allows all others.

Instructor’s Comments and Technical Tips
N/A

Technical Verification
Technical Verification For Task A
r2#sh frame-relay map
Serial1/0.244 (up): point-to-point dlc, dlci 244(0*F4, 0*3C40), broadcast status defined, active
r2#
r4#sh frame-relay map
Serial1/0.442 (up): point-to-point dlc, dlci 442(0*1BA,0*6CA0), broadcast Status defined, active
r4#

Technical Verification For Task B
r1#sho ip route sum
IP routing table name is Default-IP-Routing-Table(0)
### CCIE LAB

<table>
<thead>
<tr>
<th>Route Source</th>
<th>Networks</th>
<th>Subnets</th>
<th>Overhead</th>
<th>Memory (bytes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>connected</td>
<td>1</td>
<td>3</td>
<td>256</td>
<td>576</td>
</tr>
<tr>
<td>static</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>eigrp</td>
<td>1</td>
<td>5</td>
<td>640</td>
<td>1440</td>
</tr>
<tr>
<td>internal</td>
<td>2</td>
<td></td>
<td>2328</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>8</td>
<td>896</td>
<td>4344</td>
</tr>
</tbody>
</table>

r1#

r2# sho ip route sum

IP routing table name is Default-IP-Routing-Table(0)

<table>
<thead>
<tr>
<th>Route Source</th>
<th>Networks</th>
<th>Subnets</th>
<th>Overhead</th>
<th>Memory (bytes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>connected</td>
<td>1</td>
<td>3</td>
<td>256</td>
<td>576</td>
</tr>
<tr>
<td>static</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>eigrp</td>
<td>1</td>
<td>5</td>
<td>640</td>
<td>1440</td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>8</td>
<td>896</td>
<td>4344</td>
</tr>
</tbody>
</table>

r2#

r3# sho ip route sum

IP routing table name is Default-IP-Routing-Table(0)

<table>
<thead>
<tr>
<th>Route Source</th>
<th>Networks</th>
<th>Subnets</th>
<th>Overhead</th>
<th>Memory (bytes)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>1</td>
<td>3</td>
<td>256</td>
<td>576</td>
</tr>
<tr>
<td>static</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>eigrp</td>
<td>1</td>
<td>5</td>
<td>640</td>
<td>1440</td>
</tr>
<tr>
<td>internal</td>
<td>2</td>
<td></td>
<td>2328</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>8</td>
<td>896</td>
<td>4344</td>
</tr>
</tbody>
</table>

r3#

r4# sho ip route sum

IP routing table name is Default-IP-Routing-Table(0)

<table>
<thead>
<tr>
<th>Route Source</th>
<th>Networks</th>
<th>Subnets</th>
<th>Overhead</th>
<th>Memory (bytes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>connected</td>
<td>1</td>
<td>3</td>
<td>256</td>
<td>576</td>
</tr>
<tr>
<td>static</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>1</td>
<td>5</td>
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<tr>
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<td>2</td>
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<td>2328</td>
<td></td>
</tr>
<tr>
<td>Total</td>
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<td>8</td>
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<td>4344</td>
</tr>
</tbody>
</table>

r4#

r5# sho ip route sum

IP routing table name is Default-IP-Routing-Table(0)

<table>
<thead>
<tr>
<th>Route Source</th>
<th>Networks</th>
<th>Subnets</th>
<th>Overhead</th>
<th>Memory (bytes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>connected</td>
<td>1</td>
<td>3</td>
<td>256</td>
<td>576</td>
</tr>
<tr>
<td>static</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>eigrp</td>
<td>1</td>
<td>5</td>
<td>640</td>
<td>1440</td>
</tr>
<tr>
<td>internal</td>
<td>2</td>
<td></td>
<td>2328</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>8</td>
<td>896</td>
<td>4344</td>
</tr>
</tbody>
</table>

r5#
r6#sho ip route sum
IP routing table name is Default-IP-Routing-Table(0)

<table>
<thead>
<tr>
<th>Route Source</th>
<th>Networks</th>
<th>Subnets</th>
<th>Overhead</th>
<th>memory (bytes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>connected</td>
<td>1</td>
<td>3</td>
<td>256</td>
<td>576</td>
</tr>
<tr>
<td>static</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>eigrp</td>
<td>1</td>
<td>5</td>
<td>640</td>
<td>1440</td>
</tr>
<tr>
<td>internal</td>
<td>2</td>
<td></td>
<td></td>
<td>2328</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>8</td>
<td>896</td>
<td>4344</td>
</tr>
</tbody>
</table>

r6#

Technical verification For Task C
r2#sho access-list
Bridge address access-list 700
deny 1000.5100.000 8000.00ff.ffff
permit 0000.0000.0000 ffff.ffff.ffff
r2#

Configuration Verification
Only relevant portions of the configuration have been included.

Router 1
r1#sh run
hostname r1
!
interface Loopback0
ip address 192.168.1.1 255.255.255.0
!
interface Ethernet0/0
ip address 172.16.136.1 255.255.255.192
half-duplex
!
interface TokenRing0/0
ip address 172.16.15.1 255.255.255.240
ring-speed 16
!
interface Serial1/0
no ip address
encapsulation frame-relay
shutdown
!
interface Serial1/1
ip address 172.16.31.1 255.255.255.252
!
router eigrp 1
network 172.16.0.0
network 192.168.1.0
no auto-summary
no eigrp log-neighbor-changes
!
!
end
r1#

**Router 2**

R2#sh run

```
! ostname r2
!
! interface Loopback0
ip address 192.168.2.2 255.255.255.0
!
interface BRI0/0
no ip address
shutdown
!
interface Ethernet0/0
no ip address
shutdown
half-duplex
!
interface TokenRing0/0
ip address 172.16.2.2 255.255.255.0
ring-speed 16
!
interface Serial1/0
no ip address
encapsulation frame-relay
no frame-relay inverse-arp
!
interface serial 1/0.244 point-to-point
ip address 172.16.24.2 255.255.255.0
frame-relay interface-dlci 244
!
interface Serial1/1
ip address 172.16.32.2 255.255.255.0
!
router eigrp 1
network 172.16.0.0
network 192.168.2.0
no auto-summary
```
no eigrp log-neighbor-changes
!
access-list 700 deny 1000.5100.000 8000.00ff.ffff
access-list 700 permit 0000.0000.0000 ffff.ffff.ffff
!
end
r2#

Router 3  
R3#sh run
hostname r3
!

interface Loopback0
ip address 192.168.3.3 255.255.255.0
!
interface Ethernet0/0
ip address 172.16.136.3 255.255.255.192
half-duplex
!
interface BRI0/0
no ip address
shutdown
!
interface serial1/0
no ip address
encapsulation frame-relay
shutdown
!
interface Serial1/1
ip address 172.16.31.2 255.255.255.252
clockrate 64000
!
interface serial1/2
ip address 172.16.32.3 255.255.255.0
clockrate 64000
!
interface Serial1/3
ip address 172.16.35.1 255.255.255.252
shutdown
clockrate 64000
!
router eigrp 1

network 172.16.0.0
network 192.168.3.0
no auto-summary
no eigrp log-neighbor-changes
!
!
end

r3#

**Router 4**

R4#sh run
hostname r4
!
interface Loopback0
ip address 192.168.4.4 255.255.255.0
!
interface Ethernet0/0
ip address 10.1.4.4 255.255.252.0
half-duplex
!
interface serial0/0
no ip address
encapsulation frame-relay
no frame-relay inverse-arp
!
interface serial0/0.442 point-to-point
ip address 172.16.24.2 255.255.255.0
frame-relay interface-dlci 442
!
interface Serial0/1
no ip address
!
router eigrp 1
network 10.0.0.0
network 172.16.0.0
network 192.168.4.0
no auto-summary
no eigrp log-neighbor-changes
!
!
end
r4#
Router 5
R5#sh run
  !
  hostname r5
  !
  interface Loopback0
  ip address 192.168.5.5 255.255.255.0
  !
  interface Ethernet0/0
  ip address 172.16.136.5 255.255.255.192
  half-duplex
  !
  interface Serial0/0
  ip address 172.16.35.2 255.255.255.252
  !
  interface TokenRing0/0
  ip address 172.16.15.5 255.255.255.240
  ring-speed 16
  !
  interface Serial0/1
  no ip address
  shutdown
  !
  interface ATM1/0
  no ip address
  shutdown
  no atm ilmi-keepalive
  !
  router eigrp 1
  network 172.16.0.0
  network 192.168.5.0
  no auto-summary
  no eigrp log-neighbor-changes
  !
  end
r5#

Router 6
R6#sh run
  !
  hostname r6
  !
  interface Loopback0

Leading the way in IT testing and certification tools, www.testking.com
ip address 192.168.6.6 255.255.255.0
no ip directed-broadcast
!
interface FastEthernet0/0
ip address 172.16.136.6 255.255.255.192
no ip directed-broadcast
duplex auto
speed auto
!
interface ATM1/0
no ip directed-broadcast
shutdown
no atm ilmi-keepalive
!
interface Ethernet2/0
ip address 10.2.6.6 255.255.254.0
no ip directed-broadcast
!
router eigrp 1
network 10.0.0.0
network 172.16.0.0
network 192.168.6.0
no auto-summary
no eigrp log-neighbor-changes
!
end
r6#
Lab Preparation Scenario - ATM (Asynchronous Transfer Mode)

Topics Covered
- Ls1010 PVC Creation
- ILMI signaling
- Defining NSAP address
- Configuration of SVC on routers
- Traffic Parameters

Difficulty Level: CCIE™
Average completion Time: 2 Hours

Standard TCP/IP Addressing and SPID Information

R1 (3620)
Loop0  192.168.1.1/24  Loopback
E/0/0  172.16.136.1/26  Ethernet Segment to Catalyst 3/1
T0/0  172.16.15.1/28  Token ring Segment to 3920
S1/1  172.16.31.1/30  Serial to R3
S1/0  unassigned  Frame-relay

R2 (3620)
Loop0  192.168.2.2/24  Loopback
T0/0  172.16.2.2/24  Token Ring segment to 3920
BRI0/0  172.16.230.2/24  BRI to R3
S1/1  172.16.32.2/24  Serial to R3
S1/0  unassigned  Frame-relay

R3 (2610)
Loop0  192.168.2.2/24  Loopback
E0/0  172.16.136.3/26  Ethernet Segment to Catalyst 3/3
BRI0/0  172.16.230.3/24  ISDN toR2
S1/3  172.16.35.1/30  Serial to R5
S1/2  172.16.32.3/24  Serial to R2
S1/1  172.16.31.2/30  Serial to R1
S1/0  unassigned  Frame-relay

R3 (2610)
Loop0  192.168.4.4/24  Loopback
E0/0  10.1.4.4/22  Ethernet Segment to Catalyst 3/5
S0/0  Unassigned  Frame-relay
CCIE LAB

R5 (3620)
- Loop0: 192.168.5.5/24  Loopback
- E0/0: 172.16.136.5/26  Ethernet Segment to Catalyst 3/5
- T0/0: 172.16.15.5/28  Token Ring segment to 3920
- S0/0: 172.16.35.2/30  Serial link to R3
- A1/0: 172.16.56.5/30  ATM-R6

R6 (3640)
- Loop0: 192.168.6.6/24  Loopback
- FA0/0: 172.16.136.6/26  Ethernet segment-R2
- E2/0: 10.2.6.6/23  Ethernet segment-BB2
- A1/0: 172.16.56.6/30  ATM-R5

ISDN Information
- Switch Type: Basic-NI 1

R2
- SPID1: 42255501210101
- SPID2: 42255501220101

R3
- SPID1: 42255501310101
- SPID2: 42255501320101

Technical Tasks

A. Configure R5 and R6 to communicate with the ILMI.
B. Configure a PVC to be used for SVC Signaling (Setup and Tear Down).
C. Configure r5 with an esi address of 555555555555.55 and r6 with an esi-address of 666666666666.66.
D. Create a PVC on the LS1010 switch connecting ATM0/0/0 with VPI/VCI (0 60) to ATM 0/0/2 with VPI VCI (2 60).
E. On R5 and R6 configure address 172.16.56.5 and 172.16.56.6 on the main ATM interface. Configure an ATM SVC on R5 and R6 with the name testking and encapsulation aal5mux. Make sure the routers can ping on another.
F. On R5 modify the SVC previously created with the following parameters; Change to VBR-NRT, output-peak cell rate=1200, sustainable cell rate 800, max burst size 72 and Input peak cell rate 1000, sustainable cell rate 500 and max burst size 64. Verify The routers can ping each other.

Instructor’s Comments and Technical Tips

A. A PVC must be configured to communicate with ILMI (Integrated Local Management Interface). The Typical VPI VCI values are 0 16. The ILMI must be configured on the ATM main interface.
B. ATM uses out-of-band signaling so a PVC must be setup to process the signaling before we can setup SVC’s. The typical VPI VCI values are 0 5. The singnaling PVC must be setup on the main ATM interface.

C. Every ATM interface involved in signaling must be configured with an unique NSAP address. In this case we have elected to only enter the ESI (Endstation ID) and receive the NSAP prefix from the ATM switch.

D. You will need to use the “atm pvc x x interface atmx/x/x x x command. This command creates the PVC for both the interface it is issued on and the one specified command. The Switch will only display the PVC on the highest numbered interface no matter which interface it is entered on.

E. Make sure the NSAP addressed entered in on the SVC is the destination address. Once you specify a name for an SVC, you can reenter interface-ATM-VC configuration made by simply entering the SVC name command.

F. When traffic parameters are entered the switch passes the values thru to the destination. If the Destination can not provide these capacity levels the call may fall. Make sure the Parameters are matched input to output on the corresponding endpoint.

**Technical Verification For task A&B**

```bash
r5#sho atm map
Map list testking_ATM1/0: PERMANENT
ip 172.16.56.6 maps to NSAP 47.0091810000000002B93AC201.666666666666.66
, broadcast, aal5mux, connection up, VC 15, VPI 0, ATM1/0

r5#

r6#sho atm map
Map list testking_ATM1/0: PERMANENT
ip 172.16.56.5 maps to NSAP 47.0091810000000002B93AC201.555555555555.55
, broadcast, aal5mux, connection up, VC 15, VPI 0, ATM1/0

r6#```

**Technical Verification For Task F**

```bash
LS10#sh atm vc
Interface VPI VCI Type X-Interf ace X-VPI X-VCI Encap Status
ATM0/0/0 0 5 PVC ATM2/0/0 0 43 QSAAL UP
ATM0/0/0 0 16 PVC ATM2/0/0 0 35 ILMI UP
ATM0/0/0 0 60 PVC ATM2/0/2 2 60 UP
ATM0/0/1 0 5 PVC ATM2/0/0 0 44 QSSAL UP
ATM0/0/1 0 16 PVC ATM2/0/0 0 36 ILMI UP
ATM0/0/2 0 5 PVC ATM2/0/0 0 45 QSAAL UP
ATM0/0/2 0 16 PVC ATM2/0/0 0 37 ILMI UP
ATM0/0/2 2 60 PVC ATM2/0/0 0 60 UP
ATM0/0/3 0 5 PVC ATM2/0/0 0 46 QSAAL DOWN
ATM0/0/3 0 16 PVC ATM2/0/0 0 38 ILMI DOWN
ATM0/0/0 0 5 PVC ATM2/0/0 0 47 QSAAL DOWN
```
ATM0/0/0  0  16  PVC  ATM2/0/0/0  0  39  ILMI DOWN
ATM0/0/1  0  5   PVC  ATM2/0/0/0  0  48  QSAAL DOWN
ATM0/0/1  0  16  PVC  ATM2/0/0/0  0  40  ILMI DOWN
ATM0/0/2  0  5   PVC  ATM2/0/0/0  0  49  QSAAL DOWN
ATM0/0/2  0  16  PVC  ATM2/0/0/0  0  41  ILMI DOWN
ATM0/0/3  0  5   PVC  ATM2/0/0/0  0  50  QSAAL DOWN
ATM0/0/3  0  16  PVC  ATM2/0/0/0  0  42  ILMI DOWN
ATM0/0/0  0  35  PVC  ATM2/0/0/0  0  16  ILMI UP
ATM0/0/0  0  36  PVC  ATM2/0/0/0  0  16  ILMI UP
ATM0/0/0  0  37  PVC  ATM2/0/0/0  0  16  ILMI UP

Technical Verification For Task D

r5#sho interface atm1/0
ATM1/0 is up, line protocol is up
Hardware is RS8234 ATMOC3
Internet address 172.16.56.5/24
MTU 4470 bytes, sub MTU 4470, BW 155000 Kbit, DLY 80 usec,
   Reliability 255/255, txload 1/255, rxload 1/255
   NSAP address: 47.0091810000000002B93AC201.555555555555.55
Encapsulation ATM, loopback not set
Keepalive not supported
Encapsulation(s): AAL5
1024 maximum active VCs, 2 current VCCs
VC idle disconnect time: 300 seconds
Signaling vc= 2, vpi=0, vci=5
UNI Version= 4.0, Link Side= user
Last input 00:00:01, output 00:00:01, output hang never
Last clearing of “show interface” counters never
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: Per VC Queueing
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
   1223 packets input, 23174 bytes, 0 no buffer
   Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
   0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
   0 input packets with dribble condition detected
   1235 packets output, 22091 bytes, 0 underruns
   0 output errors, 1 collisions, 3 interface resets
   0 babbles, 0 late collision, 6 deferred
   0 output buffer failures, 0 output buffers swapped out
r5#

r6#sho interface atm 1/0
ATM1/0 is up, line protocol is up
Hardware is RS8234 ATMOC3
Internet address 172.16.56.5/24
MTU 4470 bytes, sub MTU 4470, BW 155000 Kbit, DLY 80 usec,
   Reliability 255/255, txload 1/255, rxload 1/255
   NSAP address: 47.0091810000000002B93AC201.666666666666666
Encapsulation ATM, loopback not set
Keepalive not supported
Encapsulation(s): AAL5
1024 maximum active VCs, 2 current VCCs
VC idle disconnect time: 300 seconds
Signaling vc=2, vpi=0, vci=5
UNI Version= 4.0, Link Side= user
Last input 00:00:07, output 00:00:07, output hang never
Last clearing of "show interface" counters never
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: Per VC Queuing
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
1223 packets input, 23174 bytes, 0 no buffer
   Received 0 broadcasts, 0 runs, 0 giants, 0 throttles
   0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
   0 input packets with dribble condition detected
   1235 packets output, 22091 bytes, 0 underruns
   0 output errors, 0 collisions, 3 interface resets
   0 babbles, 0 late collision, 0 deferred
   0 output buffer failures, 0 output buffers swapped out
r6#

Technical Verification For Task E

r5#sho atm svc interf atm 1/0

<table>
<thead>
<tr>
<th>Interface</th>
<th>Name</th>
<th>VPI</th>
<th>VCI</th>
<th>Type</th>
<th>Encaps SC</th>
<th>SC Kbps</th>
<th>Kbps</th>
<th>Cells</th>
<th>Sts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/0</td>
<td>testking</td>
<td>0</td>
<td>42</td>
<td>SVC</td>
<td>MUX VBR</td>
<td>1200</td>
<td>800</td>
<td>72</td>
<td>UP</td>
</tr>
</tbody>
</table>

r6# atm svc interf atm 1/0

<table>
<thead>
<tr>
<th>Interface</th>
<th>Name</th>
<th>VPI</th>
<th>VCI</th>
<th>Type</th>
<th>Encaps SC</th>
<th>SC Kbps</th>
<th>Kbps</th>
<th>Cells</th>
<th>Sts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/0</td>
<td>testking</td>
<td>0</td>
<td>42</td>
<td>SVC</td>
<td>MUX VBR</td>
<td>1000</td>
<td>500</td>
<td>64</td>
<td>UP</td>
</tr>
</tbody>
</table>

Technical Verification For Task D

r5#sho atm map

Map list ATM 1/0.1pvc4: PERMANENT
ip 172.16.56.5 maps to VC 4, VPI 0, VCI 60, ATM1/0.1
   broadcast, all5mux
ip 172.16.56.6 maps to VC 4, VPI 0, VCI 60, ATM1/0.1
Map List ATM1/0.1pvc4: PERMANENT
ip 172.16.56.5 maps to VC 7, VPI 1, VCI 70, ATM1/0.2, broadcast
ip 172.16.56.6 maps to VC 7, VPI 1, VCI 70, ATM1/0.2, broadcast
ipx 65.0002.b934.6421 maps to VC 4, VPI 0, VCI 60, ATM1/0.2, broadcast
ipx 65.0002.fd69.9e00 maps to VC 4, VPI 0, VCI 60, ATM1/0.2, broadcast

r5#sho atm pvc

<table>
<thead>
<tr>
<th>Interface</th>
<th>Name</th>
<th>VPI</th>
<th>VCI</th>
<th>Type</th>
<th>Encaps</th>
<th>SC</th>
<th>Kbps</th>
<th>Kbps</th>
<th>Cells</th>
<th>Sts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/0.1</td>
<td></td>
<td>4</td>
<td>0</td>
<td>PVC</td>
<td>MUX</td>
<td>UBR</td>
<td>155000</td>
<td></td>
<td></td>
<td>UP</td>
</tr>
<tr>
<td>1/0.2</td>
<td></td>
<td>7</td>
<td>1</td>
<td>PVC</td>
<td>SNAP</td>
<td>UBR</td>
<td>155000</td>
<td></td>
<td></td>
<td>UP</td>
</tr>
</tbody>
</table>

r5#

r6#sho atm map

Map List ATM1/0.1pvc4: PERMANENT
ip 172.16.56.5 maps to VC 4, VPI 0, VCI 60, ATM1/0.1, broadcast, all5mux
ip 172.16.56.6 maps to VC 4, VPI 0, VCI 60, ATM1/0.1, broadcast, all5mux

Map List ATM1/0.1pvc4: PERMANENT
ip 172.16.56.5 maps to VC 4, VPI 3, VCI 70, ATM1/0.2, broadcast
ip 172.16.56.6 maps to VC 4, VPI 3, VCI 70, ATM1/0.2, broadcast
ipx 65.0002.b934.6421 maps to VC 4, VPI 3, VCI 60, ATM1/0.2, broadcast
ipx 65.0002.fd69.9e00 maps to VC 4, VPI 3, VCI 60, ATM1/0.2, broadcast

r6#sho atm pvc

<table>
<thead>
<tr>
<th>Interface</th>
<th>Name</th>
<th>VPI</th>
<th>VCI</th>
<th>Type</th>
<th>Encaps</th>
<th>SC</th>
<th>Kbps</th>
<th>Kbps</th>
<th>Cells</th>
<th>Sts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/0.1</td>
<td></td>
<td>2</td>
<td>2</td>
<td>PVC</td>
<td>MUX</td>
<td>UBR</td>
<td>155000</td>
<td></td>
<td></td>
<td>UP</td>
</tr>
<tr>
<td>1/0.2</td>
<td></td>
<td>4</td>
<td>3</td>
<td>PVC</td>
<td>SNAP</td>
<td>UBR</td>
<td>155000</td>
<td></td>
<td></td>
<td>UP</td>
</tr>
</tbody>
</table>

r6#

**Technical Verification For Task E**
### r5#sho atm pvc

<table>
<thead>
<tr>
<th>VCD/</th>
<th>Interface Name</th>
<th>VPI</th>
<th>VCI</th>
<th>Type</th>
<th>Encaps SC</th>
<th>Peak</th>
<th>Avg/Min</th>
<th>Burst</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/0.1</td>
<td>4</td>
<td>0</td>
<td>PVC</td>
<td>MUX</td>
<td>UBR+10000</td>
<td>10000</td>
<td>UP</td>
</tr>
<tr>
<td></td>
<td>1/0.2</td>
<td>7</td>
<td>1</td>
<td>PVC</td>
<td>SNAP</td>
<td>UBR</td>
<td>155000</td>
<td>UP</td>
</tr>
</tbody>
</table>

### r6#sho atm pvc

<table>
<thead>
<tr>
<th>VCD/</th>
<th>Interface Name</th>
<th>VPI</th>
<th>VCI</th>
<th>Type</th>
<th>Encaps SC</th>
<th>Peak</th>
<th>Avg/Min</th>
<th>Burst</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/0.1</td>
<td>2</td>
<td>2</td>
<td>PVC</td>
<td>MUX</td>
<td>UBR+10000</td>
<td>5000</td>
<td>UP</td>
</tr>
<tr>
<td></td>
<td>1/0.2</td>
<td>4</td>
<td>3</td>
<td>PVC</td>
<td>SNAP</td>
<td>UBR</td>
<td>155000</td>
<td>UP</td>
</tr>
</tbody>
</table>

### Configuration Verification

*Only Relevant Portions of the configuration have been included.*

**Router 5**

r5#sho run

Hostname r5

interface loopback0

ip address 192.168.5.5 255.255.255.0

interface Ethernet0/0

ip address 172.16.136.5 255.255.255.192

half-duplex

interface ATM1/0

ip address 172.16.56.5 255.255.255.0

atm esi-address 555555555555.55

no atm imli-keepalive

pvc qsaal 0/5 qsaal

pvc ilmi 0/16 ilmi

svc testking nsap 47.0091810000000002B93AC201.666666666666.66

protocol ip 172.16.56.6 broadcast

vbr-nrt 1200 800 72 1000 500 64
encapsulation aal5mux ip
!

**Router 6**

R6#sh run
!
hostname r6
!
interface loopback0
  ip address 192.168.6.6 255.255.255.0
  no ip directed-broadcast!
interface FastEthernet0/0
  ip address 172.16.136.6 255.255.255.192
  no ip directed-broadcast
  Duplex auto
  Speed auto
!
interface ATM1/0
  ip address 172.16.56.6 255.255.255.255.0
  no ip directed-broadcast
  atm esi-address 666666666666.66
  no atm ilmi-keepalive
  pvc ilmi 0/16 ilmi
!
  pvc qsaal 0/5 qsaal
!
svc testking nsap 47.0091810000000002B93AC201.555555555555.55
  protocol ip 172.16.56.5 broadcast
  vbr-nrt 1000 500 64 1200 800 72
  encapsulation aal5mux ip
!
!
interface Ethernet2/0
  ip address 10.2.6.6 255.255.254.0
  no ip directed-broadcast
r6#

Switch is1010

r1#sh Is10

hostname
!
ip subnet-zero

atm address 47.0091.8100.0000.0002.b93a.c201.b93a.c201.00
atm router pnni
no aesa embedded-number left-justified
node 1 level 56 lowest
redistribute atm-static

interface ATM0/0/0
no ip address
no ip directed-broadcast
no atm ilmi-keepalive

interface ATM0/0/2
no ip address
no ip directed-broadcast
no atm ilmi-keepalive
atm pvc 2 60 interface ATM0/0/0 0 60
atm pvc 2 70 interface ATM0/0/0 0 70
atm pvc 3 70 interface ATM0/0/0 1 70

Lab Preparation Scenario - Data Link Switching (DLSw)

Topics Covered
- DLSw Peers
- Token-Ring to Ethernet
- Token-ring Token-Ring
- Ring lists/Bridge lists
- Backup Peers

Difficulty Level: CCIE™
Average completion Time: 2 Hours

Standard TCP/IP Addressing and SPID Information

R1 (3620)
Loop0  192.168.1.1/24  Loopback
E/0/0  172.16.136.1/26  Ethernet Segment to Catalyst 3/1
T0/0  172.16.15.1/28  Token ring Segment to 3920
S1/1  172.16.31.1/30  Serial to R3
S1/0  unassigned  Frame-relay

R2 (3620)
Loop0  192.168.2.2/24  Loopback
T0/0  172.16.2.2/24  Token Ring segment to 3920
BRI0/0  172.16.230.2/24  BRI to R3
S1/1  172.16.32.2/24  Serial to R3
S1/0  unassigned  Frame-relay

R3 (2610)
Loop0  192.168.2.2/24  Loopback
E0/0  172.16.136.3/26  Ethernet Segment to Catalyst 3/3
BRI0/0  172.16.230.3/24  ISDN toR2
S1/3  172.16.35.1/30  Serial to R5
S1/2  172.16.32.3/24  Serial to R2
S1/1  172.16.31.2/30  Serial to R1
S1/0  unassigned  Frame-relay

R3 (2610)
Loop0  192.168.4.4/24  Loopback
E0/0  10.1.4.4/22  Ethernet Segment to Catalyst 3/5
S0/0  Unassigned  Frame-relay
**R5 (3620)**

- **Loop0**: 192.168.5.5/24  
- **E0/0**: 172.16.136.5/26  
- **T0/0**: 172.16.15.5/28  
- **S0/0**: 172.16.35.2/30  
- **A1/0**: 172.16.56.5/30

**R6 (3640)**

- **Loop0**: 192.168.6.6/24  
- **FA0/0**: 172.16.136.6/26  
- **E2/0**: 10.2.6.6/23  
- **A1/0**: 172.16.56.6/30

**ISDN Information**

<table>
<thead>
<tr>
<th>Switch Type</th>
<th>Basic-NI 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>R2</strong></td>
<td></td>
</tr>
<tr>
<td>SPIID1:</td>
<td>42255501210101</td>
</tr>
<tr>
<td>SPIID2:</td>
<td>42255501220101</td>
</tr>
<tr>
<td><strong>R3</strong></td>
<td></td>
</tr>
<tr>
<td>SPIID1:</td>
<td>42255501310101</td>
</tr>
<tr>
<td>SPIID2:</td>
<td>42255501320101</td>
</tr>
</tbody>
</table>

**Technical Tasks**

A. Using sub-interface, configure the frame-relay interfaces as follows:

<table>
<thead>
<tr>
<th>Routers</th>
<th>DLCI’s</th>
<th>Subnet</th>
</tr>
</thead>
<tbody>
<tr>
<td>R2-R1</td>
<td>221-122</td>
<td>172.16.21.0/30</td>
</tr>
<tr>
<td>R2-R1</td>
<td>223-322</td>
<td>172.16.32.0/30</td>
</tr>
<tr>
<td>R2-R4</td>
<td>224-422</td>
<td>172.16.24.0/30</td>
</tr>
</tbody>
</table>

B. Use EIGRP to enable routing between all subnets of all routers.

C. Using the most reliable encapsulation method, enable DLSw connectivity between R4-e0/0 and R2-to0/0, R4-e0/0 and R6-e2/0, R2-to0/0 and R6-to0/0.

D. Ensure that DLSw traffic from R4e0/0 cannot reach R6-fa0/0.

E. Enable DLSw connectivity between R2-to0/0 and R1-to0/0, also between R2-to0/0 and R5-to0/0.

F. Configure R2 to use R1 to forward traffic to the token-ring between R1 and R5. If the connection to R1 is down, R2 should use the path through R5. Only one connection should be active at a time.

**Instructor’s Comments and Technical Tips**

A. Create three sub-interfaces on R2 and a single sub-interface on R1, R3 and R4. You could use the physical interfaces or R1, R3 and R4 but this would be limiting from a design perspective.

B. Remember to disable auto-summary.

C. TCP is the most reliable encapsulation method. You need to create a virtual-ring on R2. Remember to create a bridge-group on R4 and R6. You must tie the bridge-group to the DLSw process with a global command.
D. You need to create a bridge-list (ring-list) on R6 and reference the bridge-list in the peering statement to R4.

E. If the encapsulation type is not specified, you should use TCP. Peer to the loopbacks if multiple paths exist.

F. By making R5 a backup-peer to R1, only one connection will be active at a time.

Technical Verification

Technical Verification For Task A

r1#sho frame map
Serial1/0.1 122 (up): point-to-point dlci, dlci 122(0*7A, 0*1CA0), broadcast status defined, active

r1#

r2#sho frame map
Serial1/0.223 (up): point-to-point dlci, dlci 223(0*DF, 0*34F0), broadcast status defined, active

Serial1/0.224 (up): point-to-point dlci, dlci 224(0*E0, 0*3800), broadcast status defined, active

Serial1/0.221 (up): point-to-point dlci, dlci 221(0*DD, 0*34D0), broadcast status defined, active

r2#

r3#sho frame map
Serial1/0.322(up): point-to-point dlci, dlci 322(0*142, 0*5020), broadcast status defined, active

r3#

r4#sho frame map
Serial0/0.422 (up): point-to-point dlci, dlci 422 (0*1A6, 0*6860), broadcast status defined, active

r4#

Technical Verification For Task B

r1#sho ip e i n e
IP-EIGRP neighbors for process 1
H Address Interface Hold UP time SRTT RTO Q Seq Type
 (sec) (ms) CntNum

<table>
<thead>
<tr>
<th>H</th>
<th>Address</th>
<th>Interface</th>
<th>Hold UP time</th>
<th>SRTT</th>
<th>RTO</th>
<th>Q</th>
<th>Seq Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>172.16.136.6</td>
<td>Et0/0</td>
<td>14 00:01:33</td>
<td>1</td>
<td>5400</td>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td>4</td>
<td>172.16.15.5</td>
<td>To0/0</td>
<td>12 00:01:57</td>
<td>7</td>
<td>200</td>
<td>0</td>
<td>35</td>
</tr>
<tr>
<td>3</td>
<td>172.16.136.5</td>
<td>Et0/0</td>
<td>11 00:01:57</td>
<td>161</td>
<td>966</td>
<td>0</td>
<td>36</td>
</tr>
<tr>
<td>2</td>
<td>172.16.31.2</td>
<td>Se1/1</td>
<td>13 00:02:40</td>
<td>26</td>
<td>200</td>
<td>0</td>
<td>106</td>
</tr>
<tr>
<td>1</td>
<td>172.16.136.3</td>
<td>Et0/0</td>
<td>12 00:02:40</td>
<td>26</td>
<td>200</td>
<td>0</td>
<td>108</td>
</tr>
<tr>
<td>0</td>
<td>172.16.21.2</td>
<td>Se1/0.122</td>
<td>11 00:02:54</td>
<td>5</td>
<td>200</td>
<td>0</td>
<td>105</td>
</tr>
</tbody>
</table>

r1#
### r2# sho ip e ne

IP-EIGRP neighbors for process 1

<table>
<thead>
<tr>
<th>Address</th>
<th>Interface</th>
<th>Hold UP time</th>
<th>SRTT</th>
<th>RTO</th>
<th>Q</th>
<th>Seq Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 172.16.24.1</td>
<td>Se1/0.224</td>
<td>14 00:02:33</td>
<td>11</td>
<td>200</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>2 172.16.32.1</td>
<td>Se1/0.223</td>
<td>13 00:03:04</td>
<td>19</td>
<td>200</td>
<td>0</td>
<td>105</td>
</tr>
<tr>
<td>1 172.16.32.3</td>
<td>Se1/1</td>
<td>11 00:03:04</td>
<td>22</td>
<td>200</td>
<td>0</td>
<td>107</td>
</tr>
<tr>
<td>0 172.16.21.1</td>
<td>Se1/0.221</td>
<td>12 00:03:15</td>
<td>9</td>
<td>200</td>
<td>0</td>
<td>94</td>
</tr>
</tbody>
</table>

### r3# sho ip e ne

IP-EIGRP neighbors for process 1

<table>
<thead>
<tr>
<th>Address</th>
<th>Interface</th>
<th>Hold UP time</th>
<th>SRTT</th>
<th>RTO</th>
<th>Q</th>
<th>Seq Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 172.16.136.6</td>
<td>Et0/0</td>
<td>14 00:02:10</td>
<td>16</td>
<td>200</td>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td>4 172.16.136.5</td>
<td>Et0/0</td>
<td>10 00:02:35</td>
<td>99</td>
<td>594</td>
<td>0</td>
<td>36</td>
</tr>
<tr>
<td>3 172.16.23.2</td>
<td>Se1/0.322</td>
<td>11 00:03:14</td>
<td>30</td>
<td>1140</td>
<td>0</td>
<td>103</td>
</tr>
<tr>
<td>2 172.16.32.2</td>
<td>Se1/0.322</td>
<td>12 00:03:15</td>
<td>39</td>
<td>1140</td>
<td>0</td>
<td>102</td>
</tr>
<tr>
<td>1 172.16.31.1</td>
<td>Se1/1</td>
<td>10 00:03:15</td>
<td>26</td>
<td>1140</td>
<td>0</td>
<td>93</td>
</tr>
<tr>
<td>0 172.16.136.1</td>
<td>Et0/0</td>
<td>11 00:03:15</td>
<td>4</td>
<td>200</td>
<td>0</td>
<td>91</td>
</tr>
</tbody>
</table>

### r4# sho ip e ne

IP-EIGRP neighbors for process 1

<table>
<thead>
<tr>
<th>Address</th>
<th>Interface</th>
<th>Hold UP time</th>
<th>SRTT</th>
<th>RTO</th>
<th>Q</th>
<th>Seq Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 172.16.24.2</td>
<td>Se0/0.422</td>
<td>14 00:03:03</td>
<td>5</td>
<td>200</td>
<td>0</td>
<td>104</td>
</tr>
</tbody>
</table>

### r5# sho ip e ne

IP-EIGRP neighbors for process 1

<table>
<thead>
<tr>
<th>Address</th>
<th>Interface</th>
<th>Hold UP time</th>
<th>SRTT</th>
<th>RTO</th>
<th>Q</th>
<th>Seq Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 172.16.136.6</td>
<td>Et0/0</td>
<td>11 00:02:36</td>
<td>372</td>
<td>2232</td>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td>2 172.16.136.1</td>
<td>Et0/0</td>
<td>13 00:03:00</td>
<td>10</td>
<td>200</td>
<td>0</td>
<td>91</td>
</tr>
<tr>
<td>1 172.16.136.3</td>
<td>Et0/0</td>
<td>11 00:03:01</td>
<td>5</td>
<td>200</td>
<td>0</td>
<td>108</td>
</tr>
<tr>
<td>0 172.16.51.1</td>
<td>To0/0</td>
<td>12 00:03:02</td>
<td>6</td>
<td>200</td>
<td>0</td>
<td>92</td>
</tr>
</tbody>
</table>

### r6# sho ip e ne

IP-EIGRP neighbors for process 1

<table>
<thead>
<tr>
<th>Address</th>
<th>Interface</th>
<th>Hold UP time</th>
<th>SRTT</th>
<th>RTO</th>
<th>Q</th>
<th>Seq Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 172.16.136.3</td>
<td>Fa0/0</td>
<td>13 00:02:47</td>
<td>1181</td>
<td>5000</td>
<td>0</td>
<td>108</td>
</tr>
</tbody>
</table>
Technical Verification For Task C

r2#sho dlsw peers
Peers state pkts-rx pkts-tx type drops ckts TCP uptime
TCP 192.168.4.4 CONNECT 3 3 conf 0 0 0 00:01:00
Total number of connected peers: 1
Total number of connections: 1
r2#

r4#sho dlsw peers
Peers state pkts-rx pkts-tx type drops ckts TCP uptime
TCP 192.168.6.6 CONNECT 57 26 conf 0 0 0 00:12:49
TCP 192.168.2.2 CONNECT 5 5 conf 0 0 0 00:01:44
Total number of connected peers: 2
Total number of connections: 2
r4#

r6#sho dlsw peers
Peers state pkts-rx pkts-tx type drops ckts TCP uptime
TCP 192.168.4.4 CONNECT 27 59 conf 0 0 0 00:13:08
Total number of connected peers: 1
Total number of connections: 1
r6#

Technical Verification For Task D
R6#sho run
dlsw local-peer-id 192.168.6.6 if 1500
dlsw bgp-list 5 bgp-list 1
dlsw remote-peer 5 tcp 192.168.4.4 if 1500
dlsw bridge-group 1
dlsw bridge-group 2

Technical Verification For Task E
r2#sho dlsw peers
Peers state pkts-rx pkts-tx type drops ckts TCP uptime
TCP 192.168.4.4 CONNECT 111 111 conf 0 0 0 00:53:36
TCP 192.168.1.1 CONNECT 9 9 conf 0 0 0 00:03:53
TCP 192.168.5.5 CONNECT 2 2 conf 0 0 0 00:00:04
Total number of connected peers: 3
Total number of connections: 3
r2#
Technical Verification For Task F

R2#sho run
Source-bridge ring-group 10
dlsw local-peer peer-id 192.168.2.2 if 1500
dlsw local-peer 0 tcp 192.168.4.4 if 1500
dlsw local-peer 0 tcp 192.168.1.1 if 1500
dlsw local-peer 0 tcp 192.168.5.5 if 1500 backup-peer 192.168.1.1

Configuration Verification

Only relevant portions of the configuration have been included.

Router 1

r1#sh run
hostname r1
!
!
source-bridge ring-group 10
dlsw local-peer peer-id 192.168.1.1 if 1500
dlsw remote-peer 0 tcp 192.168.2.2 if 1500
!
!
interface Loopback0
ip address 192.168.1.1 255.255.255.0
!
interface Ethernet0/0
ip address 172.16.136.1 255.255.255.192
half-duplex
!
interface TokenRing0/0
ip address 172.16.51.1 255.255.255.240
ring-speed 16
source-bridge 1 1 10
!
interface Serial1/0
no ip address
encapsulation frame-relay
no frame-relay inverse-arp
!
interface Serial1/0.122 point-to-point
ip address 172.16.21.1 255.255.255.252
frame-relay interface-dlci 122
!
interface Serial1/1
ip address 172.16.31.1 255.255.255.252
!
router eigrp 1
network 172.16.0.0
network 192.168.1.0
auto-summary
no eigrp log-neighbor-changes
!
end

**Router 2**

r2#sh run

Hostname r2
!
!
source-bridge ring-group 10
dlse local-peer peer-id 192.168.2.2 if 1500
dlse remote-peer 0 tcp 192.168.4.4 if 1500
dlse remote-peer 0 tcp 192.168.1.1 if 1500
dlse remote-peer 0 tcp 192.168.5.5 if 1500 backup-peer 192.168.1.1
!
!
interface Loopback0
ip address 192.168.2.2 255.255.255.0
!
interface BRI0/0
no ip address
shutdown
half-duplex
!
interface TokenRing0/0
ip address 172.16.2.2 255.255.255.0
ring-speed 16
source-bridge 5 1 10
source-bridge spanning
!
interface Serial1/0
no ip address
capsulation frame-relay
no frame-relay inverse-arp
!
interface Serial1/0.221 point-to-point
ip address 172.16.21.2 255.255.255.252
frame-relay interface-dlsi 221
!
interface Serial1/0.223 point-to-point
ip address 172.16.23.2 255.255.255.252
frame-relay interface dlci 223
!
interface Serial1/0.224 point-to-point
ip address 172.16.24.2 255.255.255.252
frame-relay interface-dlci 224
!
interface Serial1/1
ip address 172.16.32.2 255.255.255.0
!
router eigrp 1
network 172.16.0.0
network 192.168.2.0
no auto-summary
no eigrp log-neighbor-changes
no eigrp log-neighbor-warnings
!
end

Router 3

r3#sh run
!
hostname r3
!
interface Loopback0
ip address 192.168.3.3 255.255.255.0
!
interface Ethernet0/0
ip address 172.16.136.3 255.255.255.192
half-duplex
!
interface BRI0/0
no ip address
shutdown
!
interface Serial1/0
no ip address
encapsulation frame-relay
no frame-relay inverse-arp
!
interface Serial1/0.322 point-to-point
ip address 172.16.31.2 255.255.255.252
frame-relay interface-dlci 322
!
interface Serial1/1
ip address 172.16.31.2 255.255.255.0
clockrate 64000
!
interface Serial1/3
ip address 172.16.35.1 255.255.255.252
shutdown
clockrate 64000
!
router eigrp 1
network 172.16.0.0
network 192.168.3.0
no auto-summary
no eigrp-summary
no eigrp log-neighbor-changes
!
end

Router 4

r4#sh run
!
hostname r4
!
!
    dlsw local-peer peer-id 192.168.4.4 if 1500
dlsw remote-peer 0 tcp 192.168.6.6 if 1500
dlsw remote-peer 0 tcp 192.168.2.2 if 1500
dlsw bridge-group 1
!
    interface Loopback0
ip address 192.168.4.4 255.255.255.0
!
interface Ethernet0/0
ip address 10.1.4.4 255.255.252.0
half-duplex
bridge-group 1
!
interface Serial0/0
no ip address
encapsulation frame-relay
no frame-relay inverse-arp
!
interface serial0/0.422 point-to-point
ip address 172.16.24.1 255.255.255.252
frame-relay interface-dlci 422
!
interface Serial0/1
no ip address
shutdown
!
router eigrp 1
network 10.0.0.0
network 172.16.0.0
network 192.168.4.0
no auto-summary
no eigrp log-neighbor-changes
!
end

Router 5

r5#sh run
!
hostname r5
!
!
source-bridge ring-group 10
dlsw local-peer peer-id 192.168.5.5 if 1500
dlsw remote-peer 0 tcp 192.168.2.2 if 1500
!
interface Loopback0
ip address 192.168.5.5 255.255.255.0
!
interface Ethernet0/0
ip address 172.16.35.2 255.255.255.252
!
interface TokenRing0/0
ip address 172.16.51.5 255.255.255.240
ring-speed 16
source-bridge 1 2 10
!
interface Serial0/1
no ip address
shutdown
!
interface ATM1/0
no ip address
shutdown
no atm ilmi-keepalive
!
router eigrp 1
network 172.16.0.0
network 192.168.5.0
no auto-summary
no eigrp log-neighbor-changes
!
!
end

Router 6
r6#sh run
!
hostname r6
!
!
dlsw local-peer peer-id 192.168.6.6 if 1500
dlsw bgroup-list 5 bgroups 1
dlsw remote-peer 5 tcp 192.168.4.4 if 1500
dlsw bridge-group 1
dlsw bridge-group 2
!
!
!
interface Loopback0
ip address 192.168.6.6 255.255.255.0
no ip directed-broadcast
!
interface FastEthernet0/0
ip address 172.16.136.6 255.255.255.192
duplex auto
speed auto
bridge-group 2
!
interface ATM1/0
no ip address
no ip directed-broadcast
shutdown
no atm ilmi-keepalive
!
interface Ethernet2/0
ip address 10.2.6.6 255.255.254.0
no ip directed-broadcast
bridge-group 1
!
router eigrp 1
CCIE LAB

network 10.0.0.0
network 172.16.0.0
network 192.168.6.0
no auto-summary
!
!
bridge 1 protocol ieee
bridge 2 protocol ieee
!
!
end
Lab Preparation Scenario  Data Link Switching II (DLSw)

Topics Covered
- DLSw Peers
- DLSw Messages
- DLSw over ISDN
- OSPF over ISDN
- DLSw Encapsulation

Difficulty Level: CCIE™
Average completion Time: 2 to 3 Hours

Standard TCP/IP Addressing and SPID Information

**R1 (3620)**
- Loop0  192.168.1.1/24  Loopback
- E/0/0  172.16.136.1/26  Ethernet Segment to Catalyst 3/1
- T0/0  172.16.15.1/28  Token ring Segment to 3920
- S1/1  172.16.31.1/30  Serial to R3
- S1/0  unassigned  Frame-relay

**R2 (3620)**
- Loop0  192.168.2.2/24  Loopback
- T0/0  172.16.2.2/24  Token Ring segment to 3920
- BR1/0  172.16.230.2/24  BRI to R3
- S1/1  172.16.32.2/24  Serial to R3
- S1/0  unassigned  Frame-relay

**R3 (2610)**
- Loop0  192.168.2.2/24  Loopback
- E0/0  172.16.136.3/26  Ethernet Segment to Catalyst 3/3
- BR1/0  172.16.230.3/24  ISDN to R2
- S1/3  172.16.35.1/30  Serial to R5
- S1/2  172.16.32.3/24  Serial to R2
- S1/1  172.16.31.2/30  Serial to R1
- S1/0  unassigned  Frame-relay

**R3 (2610)**
- Loop0  192.168.4.4/24  Loopback
- E0/0  10.1.4.4/22  Ethernet Segment to Catalyst 3/5
- S0/0  Unassigned  Frame-relay
R5 (3620)
Loop0  192.168.5.5/24  Loopback
E0/0  172.16.136.5/26  Ethernet Segment to Catalyst 3/5
T0/0  172.16.15.5/28  Token Ring segment to 3920
S0/0  172.16.35.2/30  Serial link to R3
A1/0  172.16.56.5/30  ATM-R6

R6 (3640)
Loop0  192.168.6.6/24  Loopback
FA0/0  172.16.136.6/26  Ethernet segment-R2
E2/0  10.2.6.6/23  Ethernet segment-BB2
A1/0  172.16.56.6/30  ATM-R5

ISDN Information
Switch Type  Basic-NI 1

R2
SPID1:  42255501210101
SPID2:  42255501220101

R3
SPID1:  42255501310101
SPID2:  42255501320101

Technical Tasks
A. Configure the frame-relay cloud with R1 using DLCI 114 and R4 using DLCI 411. Shutdown the frame-relay interfaces of R2 and R3. Use subnet 172.16.14.0/30. The ATM interface will not be used in this lab. Shutdown subnet 172.16.32.0/24. Shutdown the e0/0 interface of R1.
B. Configure OSPF between R2 and R3 over the ISDN link use Chap authentication. Place all interface of R2 into area 0. Configure the loopback interface of R3 in area 0. Use EIGRP for IP connectivity between all other subnets.
C. Configure DLSw support all other subnets.
D. Configure DLSw support between R3-e0/0 and R1-to0/0. The serial link between R3 and R1 should be considered high-speed and very reliable.
E. Configure DLSw support between R4-e0/0 and R6-e2/0.
F. There are devices on the Ethernet of R4 that do not respond well to the receiver not ready message while attempted to form connections. Configure your network to prevent these messages from being sent.

Instructor’s Comments and Technical Tips
A. N/A.
B. Configure OSPF demand-circuit. If not, OSPF hellos will keep the circuit up.
C. When configuration DLSw over ISDN you need to disable keepalive in the remote-peer statement or the keepalives will keep the circuit up. You also need to specify the remote-peer as dynamic.
D. We want you to configure FST encapsulation. In reality, FST would not work in this case as the users of R3 are on Ethernet. The point is when you have a “hight-speed” and/or “very reliable” path, you may want to consider FST.

E. N/A.

F. When applied to R4, the command “dlsw llc2 norm”, will prevent receiver not ready messages from being sent while establishing an LLC2 connection.

**Technical Verification**

**Technical Verification For Task A**

```
r1#sho frame map
Serial1/0(up) : ip 172.16.24.2 dlci 114(0*72, 0*1C20), static, broadcast, CISCO, status defined, active
r1#
```

```
r4#sho frame map
Serial1/0 (up): ip 172.16.14.1 dlci 411(0*19B, 0*64B0), static, broadcast, CISCO, status defined, active
r4#
```

**Technical Verification For Task B**

```
r2#sho ip osp interf
BRI0/0 is up, line protocol is up (speefing)
Internet Adress 172.16.23.2/30, Area 0
Process ID 1, Router ID 192.168.2.2, Network Type POINT_TO_POINT, Cost: 1562
Configured as demand circuit.
Run as demand circuit.
DoNotAge LSA allowed.
Transmit Delay is 1 sec, State POINT_TO_POINT,
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:09
Index 3/3, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 1, maximum is 1
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
Adjacent with neighbor 192.168.3.3 (Hello suppressed)
Suppress hello for 1 neighbor(s)
Loopback0 is up, line protocol is up
Internet Address 192.168.2.2/24, Area 0
Process ID 1, Router ID 192.168.2.2, Network Type LOOPBACK, Cast: 1
Loopback interface is treated as a stud Host
TokenRing0/0 is up, line protocol is up
Internet Address 172.16.2.2/24, Area 0
Process ID 1, Router ID 192.168.2.2, Network Type BROADCAST, Cost:6
Transmit Delay is 1 sec, State DR, Priority 1
```

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Designated Router (ID) 192.168.2.2, interface address 172.16.2.2
No backup designated router on this network
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:04
Index 3/3, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 0, maximum is 0
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 0, Adjacent neighbor count is 0
Suppress hello for neighbor(s)

r2#

r3#sho ip osp interf
BRI0/0 is up, line protocol is up (speefing)
Internet Address 172.16.23.1/30, Area 0
Process ID 1, Router ID 192.168.3.3, Network Type POINT_TO_POINT, Cost: 1562
Configured as demand circuit.
Run as demand circuit.
DoNotAge LSA allowed.
Transmit Delay is 1 sec, State POINT_TO_POINT,
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:00
Index 3/3, flood queue length 0
Next 0*0(0)/0*0(0)
Last flood scan length is 1, maximum is 1
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
Adjacent with neighbor 192.168.2.2 (Hello suppressed)
Suppress hello for 1 neighbor(s)
Loopback0 is up, line protocol is up
Internet Address 192.168.3.3/24, Area 0
Process ID 1, Router ID 192.168.3.3, Network Type LOOPBACK, Cast: 1
Loopback interface is treated as a stud Host

r3#

r1#shoip ei ne
IP-EIGRP neighbors for process 1
<table>
<thead>
<tr>
<th>H</th>
<th>Address</th>
<th>Interface</th>
<th>Hold UP time</th>
<th>SRTT</th>
<th>RTO</th>
<th>Q</th>
<th>Seq</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>172.16.15.5</td>
<td>To0/0</td>
<td>12 00:00:43</td>
<td>3</td>
<td>200</td>
<td>0</td>
<td>196</td>
</tr>
<tr>
<td>1</td>
<td>172.16.31.2</td>
<td>Se1/1</td>
<td>14 00:29:18</td>
<td>27</td>
<td>200</td>
<td>0</td>
<td>68</td>
</tr>
<tr>
<td>2</td>
<td>172.16.14.2</td>
<td>Se1/0</td>
<td>176 01:12:52</td>
<td>6</td>
<td>200</td>
<td>0</td>
<td>74</td>
</tr>
</tbody>
</table>

r1#

r3#shoip ei ne
IP-EIGRP neighbors for process 1
<table>
<thead>
<tr>
<th>H</th>
<th>Address</th>
<th>Interface</th>
<th>Hold UP time (sec)</th>
<th>Hold UP time (ms)</th>
<th>SRTT</th>
<th>RTO</th>
<th>Q</th>
<th>Seq Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>172.16.31.1</td>
<td>Se1/1</td>
<td>10 00:29:33</td>
<td>27</td>
<td>1140</td>
<td>0</td>
<td>365</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>172.16.136.5</td>
<td>Et0/0</td>
<td>12 00:29:41</td>
<td>3</td>
<td>200</td>
<td>0</td>
<td>195</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>172.16.136.6</td>
<td>Et0/0</td>
<td>10 00:29:41</td>
<td>1</td>
<td>200</td>
<td>0</td>
<td>88</td>
<td></td>
</tr>
</tbody>
</table>

r3#
r4#sho ip eigrp
IP-EIGRP neighbors for process 1
<table>
<thead>
<tr>
<th>H</th>
<th>Address</th>
<th>Interface</th>
<th>Hold UP time (sec)</th>
<th>Hold UP time (ms)</th>
<th>SRTT</th>
<th>RTO</th>
<th>Q</th>
<th>Seq Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>172.16.14.1</td>
<td>Se0/0</td>
<td>14 00:13:51</td>
<td>107</td>
<td>642</td>
<td>0</td>
<td>69</td>
<td></td>
</tr>
</tbody>
</table>

r4#
r5#sho ip eigrp
IP-EIGRP neighbors for process 1
<table>
<thead>
<tr>
<th>H</th>
<th>Address</th>
<th>Interface</th>
<th>Hold UP time (sec)</th>
<th>Hold UP time (ms)</th>
<th>SRTT</th>
<th>RTO</th>
<th>Q</th>
<th>Seq Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>172.16.15.1</td>
<td>To0/0</td>
<td>14 00:01:13</td>
<td>7</td>
<td>200</td>
<td>0</td>
<td>366</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>172.16.136.3</td>
<td>Et0/0</td>
<td>14 00:30:00</td>
<td>3</td>
<td>200</td>
<td>0</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>172.16.136.6</td>
<td>Et0/0</td>
<td>13 01:12:12</td>
<td>1</td>
<td>200</td>
<td>0</td>
<td>88</td>
<td></td>
</tr>
</tbody>
</table>

r5#
r6#sho ip eigrp
IP-EIGRP neighbors for process 1
<table>
<thead>
<tr>
<th>H</th>
<th>Address</th>
<th>Interface</th>
<th>Hold UP time (sec)</th>
<th>Hold UP time (ms)</th>
<th>SRTT</th>
<th>RTO</th>
<th>Q</th>
<th>Seq Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>172.16.136.3</td>
<td>Fa0/0</td>
<td>12 00:30:26</td>
<td>1</td>
<td>200</td>
<td>0</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>172.16.136.5</td>
<td>Fa0/0</td>
<td>14 01:12:40</td>
<td>1</td>
<td>200</td>
<td>0</td>
<td>195</td>
<td></td>
</tr>
</tbody>
</table>

Technical Verification For task C

r2#sho dlsw peers
Peers: state pkts_rx pkts_txytype drops cks TCP uptime
TCP 192.168.3.3 CONNECT 5 2dynam 0 0 00:00:48

Total number of connected peers: 1
Total number of connections: 1
r2#

r2#sho isdn active

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ISDN ACTIVE CALLS

Call Type | Calling Number | Called Number | Remote Name | Seconds Used | Seconds Left | Seconds Idle | Charges Units/Currency
---|---|---|---|---|---|---|---
--------------------------
r2#

r3#sho dlsw peers
Peers: state pkts_rx pkts_txtype drops ckts TCP uptime
TCP 192.168.2.2 CONNECT 2 9dynam 0 0 0:01:31

Total number of connected peers: 1
Total number of connections: 1
r3#

r3#sho isdn active

ISDN ACTIVE CALLS

Call Type | Calling Number | Called Number | Remote Name | Seconds Used | Seconds Left | Seconds Idle | Charges Units/Currency
---|---|---|---|---|---|---|---
--------------------------
r3#

Technical Verification For Task D

r1#sho dlsw peers
Peers: state pkts_rx pkts_txtype drops ckts TCP uptime
FST 192.168.3.3 CONNECT 17 7conf 0 - - 0:01:31

Expected: 0 Next Send: 0 Seq errors: 0
Total number of connected peers: 1
Total number of connections: 1
r1#

r3#sho dlsw peers
Peers: state pkts_rx pkts_txtype drops ckts TCP uptime
FST 192.168.1.1 CONNECT 7 19conf 0 - - 0:02:54
Technical verification For Task E

r4# sho dlsw peers
Peers: state pkts_rx pkts_t xtype drops ckt s TCP uptime
TCP 192.168.6.6 CONNECT 2 2consf 0 0 0 0 00:00:18

Total number of connected peers: 1
Total number of connections: 1

r4#

r6# sho isdn active
--------------------------------------------------------
ISDN ACTIVE CALLS
--------------------------------------------------------
Call Calling Called Remote Seconds Seconds Seconds Charges
Type Number Number Name Used Left Idle Units/Currency
--------------------------------------------------------
--------------------------------------------------------

r6#

r3# sho dlsw peers
Peers: state pkts_rx pkts_t xtype drops ckt s TCP uptime
TCP 192.168.2.2 CONNECT 2 9dynam 0 0 0 0 00:01:31

Total number of connected peers: 1
Total number of connections: 1

r6#

Technical Verification For Task F

Dlsw llc2 nornr

Configuration Verification

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Only relevant portions of the configuration have been included.

Router 1

r1#sho run
!
hostname r1
!
!
source-bridge ring-group 10
dlsw local-peer peer-id 192.168.1.1
dlsw local-peer 0 fst 192.168.3.3 if 1500
!
!
interface Loopback0
ip address 192.168.1.1 255.255.255.0
!
interface Ethernet0/0
ip address 172.16.136.1 255.255.255.192
shutdown
half-duplex
!
interface TokenRing0/0
ip address 172.16.15.1 255.255.255.240
ring-speed 16
source-bridge 1 1 10
source-bridge spanning
!
interface Serial1/0
ip address 172.16.14.1 255.255.255.252
encapsulation frame-relay
frame-relay map ip 172.16.14.2 114 broadcast
no frame-relay inverse-arp
!
interface Serial1/1
ip address 172.16.31.1 255.255.255.252
!
router eigrp 1
network 172.16.0.0
network 192.168.1.0
no auto-summary
no eigrp log-neighbor-changes

end
r1#

Router 2

r2#sho run
!
hostname
!
username r2
!
username r2 password 0 isdn
isdn switch-type basic-ni
!
source-bridge ring-group 10
dlsw local-peer peer-id 192.168.2.2
dlsw remote-peer 0 tcp 192.168.3.3 if 1500 keepalive 0 timeout 90 dynamic
!
!
interface Loopback0
ip address 192.168.2.2 255.255.255.0
!
interface BRI0/0
ip address 172.16.23.2 255.255.255.0
encapsulation ppp
!
ip ospf demand-circuit
dialer map ip 172.16.23.1 name r3 broadcast 5550131
dialer map ip 172.16.32.1 name r3 broadcast 5550132
dialer-group 1
isdn switch-type basic-ni
isdn spid1 42255501210101 5550121
isdn spid2 42255501220101 5550122
ppp authentication chap
!
interface TokenRing0/0
ip address 172.16.2.2 255.255.255.0
ring-bridge 16
source-bridge 1 1 10
source-bridge spanning
!
interface Serial1/0
encapsulation frame-relay
shutdown
!
interface Serial1/1
ip address 172.16.32.2 255.255.255.0
shutdown
!
router ispf 1
log-adjacency-changes
network 172.16.2.0 0.0.0.255 area 0
network 172.16.32.0 0.0.0.3 area 0
network 192.168.2.0 0.0.0.255 area 0
!
ip kerberos source-interface any
ip classless
no ip http server
!
access-list 101 permit tcp any eq 2065 any
access-list 101 permit tcp any any eq 2065
access-list 101 permit ospf any any
dialer-list 1 protocol ip list 101
!
!
end

r2#

**Router 3**

r3#sho run
!
hostname r3
!
!
username r2 password 0 isdn

isdn switch-type basic-ni
call rsvp-sync
!
dlsw local-peer peer-id 192.168.3.3 If 1500
dlsw remote-peer 0 fst 192.168.1.1 If 1500
dlsw remote-peer 0 tcp 192.168.2.2 If 1500 keepalive 0 timeout 90 dynamic
dlsw bridge-group 1
!
!
interface Loopback0
ip address 172.16.136.3 255.255.255.192
half-duplex
bridge-group 1
!  
interface BRI0/0  
ip address 172.16.23.1 255.255.255.252  
encapsulation ppp  
ip ospf demand-circuit  
dialer enable-timeout 30  
dialer enable-timeout 60  
dialer map ip 172.16.32.2 name r2 broadcast 5550121  
dialer map ip 172.16.32.2 name r2 broadcast 5550122  
dialer-group 1  
isdn switch-type basic-ni  
isdn spid1 42255501310101 5550131  
isdn spid2 42255501320202 5550132  
ppp authentication chap  
!  
interface Serial1/0  
no ip address  
encapsulation frame-relay  
shutdown  
!  
interface Serial1/1  
ip address 172.16.31.2 255.255.255.252  
cloackrate 64000  
!  
interface serial1/2  
ip address 172.16.32.3 255.255.255.0  
shutdown  
cloackrate 64000  
!  
interface eigrp 1  
redistribute ospf 1 metric 64 10 255 1 1500  
passive-interface BRI0/0  
network 172.16.0.0  
auto-summary  
no eigrp log-neighbor-changes  
!  
router ospf 1  
log-adjacency-changes  
redistribute eigrp 1 metric 6 subnets  
network 172.16.23.0 0.0.0.3 area 0  
network 192.168.3.0 0.0.0.255 area 0  
!
access-list 101 permit tcp any eq 2065 any
access-list 101 permit tcp any any eq 2065
access-list 101 permit ospf any any
dialer-list 1 protocol ip list 101
!
bridge 1 protocol ieee
!
end

r3#

**Router 4**

R4#sho run
!
hostname r4
!
!
dlsw local-peer peer-id 192.168.4.4 If 1500
dlsw remote-peer 0 tcp 192.168.6.6 If 1500
dlsw bridge-group 1
dlsw llcw normr
!
!
interface Loopback 0
ip address 192.168.4.4 255.255.255.0
!
interface Ethernet0/0
ip address 10.1.4.4 255.255.252.0
half-duplex
bridge-group 1
!
interface serial0/0
ip address 172.16.14.2 255.255.255.252
encapsulation frame-relay
frame-relay map ip 172.16.14.1 411 broadcast
no frame-relay inverse-arp
!
interface serial0/0
no ip address
shutdown
!
router eigrp 1
network 10.0.0.0
network 172.16.0.0
network 192.168.4.0
no auto-summary
no eigrp log-neighbor-changes
!
!
bridge 1 protocol isss
!
end
r4#

**Router 5**

r5#sho run
!
hostname r5
!
!
interface Loopback0
ip address 192.168.5.5 255.255.255.0
!
interface Ethernet0/0
ip address 172.16.136.5 255.255.255.192
half-duplex
!
interface Serial0/0
ip address 172.16.35.2 255.255.255.252
!
interface Tokenring0/0
ip address 172.16.15.5 255.255.255.240
ring-speed 16
!
interface Serial0/1
no ip address
shutdown
no atm ilmikeepalive
!
router eigrp 1
network 172.16.0.0
network 192.168.5.0
auto-summary
no eigrp log-neighbor-changes
!
end
r5#
Router 6
r6#sho run
!
hostname r6
!
!
dlsw local-peer peer-id 192.168.6.6 If 1500
dlsw remote-peer 0 tcp 192.168.4.4 If 1500
dlsw bridge-group 1
!
!
!
interface Loopback0
ip address 192.168.6.6 255.255.255.0
no ip directed-broadcast
!
interface FastEthernet0/0
ip address 172.16.136.6 255.255.255.192
no ip directed-broadcast
duplex auto
speed auto
!
interface ATM1/0
no ip address
no ip directed-broadcast
shutdown
no atm ilmi-keepalive
!
interface Ethernet2/0
ip address 10.2.6.6 255.255.254.0
no ip directed-broadcast
bridge-group 1
!
router eigrp 1
network 10.0.0.0
network 172.16.0.0
network 192.168.6.0
no auto-summary
!
!
bridge 1 protocol isss
!
end
r6#
Section A – Older labs
9 Labs

Lab 1.
Day 1, Forenoon:

1. Commserver (1 point)
   Configure reverse telnet. line1-6 are R1-R6,line7 is CAT5002,line8 is 3900,line9 is backbone switch.

   Answer: No exec, transport input all

2. Physical connection (1 point)

3. Draw a topology diagram (1 point)
   Include ip address, area number, VLAN, etc. makes it updated.

4. Loopback address (1 point)
   Setup loopback address as 132.Y.X.X at your router, where Y is your rack number and X is your router number.

5. CAT5002 setup (1 point)
   R3 in VLAN A, use 100, R5 in VLAN B, use 200. Set sc0 (132.3.9.9) in VLAN A, And make the switch able to reach all the topology through R3.

6. Address (2 points)
   All the interfaces use 132.Y.0.0 network as their addresses and use 24bits mask. The frame relay interface use 27 bits mask. Draw them on your diagram
   Answer: Imply that the loopback address use 24bits mask, don’t use 32 bits mask.

7. Frame-relay setup (2 points)

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Setup frame relay-relay, the frame relay switch is a 45000 which also ac as a backbone router. The switch is configured as fully meshed, but you are demanded to only use the pvc showed on the diagram they provide. (see the diagram)

8 RIP setting (2 points)
R1 ethernet address is 150.100.1.Y. setup RIP in R1, several network will send to R1 from Backbone 1, you are requested to permit only 193.68.3.0 to add in your RIP routing table and advertise it and 150.100.1.0 to your topology. Also advertise only the classful network 132.3.0.0 to your RIP domain.

Answer: Distribute-list, mutual redistribute

9. OSPF

9.1 Basic configuration (2 points)
Frame-relay interface in area 0; R4’s tokenring interface in area 4; serial interfaces between R3 and R2, R2’s tokenring interface, VLAN A in area 3; VLAN B in area 5; make area 5 as NSSA area. Put all loopback interface in the area. Make all interfaces reach each other.

Answer: virtual-link, nssa

9.2 default-information (2 points)
Make R2 generate a default route to area 5, make the default route only appear on R5.

Answer: At R2: Area 5 nssa default-information originate

9.3 external route (2 points)
Make another loopback interface in R5 (network 192.192.1.0) . male this network able to be reached by ospf topology but you are not allowed to put it in any area. And it must appear as different metric at R3 and R1.
9.4 OSPF timers (2 points)
You are informed that R2 use much resource to run the ospf process, tune the R3 to run not less than 30 seconds between two process.

Answer: Timers spf 5 30
Make sure you know the difference between the two spf timers.

10. Frame-relay QoS (3 points)
You are requested to run the frame relay include mincir,cir,bc,be as below:
mincir 16kbps; measure interval is 125ms;set DE when 48kbps;drop when 64kbps

Answer:
frame-relay traffic-shaping
fram-relay class QoS
map-class frame-relay QoS
mincir 16000
cir 48000
bc 6000
be 2000

11. ISDN

11.1 DDR (2 points)
Traditional DDR between R3 and R5, not mentioned about ppp or authentication.
isdn switch-type is basic-5ess, no spids. numbers are 680020X01 and 68020X02, where X is your rack number.

11.2 Toll avoidance (2 points)
When R5 generate a call, R3 will drop it and call back (ppp callback).

Answer:
Ppp callback request
Ppp callback accept
Dialer map ip 132.3.100.5 name R5 class CALLBACK 68020302
Map-class dialer CALLBACK
Dialer call-back username

11.3 routing backup (floating static) (2 points)
Put some specific static route at R3 and a default route at R5 to: when R3 or R5 lose some route from ospf, both them can generate a call to each other; any router in your topology can each the active interface of R5; Network 192.192.1.0 must still appear as different metric at R3 and R1.
When R5’s ethernet interface is still up, R5 is not allowed to generate the call???

Answer:
They don’t tell you use which method, you must decide by yourself. Use floating static
At R3:
Ip route 132.3.5.5 255.255.255.0 132.3.100.5 150
Ip route 192.192.1.0 255.255.255.0 132.3.100.5 150
Router ospf 3
Redistribute static subnet route-map BACKUP
Route-map BACKUP permit 10
Match ip address 50
Set metric-type 1
Access-list 50 permit 192.192.1.0 255.255.255.0
At R5
Ip route 0.0.0.0 0.0.0.0 132.3.100.3 150

12. BGP

12.1 IBGP, EBGP (2 points)
R1 in AS 1031, R4 in AS 1034, R3, R2, R5 in AS 1099; IBGP must be fully meshed.
Answer: Straight forward.
Use loopback interface as update-source in AS 1099 is better (for the sake of keeping the BGP peering stable when ISDN backup is functioning, see previous and below).

12.2 confederation and filters (2 points)
There is an external AS 254 on backbone 2 (which peer address is 150.100.2.254, and your is 150.100.2.X, where X is your rack number). You are requested to send your topology’s route to that AS and appear as from only AS 3. AS 254 will advertise several route to your topology, you are requested to only permit 197.68.x.0 to be put into your topology, where x is any number, The proctor said that the mask had no limit.

Answer: The question has no word such as ‘confederation’, you must decide by yourself to implement confederation.
Bgp confederation identifier 3
Bgp confederation peer-id 1031 1099

12.3 route advertisement (2 points)
Make another advertisement interface in R5 (network 192.192.2.0). Make this network the only route to advertise to the AS 254 and make it as the BGP route at R1’ routing table.

Answer: ‘No synchronous” at every router

12.4 reduce route (2 points)
For some memory consume problem, you are requested to change the 197.68.x.0 network to a supernet 197.68.0.0 expect 197.68.22.0, advertise them in your topology and do not send them back to AS 254.

Answer: There are four network incoming: 197.68.1.0, 197.68.4.0, 197.68.5.0, 197.68.22.0, so use suppress-map and AS-SET. Because network 150.100.2.0 is not seen by ospf, all router except R4 consider the 197.68.x.0’s next hop as unreachable, they don’t put them in their routing table since the BGP routes are not the best.
I have put the 150.100.2.0 into ospf, I don’t know whether it is acceptable, but the proctor seem to not mind it.

(or use next-hop-self)
Aggregate-address 197.68.0.0 255.255.0.0 as-set suppress-map SPECIFIC
Route-map SPECIFIC permit 10
Match ip address 1
Access-list 1 permit 197.68.1.0 0.0.0.255
Access-list 1 permit 197.68.4.0 0.0.0.255
Access-list 1 permit 197.68.5.0 0.0.0.255

13. dlsw+

13.1 normal setting (2 points)
Hosts on R2’s ring 1 and VLANB want to communicate with hosts on R3’s VLAN A.

13.2 additional peer (2 points)
Hosts on R4’s ring2 want to communicate with VLAN A on VLAN B’s hosts.
You are asked to add only one new peer connection, border peer is not allowed.

Answer: Maybe: rif passthrough , 3920 config

13.3 source-route bridge tuning (2 points)
Ring 1 in R2 experience a explore storm and cause packet drop. Tune the R2 to let the tokenring interface to
deal with 100 packets (include day and explorer packets) at one time.

Answer: Hold-queue

13.4 SNA filter (2 points)
Set filter to make R4’s dlsw only allow test explorer (0x0000) and SNA traffic (0x0004, 0x0008, 0x000c) an their response frames.

Answer:
Access-list 200 permit 0x0000 0x0d0d
Dlsw remote-peer 0 tcp 132.3.4.4 lsap-output-filter 200
Day 2

IPX
- Only Eigrp on FR and VLANB. Enable IPX on all interface except ISDN, BB1, loopback, ATM.
- R4 Accept a AA00 from BB2, but the ipx network number of BB2 is not specified- AA00 should be seen on all routers.(debug)
- Configure R2 such R5 can only receive FSERV1 on AA00.
- no ipx client on VLAN B can receive the SAP of FSERV1, but ipx client on VLAN B can accept others SAP.
-> Make a tunnel between R2 and R4

Appletalk
- Only Eigrp on FR. Enable apple on all interfaces except ISDN, BB1 and BB2. The zone of Vlan A and Vlan B is ether.
- Config R1 such that it cannot see the network of VLAN A, but it can see the network VLAN B.

- Enable Apple on ISDN.
- The ISDN is only activated when R3-R2 link fails.
- Disable IP on ISDN
- Static route is permitted.
- Vlan A can access R2 (Ring 1) and Vlan B, when R3-R2 fails.
- Callback is used.

Note: After test – Even if configuration is correct, apple callback will not work until reboot.

IOS feature
- Mobile ARP
- When VLAN A user is roamed to VLAN B and BB1, it still can be accessed.
  -->Configure as the document.

Router Access
- A specific IP address is allowed to configure R3 by a web browser
  - http server with access-list
- Privilege Control
- A user with a specific password can only be allowed to enter “show” command
- Broad-Control on FR
- Exact the same as command reference, pay attention to the byte or the bit.

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Catalyst
- Span
- Change spanning tree Maxage, you must ' set spantree router’ too, because the spanning tree maxage will follow the routers config when a router is connected to the switch.

Trouble Shooting

Requisite
- All router configuration will be based on RACK 5. Say, loopback interface is according to RACK 5.
- 132.x.0.0 is 132.5.0.0.
- ISDN number, AS number, BB1 and BB2 are used the old rack number.
- Cannot change download configuration IP address
- Cannot erase a whole routing process to enter a brand new configuration.

Wrong Connection
- A cable is inserted from 3920 to a Catalyst port (prepend a router interface)
- Serial cable is inserted in a wrong fashion.

- R5 host name is changed to R3.
- Tunnel destination disappear on R2 tunnel interface.
- Tunnel source disappear on R5 tunnel interface.
- R3 serial 0 and serial 1 configuration are interchanged.
- Token Switch configuration is erased.
- Catalyst module is disabled.
- Wrong FR map
- Wrong OSPF area, and its parameter like stub area (R5), hello interval (R3), router ID (wrong loopback ip address), no route-map, ospf network type.
- Wrong Apple zone
- Wrong IP address (R5, R3)
- VLAN is erased
- Wrong Catalyst IP address and allocated VLAN
- Wrong IPX network address on BB2

Other questions

1. Voip
Change the timer such that when you pick up the phoneset, the waiting timeout before you press the digit is the longest.
-->initiate-timeout?
2. **ACL**  
R2’s serial interface has a access-list

3. **3920**

2 TrBrf in 3920, the first TrBrf has an ip address.  
-->same as the document.

4. **ISDN callback**  
Use isdn callback for toll avoidance, and callback as soon as possible when the server receive a call.  
chap authentication  
-->isdn caller xxxxxxxx callback  
because the isdn cloud is the isdn simulator, it cant send calling number, so you have to add a command on calling site:  
isdn calling-number xxxxxxxx  
Change enable-timeout to shortest.
LAB 2.

Note: Diagram might have some minor inaccuracies.

2503: R3, R5
2611: R1
3640: R2, R4, R6
5002: Cat5
3920: Tokenring switch

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Day 1

1. Comm server (1 point)

2. Diagram (1)
   Include ip address, area number, interface, make your diagram update.
   Remember to mark FRSW’s interface number too, you will need it on troubleshooting.

3. Physical connection (1)

4. cat5002 setup (1)
   two VLANs, VLANA:50; VLANB:75

5. cat5 address (1)
   sc0 address on VLANA, 135.x.30.30/22, where x is the rack number, make it be reached by your topology

6. IRDP (2)
   ip irdp preference 100

7. Framerelay (2)
   28 bits subnet. only use the dlci showed on the given diagram ( hub & spoke, not fully meshed).
   no frame-relay inverse-arp
   frame map ip …

8. Loopback address (1)
   All of the routers has loopback interface. 135.y.x.x, where y is the rack num.
   And x is the router num.

9. Address (1)
   vlana: /22  vlang: /26; framerelay int: /28; idsn: /30; others:
   /24
   Use 135.x.0.0 to setup all interfaces except explicitly asked.
   e0/0 on R1 is 150.100.1.x (BB1); e0/0 on R4 is 150.100.2.x (BB2).

10. OSPF (3)
    Frame relay cloud on area 1, vlana on area 0, R2’s ring on area 2, vlang on area 5, isdn on area 6.
Make loopbacks on existing area.

11. OSPF cost (2)
Change the ospf cost, should not use ‘ip ospf cost…’ on interface. Make cost on ethernet as 90.

auto-cost reference-bandwidth 900

12. RIP (2)
Rip on R1 e0/0, manual redistribution with ospf. Should receive only 199.172.x.0, make 199.172.1.0 and 199.172.3.0 as one network on your ospf topology, also advertise 150.100.1.0. only class B 135.x.0.0/16 can be advertised from ospf to rip.

There are 4 networks received by rip: 199.200.1.0, 199.172.1.0, 199.172.3.0, 199.172.12.0

router rip
redistribute ospf 3 metric 2
network 150.100.0.0

router ospf 3
redistribute rip subnet
summary-address 199.172.0.0 255.255.240.0
distribute-list 1 out rip

access-list 1 permit 199.172.0.0 255.255.0.0

13. IGRP (2)
Igrp at R3 and R4. AS is x. mutual redistribute with ospf, only configure RP3 such that R4 can receive a default route, no static route, summary address, additional network are permitted.

router igrp 3
network 150.100.0.0
redistribute ospf metric 2000 10 255 1 1500
ip default-network 199.172.12.0
(only this network is the classful network in R3’s routing table, this is the only answer.)

14. IPX (4)
Setup ipx network on all interfaces except ATM, loopback, ISDN, backbone. You can use rip and/or
Eigrp. R3 and R6 should be at different network.

Different network with different encapsulation on R2.
frame-relay map ipx …

15. SAP (2)
vlana’s sap is interferenced by something, assume that there is no servers on vlana, make the sap
Advertise only when it changed.

at R2, R3, R6, set on interface:
ipx sap-incremental eigrp 3

16. ISDN (4)
Only R5 can generate the call, use chap authentication, but R5 should not challenge R3, R5 should not use its own name to authenticate, must use userx.

oneway authentication. oneway dialer map
at R5:
user user3 password cisco
user R3 password cisco
int bri0
dialer map ip 135.3.9.1 broadcast 68020301
ppp chap hostname user3

at R3:
user user3 password cisco
user R3 password cisco
int bri0
ppp authentication chap

17. ISDN routing (2)
Setup RD and R5 such that when R5 can access the topology when its serial interface down.

at R5
router ospf 3
network 135.5.5.0 0.0.0.255 area 5
network 135.5.55.0 0.0.0.255 area 5
area 1 virtual-link 135.5.2.2
area 1 virtual-link 135.5.3.3
int bri0
ip ospf demand-circuit
I use backup interface also, but the protor said its wrong (if interface is up, but the dlc mapping in telecom is wrong, the isdn will not up). so just demand-circuit is ok.
Make the loopback interface at area 5, and setup two virtual-link to make sue the area5 and the loopback interface is seen by the topology when serial is down and isdn is up.

18. ATM (2)
R6, no subinterface, no autolearn ip address from client. vpi: 0, vci: 10x. ip address: 192.1.x.1, remote ATM router ip: 192.1.x.254

int atm 3/0
pvc 0/103
protocol ip 192.1.3.254 broadcast
no inarp

19. VPN (2)
You have a VPN client, they use CIDR 192.1.32.0/20, some of your client’s employees are connected at R5’s ethernet, their gateway is 192.1.32.175. You can use any network in 192.1.32.0/20 to build the VPN. VPN still on function when R5’s serial is down.

Setup tunnel between R5 and R6, secondary ip address at R5’s e0:

R6:
int tunnel 0
ip address 192.1.33.1 255.255.0
source loopback 0
tunnel destination 135.3.5.5

R5:
int tunnel 0
ip address 192.1.33.2 255.255.255.0
source loopback0
tunnel destination 35.3.6.6

interface e0
ip address 192.1.32.175 255.255.255.0 secondary

20. VPN routing (2)
Your client are using eigrp 100, setup such that your clients employees at R5 can be reached by their remote network, also advertise the route received from the remote ATM router to the employees. All the routes of your client are not allowed to be advertised out of R5 and R6.

router eigrp 100
network 192.1.33.0
network 192.1.32.0
passive-interface …

21. VPN routing (2)
All traffic from your clients employees at R5 to outside, either traffic to their networks to your networks, should be route to the remote ATM router first (assume they don’t need to telnet to R5 or R6). Setup R5 and R6 to comply this policy.

policy routing
R5:
interface e0
ip policy route-map VPN

route-map VPN
match ip address 2
set ip next-hop 192.1.33.1

access-list 2 permit 192.1.32.0 0.0.0.255

R6:
interface tunnel 0
ip policy route-map VPN

route-map VPN
match ip address 2
set ip next-hop 192.1.3.254

access-list 2 permit 192.1.32.0 0.0.0.255

22. dlsw
R2’s ring 1 to R4’s ring 2; R2’s vlana to R5’s vlanb. Others are not allowed.

Use bgroup-list and ring-list

R2
dlsw local-peer peer-id 135.5.2.2
dlsw remote 1 tcp 135.5.4.4
dlsw ring-list 1 rings 1
dlsw remote 2 tcp 135.5.5.5
dlsw bgroup-list 2 bridge 1
dlsw bridge-group 1
source-route ring-group 200
23. dlsw efficiency

R4’s hosts can reach R2’s hosts which mac address are 4000.2300.xxxx, but they would not send any explorers.

R2:

dlsw i-can-reach mac 4000.2200.0000 mask ffff.ffff.0000
Day 2 morning

1. BGP (3)
   R4 in AS x, R2, R3, R6 in AS 100x, R1 in AS 200x, R5 in AS 300x. x, 200x, and 300x should peer with 100x. 300x still peer to 100x when R5’s serial is down.

   Use ebgp-multihop on the 100x and 300x peering by loopback interface.
   peer to R2 or R3

2. EBGP (2)
   AS 254 at backbone 2, peer 150.100.2.254. Setup R4 to peer with. Only received network 172.68.y.0, where y is any number.

   neighbor 150.100.2.254 distribute-list 1 in
   access-list 1 permit 172.68.0.0 0.0.255.255

3. Aggregation (2)
   Aggregate networks 172.68.y.0, such that R5 can only see the aggregated route and see it come from AS x. other routers should see the specific routes, also, they can see the aggregate route or not.

   AS-SET maybe reasonable

4. Default information (2)
   New loopback interface 192.192.4.0 at R4. Advertise it only by BGP throughout the topology, AS 254 are asked to receive it only. R2 generate a default route to R1 as long as it receive this route.

   R2:
   neighbor 135.3.1.1 default-information originate route-map DEFAULT

   route-map DEFAULT
   match ip address 1

   access-list 1 permit 192.192.4.0 0.0.0.255

   R4:
   Distribute-list out

5. Appletalk (3)
   Setup appletalk at all interface except ATM, loopback, ISDN, backbone.
   VLAN A zone is viana, only eigrp

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on framerelay cloud.

appletalk route-redistribute
no appletalk eigrp split-horizon
appletalk local-routing
appletalk protocol eigrp (framerelay int)
no appletalk protocol rtmp (framerelay int)
frame-relay map appletalk ...

Setup vlan on tokenring switch 3920 to separate the two rings so that appletalk can be active on each ring.

6. Appletalk filter (2)
R4 can see all the appletalk cable-range, but others cannot see the cable-range of R4’s ring2.
No filter is allowed.
No appletalk send-rtmp on R4’s serial 0/0 (appletalk on R3’s serial 1 maybe inactive)

or

Appletalk eigrp on R4’s ring2, rtmp on R4’s serial 0/0 and no appletalk route-redistribute

7. Appletalk filter (2)
R5 can’t see zone vlana and the cable-range associate with it.

Distribute-list in on R5’s serial 0
Pay attention to the setup steps, you had better setup distribute-list first and enable appletalk eigrp last, or the zone “vlana” would appear at R5’s zone table.

8. Access-list (3)
Only setup one output access-list on R2’s serial 0/0 to:
Mail traffic from ring2 to vlanc is not allowed;
R3 can ping R1, R1 cant ping R3. (just the nearest interface is enough);
Users on ring1 is allowed to use port 6000 to 7000 (inclusive) to access vlanc;
No snmp traffic is allowed:
Users on backnone1 cant use ring2’s tacacs service;
Any other traffic is allowed.

access-list 100 deny tcp 135.3.22.0 0.0.0.255 135.3.55.0 0.0.127 eq smtp
access list 100 deny tcp 135.3.22.0 0.0.0.255 135.3.55.0 0.0.127 eq pop2
access-list 100 deny tcp 135.3.22.0 0.0.0.255 135.3.55.0 0.0.127 eq pop3
access list 100 deny icmp 135.3.30.3 0.0.0.0 135.3.0.1 0.0.0.0 eq echo-reply
access list 100 permit udp 135.3.22.0 0.0.0.255 range 6000 7000 135.3.55.0 0.0.0.127
access-list 100 deny ip 135.3.22.0 0.0.0.255 135.3.55.0 0.0.0.127
access-list 100 deny udp any any eq snmp
access-list 100 deny udp any any eq snmp-trap
access-list 100 deny tcp 135.3.44.0 0.0.0.255 eq tacacs 150.100.1.0 0.0.0.255
access-list 100 permit ip any any

9. Broadcast control (2)
Configure vlanb on CAT5, make the broadcast traffic under 20% assume that the frame size is 768 bytes, including preamble.

Set port broadcast 2/4 20%

10. Traffic control (2)
Webservers on ring2, configure R4 such that output rate to the webserver is under 1.5Mbps, any traffic higher than 1.5Mbps is dropped.

I use CAR, but the protor said rate-limit is the wrong solution.
Maybe general traffic-shaping

11. Multicast (2)
Setup R1 to join a multicast group 224.0.5.5, R2, R3, R6 can ping this group but shouldn’t be explicitly setup to join it.

ip igmp join-group 224.0.0.5
Either dense-mode or sparse-mode is ok.

12. CGMP (3)
R2 and R6 can inform CAT5 the multicast group, CAT5 can send it to R3 even it is rebooting

at R2 and R6:
ip cgmp

at CAT5
set cgmp enable
set cam permenrant 01-00.5e-00-05-05 2/2 (2/2 connect to R3)

13. netbios filter (2)
setup a output filter on R4’s tokenring interface such that:
access to host SERVxNR is not allowed, which x is any character.

netbios output-access-list host ABC
netbios access-list host ABC deny SERV?NR( ^v first to input the “?”)
netbios access-list host ABC permit *

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Day 2 afternoon troubleshooting (25)

Both console and aux ports in all of the routers are set to ‘no exec’ except commserver.
All the console ports’ speed are changed-
Some consoles are set to exec-timeout 0 1
Enable secret in some routers.
Console speed of CAT5 is changed.

I use one hour to break in all the equipments, its too long.
There are different strange characters on different speed, make sure you remember it and have practice on it
before you test.

Some physical connections are wrong.

There are many additional config on the equipments, the aim of them is to avoid your clear the config and
retype the correct, you need to erase them which not bother your correct answer.

Rack number was changed to 5

Frame-relay mapping wrong

CAT5 module and ports disabled, vlan dispeared.
After the vlan and ports are set to right (I’m sure), all the ports appear ‘connected’ and routers on backbone
vlana can ping itself, but they can’t ping each other, so routing failed, this is why I failed the test.
(I don’t know the reason, maybe port broadcast is set to 0%, so arp wasn’t successful).
( The routers probablyly were set wrong static arp, I hadn't ever check the arp table on each router).

Serial between R3 and R4’s clockrate dispeared. appletalk was set to no send-rtmp.
LAB 3.

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Day 1

1. Diagram (1)
Draw diagram, including IP addresses of all interface, ospf area, BGP AS number, IPX network number, physical links. Make your diagram update.

Answer: mark as many as you can, include the serial ports of the FRSW, esi or PVC or ATM, Ip addresses outside your topology, routes from outside, the addresses you need to filter, summarize or aggregate. It’s very important for your troubleshooting.

2. Physical connection (1)

3. Names & password (1)
Names are: RackYYRX, which YY is your rack num, X is the router num.(for example, rack4 router3 is Rack04R3)
Set password: cisco, set exec-timeout never, users can access on con, aux, ttys.

Answer:
You should add ‘loggin’ command on line con 0, line aux 0, line vtys.

4. Framerelay (3)
Same as the diagram, not fully mesh.

Answer: disable the inverse-arp

5. Address (1)
Loopback address is 138.Y.X.X, Backbone1 is 150.100.1.X, Backbone2 is 150.100.2.X.
6. Address (1)
Use 138.Y.0.0 as your topology address scheme. Framerelay cloud is /29, isdn is /20, ring 10 has 10 hosts, make your subnet mask decision. (that means /28), others are /24.

7. Vlan (2)
VLANA(20), VLANB(30), VLANC(50), VLAND(70), VLANE(80)

8. Tokenring switch
Setup two Trbrf, use bridge number as 1 and 2, ring number as 10(R2&R6) and 20(R4).

Answer:
Note that the ring number in questions and routers is decimal, but in 3920 is hexadecimal.

9. Trunk (2)
Setup trunk at CAT5, VLANE is not allowed in trunk. R6 connect to trunk. Be careful that not all switch ports are able to be a trunk.

10. OSPF (3)
Framerelay at area 0, ethernet at area 3, ring20 at area 4. No additional area is allowed. Routers in area 4 have not enough memory to handle lots routes, configure R4 to adjust it.

Answer:
Make area 4 totally stub area.

11. RIP (3)
R5’s serial port and R1 run RIP, inject the specific routes from ospf into RIP, but only advertise 138.Y.0.0 to BB1, no summary and static route are permitted. Only permit one route 193.67.15.0/24 received from BB1. mutual redistribute between RIP and OSPF.
Answer:
Use rip version 2 but send and receive version 1 on R1’s ethernet.
Distribute-list on R1’s ethernet.
Remember to use debug to check the route update whether it is right.
Make a redistribute-list at R5’s OSPF, just permit the routes belongs to rip to be redistributed from rip to ospf,
or the isdn will flap.
bri as passive interface

12. ISDN (2)
Just R5 can initiate the call, use pap authentication with different passwords at each side.

Answer:
‘dialer map’ at R5 only, ppp pap sent ....

13. ISDN routing (3)
BRI interface at area 3, when ethernet down, keep topology consistent. Flapping is not allowed.

Answer: demand circuit

14. ATM (3)
PVC 0/10Y, autolearn is not allowed, ip address 192.1.1.Y pvc peak rate 100M, minimum rate 10M.

Answer:
Use static map, ubr+

15. EIGRP (3)
ATM, tokenring on R2 and R6 run EIGRP, only configure R6, permit 128.20.0.0 and 4.1.1.0 into R6, permit
128.28.0.0, 4.1.1.0, 192.1.1.0 into R2 by EIGRP.
Configure R2 or R6, such that OSPF and EIGRP can redistribute each other
Answer:
No auto-summary, set distribute-list at ‘arm in’, ‘tokenring out’, also set ‘tokenring in’ to deny all eigrp update from R2, to prevent R2 advertising the 138.Y.0.0 by EIGRP instead of OSPF. (because of its lower distance).

16. DHCP (2)
R6 as a dhcp server and you should not define a database agent.

Answer:
no ip dhcp conflict logging
ip dhcp exclude
ip dhcp pool
…

17. HSRP (2)
Define HSRP on R2 and R6 ring 10, R6 as the primary, when tokenring or ethernet interface of R6 fail, R2 as the primary.

Answer: Use ‘track interface’ at R6

18. BGP (4)
R3, R4, R5, R6 in AS Y, BB2, in AS 254, R1 in AS 10Y. AS Y are not full mesh, when R4 or R6 failed, other routers can still receive all the other BGP routes. Just allow 192.200.0.0 received from BB2.

Answer:
R4 and R6 act as Route Reflector.
input prefix-list at R4 is the best.

19. BGP advertisement (2)
Another loopback interface at R1 (195.82.Y.Y/32), advertise it throughout the network. Another loopback interface at R3 (195.83.Y.Y/32), advertise these two route only to BB2.

**Answer:**
Assign distribute-list out at R4 although eventually there are just two BGP routes advertise to BB2. Do what they ask you to do perfectly and accurately.

**20. BGP filter (3)**
Configure R5 such that 195.83.Y.Y is not seen on R1, but you can’t use any filter base on ip address.

**Answer:**
Use filter-list (as-path). Don’t use community, because you have to change community based on ip address.

**21. Voice (1)**
R6: port 2/0/0 is 50YO, port 2/0/1 is 60Y2, remote phone is 3002, remote peer 128.28.2.8 (behind ATM cloud). Make you voices able to call each other and 3002.

**Answer:**
Make sure you can reach 128.28.2.8 and 128.28.2.8 can reach your topology (not just the ATM int). Redistributing OSPF to EIGRP is important.

**22. Voice (2)**
Configure R6 so that when port 2/0/1 offhook, you can reach 3002 without inputting any digits.

**Answer:**
‘connection plar’ at port 2/0/1.
Day 2

1. Multicast (3)
R1, R5, R6. R5 as RP, R5 join group 224.1.2.3, setup R1 and R6 so that R5 as the only RP for 224.1.2.3.

Answer:
I think I lost the points. Check this command: ip pim rp x.x.x.x. [ACL]; ip pim accept-rp x.x.x.x [ACL]

2. Multicast (2)
Inform Catalyst the multicast group.

Answer: CGMP at R5 and CAT.

3. IPX (4)
Atm, loopback, isdn, BB1 are not running ipx, rip on R5’s serial int and R1, others are eigrp only. you don’t know the BB2’s ipx network and the encapsulation type, find it.

Answer:
‘denbug ipx packet’ and try all the encapsulation type in R4’s ethernet, you can find the encapsulation and network number. Remember to config the framerelay mapping at FR cloud, or you cant ping each other although your routing table is right.

4. IPX filter (2)
Assume that you will have an additional wan link between R1 and R5, configure R1 so that it can use both links to each other networks that are not connected directly to R1.
Only configure R5, just allow network aa00 and service FSERV1 into R1.

Answer:
ipx maximum-path 2
ipx output-network-filter, ipx output-sap-filter.
5. **IOS feature (2)**
At VLANB, there are some users have not setup their gateways, configure VLANB such that these users can't access your topology by anyway.

**Answer:** Disable proxy-arp at R3 and R6’s VLANB subinterface.

6. **Menu (2)**
Setup a menu, include `show interface`, `show ip route`, `show startup`, `exit menu`.

**Answer:** Search the document.

7. **Link efficiency (3)**
Use compression method predict (software) to compress the link between R1 and R5.

**Answer:**
Change encapsulation to PPP, and you can use preditor now.

8. **Dlsw (3)**
Bridge connectivity between ring10 and ring20, ring10’s host communicate with ring20’s host through R6, when R6’s tokenring interface fail, they will use R2 instead. When R6 resume, R2’s connection must be undone, but should be maintained 6 minutes before disconnect. R2 and R6 should not be configured a remote peer. Source-bridge number must be consistent with tokenring switch.

**Answer:**
Backup peer, linger as 6. R4’s remote peer must be R2 and R6’s tokenring interface. Promicous. Redistribute eigrp into ospf in R2 but not R6, because of the redistribution is in R6, when R6’s tokenring down, the network of the ring will be down, and can't be distribute into ospf, R4 will not have the ip routing connectivity to R2’s tokenring interface.
9 Dlsw (2)
A mainframe in ring10, make R4 have this mainframe’s mac address in its cache, and can only reach this host.

Answer: icanreach, icanreach max-exclude.

10. Catalyst feature (1)
VLANE have end station only, and have heavy traffic, configure it to reduce the BPDU traffic.

Answer: Disable the spanning tree on VLANE.

11. Catalyst feature (1)
Port 2/11 belongs to VLANE, and connect to a host with a mac address, configure the switch so that it need not learn the hosts mac address event at bootup period.

Answer: Set cam peranent. Set the port belongs to VLANE

12. Catalyst feature (1)
Port 2/12 connect to a host, and belongs to VLANE, configure the switch so that only this host can use this port.

Answer: Set port security. Set the port belongs to VLANE.

13. Autoinstall (3)
A TFTP server with address 150.100.2.17 on BB2, a router with no startup-config in FR cloud, configure R4 such that the router can bootup with a startup-config which in the TFTP server, use CLCI 110.

Answer:
frame-relay map ip 138.5.234.5 110 (the ip address must be in your FR cloud’s subnet)
**Day 2 Troubleshooting**

Use rack number 6 instead of your original rack number.

Wrong console speed, no exec at con or aux, exec-timeout 0 1 at con or aux R3’s host name was changed to R5, and ipx routing also was changed to 5.5.5 to make you confused.

One FR serial cable failed; R3’s s0 config was moved to s1. Wrong mapping at every serial interfaceS.

Wrong ospf network type, ospf authentication at one side but not in other side.

Wrong network or wrong area.

Wrong BGP AS number. Wrong peering.

Rip was changed to version 1.

Wrong ATM ip address. Wring distribute-list in EIGRP.

Wrong ipx network.

Catalyst module and ports are disabled, vlan removed.

Anyhow, you have to correct everything when you are troubleshooting.

**Other questions:**

1. **IRB**
Use IRB at R6.
--> Different bridges for different subinterfaces. Add “bridge X route ip” in R6.

2. **OSPF security**
The requirement is that in every VLAN, only Rx(2 or 3 or 5) can have adjacency with R6, assume that there are other routers in that VLAN.
--> Do not use non-broadcast type and the neighbor command. Because the other routers can have adjacency with R6 by putting neighbor command with R6 although R6 do not have the neighbor command with it.
Method 1:
Add a tunnel in every VLAN, and make the ethernet interface passive.
Networks will be increased. This method was proved by the proctor.

Method 2:
Add mac-address filter at R6.
Not only make the neighborship secure but also break the connectivity of the VLAN (maybe wrong)

3. SNAPSHOT
Isdn run ipx rip, active period: 5 minutes; quiet period: 120 minutes.
---> Idle-timeout 120 seconds is too short and make the snapshot bounce, set it longer, say 250 seconds.

4. ATM arp-server
R6 as ATM arp-server; ESI is 1111.0000.00YY.00, which YY is your rack number.
Setup PVC 0/5 to handle SVC signaling; setup PVC =0/16 to get the prefix.
Arp-server self.
LAB 4.
Day 1

1. Framerelay
R5 as hub, 2 subinterface, point-to-point subinterface connect to R4, point-to-multipoint subinterface connect to R2 and R3.

2. Addressing
BB1, 150.100.1.Y; BB2 150.100.2.Y; framerelay cloud(R2,R3,R5) /28; VLANA /25; Ring1 /27; VLANC /29; ISDN /30; others /24.

3. OSPF
Framerelay cloud (2,3,5), ISDN in area 0; VLANA and ring1 in area 3; R5 and R6’s serial interface in area 5; VLANC in area 6.
--> R2 and R3 need to establish virtual-link for area 0, prevent the inconsistence of backbone once the framerelay pvc is down. (Ask the proctor whether you need to do this)
Use the most secure method to authenticate ospf neighbor in backbone and ethernet.
--> MD5 authentication, note that level 7 may have problem.
Change the dead-interval, but you are not allowed to explicitly change the dead-interval timer.
--> Change the hello-interval.

4. EIGRP
R1 and R2’s serial interface run EIGRP, 4 loopback interfaces in R1, place them in EIGRP, summarize them into one network and advertise it to R2. --> Summary in interface.
Redistribute OSPF and EIGRP mutually in R2, cost of routes redistributed to OSPF should have a fix value.
--> metric-type.

5. RIP
R1’s ethernet interface run RIP, redistribute even network into EIGRP. --> wildcard mask!

6. IGRP
R4 and R5’s link (p2p framerelay), Ring2, VLANB run IGRP. Redistribute OSPF and IGRP mutually in R5. Loopback of R4 shouldn’t be placed in IGRP, should be redistribute in it??
You are permitted to add a static route but not a default-route in R4 pointing to BB1.
--> Because IGRP is a classful protocol, you must add a static route ‘ip route 133.Y.0.0 255.255.0.0 150.100.1.Y’ (for example) in R4, so that R4 can reach all the subnets in ospf topology.

7. ISDN
Only R5 can make a call, chap authentication, R5’s hostname should not be itself.
Ospf routing. --> demand-circuit (be careful for the redistribution)

8. ATM
PVC, you are 192.1.1.Y, remote peer 192.1.1.254.
Should not add a default-route, networks behind ATM can reach your topology?
--> ATM run EIGRP? Then use summary in ATM interface?

9. BGP
R1,2,3,4,5,6 are in AS Y. -->IBGP
All the routers in IBGP must receive bgp routes from R5. -->R5 as RR.
BB1 and BB2 are both in AS 254, setup R1 and R4 so that the bgp routes from AS254 have weight 1000.
-->route-map in
AS Y shouldn’t be a transit AS, but you are not allowed to use AS-path to filter it.
--> Apply no-export community to the BGP routes coming from AS254.
R1 and R4 advertise networks of Ring1, Ring2, VLANA, VLANB such that outside world reach RING1, VLANA through R1, reach RING2, VLANB through R2.---> route-map out with different metrics.
Configure R1 and R4 so that only the new routes from AS254 are received???
DAY 2

A) DLSW
Ring1, VLAN A of R2 and Ring2 have bridge connectivity, R2 should not add a remote-peer. --> promiscuous
R3 act as backup of VLAN peering to R4; LLC of R4 use R2 to deliver SNA traffic when R2 isn’t down.
--> cost.
A SNA host in VLAN A, configure R4’s Ring2 so that R4’s explorer for this host should not cross the FR cloud,
at CAT5 you can see the host’s mac address is X.X.X.
--> proxy-explorer, pay attention to the canonical and non-canonical address style.

B) IPX
R2,3,4,5 run ipx, EIGRP only in FR.
You don’t know BB2’s ipx encapsulation type and network. --> debug ipx packet.
Only allow AA00-AAFF coming from BB2. --> input-network-filter.
Client of Ring1 only get one ipx service: PTSVR. --> output-sap-filter.

C) Other questions

1. OSPF non-broadcast type
 --> use neighbor

2. BGP
 set origin IGP
 prefix-list

3. CAT5
 set spanning tree root
LAB 5.
Day One
FR – non broadcast
ISDN – Chap, One-way authentication, different hostname. R5 to R3
OSPF – Summarization, filter
IGRP – R3 generate default route to R4
IPX routing – R3, R6 different network, SAP incremental update on VLAN A, no server is allowed on VLAN A
ATM – PVC to remote backbone router
EIGRP – Run over ATM
VPN – Make a tunnel from R5 to BB1
DLSW – Icanreach, Token to Token, Eth to Eth

Day Two
Multicast routing
Appletake – filter
BGP – Announce default route, no RR, but like previous exam
Access control
1. Setup the network with 137.2.0.0
   1a. Frame relay use 140.2.10.0/255.255.255.240
   1b. TR2 use 137.2.44.0/255.255.255.248
   1c. ISDN use 137.2.25.0/255.255.255.252
   1d. BB1 use 150.100.1.0/24
   1e. BB2 use 150.100.2.0/24
   1f. TR1 use 137.2.26.0/24
   1g. Make a loopback interface in each router, the loopback address need to be advertised on the following setup. The loopback ip address can be put into any area or routing process.
   1f. A low memory router will be connected to TR2, select the best way.
   1g. R1 is a RIP only router. It can send unicast update to RR1.
   1h. R5 and R1 run RIP. R1 can reach throughout the network. Summarization is now allowed.

2. Establish VLAN A(20), VLAN B(3), VLAN C(50), VLAN D(70), VLAN E(80).
   Catalyst is located in the VLAN D.

   R2 -> VLAN A
   R3 -> VLAN B
   R5 -> VLAN C
   R6 -> ISL

   2a. Set up ISL with R6 and Catalyst.
   2b. VLAN E is not allowed in the ISL

3. IRB
   Use R2, R3, R6 are routed through R6 by IRB

4. Security
   R2 can only establish adjacency with R6. R3 and R5 do the same as R2.
   Authentication or address filtering cannot be used.
I used Non-broadcast and Neighbour, it is wrong. I tested that if the timer of others router is changed to the same to the R6 and R2, the others router can establish adjacency with R2 and R6.

**ISDN switch: basic-5ess, No Spid**

5a. Only IP traffic can bring up the ISDN interface. If the error rate is more than 10%, put it into “Down” state.

5b. ip ospf demand-circuit. ??

6. **ATM**

6a. R6 is acting as LECS with a specified IP address. (do not use the auto load address)
6b. R6 is acting as LES.
6c. LANE name RACKY.
6d. R6 can ping ATM core router.
6e. Only R2, R6 Token ring interface and ATM interface run EIGRP 100. Other interface are not allowed to send EIGRP.

7. **IP feature**

7.1 There is DHCP client in TR1. Make R6 as the DHCP server, it can distribute the default gateway to the client and the lease period will be infinity.
7.2 Configure HSRP on R6 and R2, R6 will be the active gateway. If the R6 fast ethernet is flapped, R2 will be the active gateway.

8. **BGP**

8.1 R4 peer with RR2
8.2 R3, R4, R5, R6 is IBGP. They are NOT fully meshed. If either R4 or R6 is not available, other IBGP peer can obtain full route from other peer. R4 and R6 will advertise the route to other Internal peer.
8.3 Make a loopback interface in R1, this is the only route to be seen on RR2. (137.2.0.0? no need to be seen in RR2)
8.4 Make a look interface in R3, this is the only route to be seen on RR2. R1 cannot see this route. Filtering is not allowing.
9. VOIP
9.1 Assign number to two phone on the FSX with the number 5020, 5021.
9.2 A no show router is located in somewhere behind ATM core router which IP address is 128.x.x.x
Try to make a call to 3001 to test the call.
9.3 Once the FSX phone is picked up, it would dial to 3001 automatically.

Answer:
3. Put different VLAN in different bridge group
4. By input filter
6. “lane config config-atm-address” in interface and “lane config-atm-address” in sub-interface

IPX (11 points)
DLSW, broder, Dynamic peer (9 points)
Catalyst, Port Security, Spanning Tree, multicast(pim, sparse) (5 points)
LAB 7.

**Day 1**

YY = your rack number, X = your router number, Z = random number,

You are given a classful B network: 139.YY.0.0. If not specify, use 24 subnet mask,

Create a loopback address for each router use: 139.YY.X.X

Catalyst5000’s sc0 ip address is 139.YY.0.50/24, all your router can ping this address

Create two VLAN: VLAN A(2/2,2/5-6) vlan id 256

and VLAN B(2/3) vlan id 30

Catalyst3920’s ip address is 139.YY.20.11/24, all your router can telnet to 3920

use this address through ring 1,

Between R1 and R2’s serial support 2 hosts,

Ring2 support up to 30 hosts,

ISDN support 2 hosts,

On R5’s e0, there are two range network, the main range network is 139.YY.25.0/24, the other range network is 139.YY.0.0/24

R1 to backbone1 address is 150.100.1.YY/24

R4 to backbone2 address is 150.100.2.YY/24

Frame-relay sw is full mesh, but you only can use the dlci number in the figure, R3’s serial cannot use subinterface.

**OSPF area**

Between R1 and R4’s serial: area 0

Between R1 and R2’s serial : area 1

R2’s token ring: area 2

R4’s token ring : area 4

**RIP(3)**

From backbone you can only let 199.172.1.9 and 199.172.3.9 appear on R1 all through your routers, the two network must have different metric on R4 all your routers can ping the ip address 150.100.1.253

You are allowed to let the subnets of your network 139.YY.0.0/16 to get to backbone

**EIGRP**

EIGRP AS number is 100

You can redistribute between OSPF and EIGRP ONLY on R2

On R4, do not allow ospf route, VLAN A and/or RIP route appear as EIGRP
Create a access-list on R4 to prevent loop route.

ISDN
(2) R3 and R5 can ping each other, when isdn is up, only permit IP packet pass through the isdn
(3) It is not permitted any ip protocol on the isdn, you can create a default route on R3 and several specify static route on R5, if R3’s serial interface is administely pulled out from the router, the isdn should be up.

BGP basic
R1,R4,R3 are in AS YY, R2,R5 are in AS 10+YY,R6 is in AS 100+YY
Backbone2 is AS 254
Let loopback to update route
Ebgp: only between R4 and backbone2, only between R1 and R2, only between R3 and R5, only between R2 and R6, only between R5 and R6.
R1,R4,R3 are full mesh ibgp.
From backbone 2, there are network : 197.68.Z.0,200.200.1.0
Only allow 197.68.Z.0 pass through your routers, R1 and R3 can see them as ip route and ip bgp route.

BGP feature 1
Create a loopback 192.YY.42.132 on R6, put it into bgp route, let all your routers can see it.
On the R4, you have two pathes to get to the network 192.YY.42.1/32, you must let R4 prefer R2 to get to 192.YY.42.1/32, do not use access-list based on ip address or ‘next-hop’.

BGP feature 2
On R5, there are routes from AS 254 pass through R2 and R3, you must let R5 prefer the routes from AS 254 from R2, do not do it based on ip address.

Multicast
Config multicast on R1’s serials, R2’s token ring and serial, R4’s serial and token ring
Use sparse-dense-mode
Only on R2’s token ring interface join two ip address: 224.1.1.1, 244.2.2.2. on other router, do not join the two groups explicitly
On R2 it is only 224.1.0.0/16 group’s rp address.
R4 can not explicitly announce rp address, R4 only see one of the rp address, do not see another rp address. But can ping the two ip address.

ATM
Config ATM arp server
ATM esi-address:1111000000YY.00
Get snap address from ATM sw
R6'atm3/0 ip address:192.2.YY.1/24
Put atm3/0 into EIGRP
From arm router, there are many route, only allow 198.2.1.0 appear on R6 and all your routers
R6 only advertise 139.YY.0.0/16 to ATM

**Catalyst3920**
Config 3 vlans
Port 2, R2’s to0/0 ring# (decimal)1, Bridge # (decimal)11
Port 4, R4’s to0/0 ring# (decimal)1, Bridge # (decimal)12
Port 6, R6’s to0/0 ring# (decimal)3, Bridge #(decimal)13

**DAY 2**
**1. Unicast RPF (3 point)**

**2. Access-list (2 point)**
Config a access-list(in) on R6’s to0/0 only allow source from FRC1918’s private address (class A, class B, class C)

**3. Telnet-1 (2 point)**
Only allow your ip address 139.YY.0.0 can telnet to R6, on R6 can identify the request against permit.

**4. Telnet-2 (2 point)**
For security, in order to increase the security, when you telnet to R6, you must be request to input user name:userYY, input password:cisco

**5. Ipx (5 point)**
look ipx figure
IPX RIP:R6’s to 0/0, VLAN A, Backbone 2
There are twp ipx network on R6’s to0/0: 100+YY,1000+YY, all routers must see them
From backbone2, do not know the backbone2’s ipx network, ipx network encap
Only allow ipx network AA00 appear on R4 and all your router.
Config R6, do load share, R6 can see two pathes, when R6’s to0/0’s stations access backbone2’s ipx network AA00, they must use the same path and are not out of order.

6. DLSW+ (2+3)
6.1 Stations on VLANA want to communicate with stations on ring2, R4 want to build peer with R2 and R6, must be CONNECT.config R2, when stations on ring 2 want to access VLANA, R4 should prefer R2.
6.2 Dlsw+ on frame-relay(3)
VLANB want to communicate ring 2, do not use TCP and FST encap.

7. voice (2+2)
7.1 Config R6, use ring number 4YY0 and 4YY1 under port 2/0/0 and 2/0/1 respectively, they can ring each other. There are many rings number with extention number 3002 on a hub or server, its ip address is 192.2.YY.254, you can not config exactly using the number 3002 or multi-period(…).
7.2 there are a ring number 526-83456(not remember) on ATM router, its ip address is 192.2.YY.254, config R6, when you dial 3002 or 52683456, it will ring. (not remember exactly)

8. Catalyst
8.1 config catalyst 5000, syslog server ip address is 150.100.1.240, facility level is SYSLOG,
8.2 set port 2/10 port level is HIGH
8.3 Bridge (not remember exactly): set port 2/6’s cost, let it have high priority to be root port prefer the port with default cost.
LAB 8.

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**CCIE LAB**

**Description:**

1. **Equipment:**
   There may be totally 7 routers and 3 switches you need to configure.
   
   Commserver: 2511  
   R1: 2610  
   R3, R5: 2500  
   R2, R4, R6: 3640  
   Ethernet switch: CAT5002  
   Tokenring switch: 3900  
   Backbone switch: 2924M-XL

   This Lab doesn’t want you to configure the R6 which have ATM interface and voice interfaces.

2. **Lab Time**
   
   Day1: 9:30----17:20 (lunch time: 11:30----12:00)  
   45 points, 30 to pass to Day2
   
   Day2: 9:00----12:00  
   35 points, total 60 to pass to afternoon’s troubleshooting
   
   15:00-18:00  
   troubleshooting, total 80 to get your number

3. **Requirement**
   
   At troubleshooting, the parameters may be changed except the topology, include ip address, area number, process tag, etc. But this is not the fault, for example, you are not allowed to change the ip address when they change the network from 132.3.0.0/16 to 132.7.0.0/16, but the subnet mask may be wrong, exactly that’s what you want to troubleshoot. Additional, the scoring is block by block, but each score is not more than 4 points.

   No static routes are permit (include to null0 or default-network) except explicitly request.
Day 1:

1. Commserver (1 point)
Configure reverse telnet. line1-6 are R1-R6, line 7 is CAT502, line87 is 3900, line9 is backbone switch.

Answer:
No exec, transport input all

2. Physical connection (1 point)
Make the right connection

Answer:
Straight forward. Normally, all the cables they provide to you must be used, if you find that there are some left, check carefully if you are right.

3. Draw a topology diagram (1 point)
Include ip address, area number, VLAN, etc. Make it updated.

4. loopback address (1 point)
Setup loopback address as 132.Y.X.X at your router, where Y is your rack number and X is your router number.

5. CAT5002 setup (1 point)
R3 in VLAN A, use 100, R5 in VLAN B, use 200. Set sc0 (132.3.9.9) in VLAN A, and make the switch able to reach all the topology through R3.

Answer:
Set vtp domain
Set vlan
Set vlan name

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6. address (2 points)
All the interfaces use 132.Y.0.0 network as their addresses and use 24bits mask.
The frame relay interface use 27 bits mask. Draw them on your diagram.

Answer:
Imply that the loopback address use 24bits mask, don’t use 32 bits mask.

7. frame-relay setup (2 points)
Setup frame-relay, the frame relay switch is a 4500 which also act as a backbone router. The switch is configured as fully meshed, but you are demanded to only use pvc showed on the diagram they provide (see diagram).

Answer:
No frame-relay inarp
Frame-relay map ip …..

8. RIP setting (2 points)
R1 ethernet address is 150.100.1.Y. Setup RIP in R1, several network will send to R1 from Backbone 1, you are requested to permit only 193.68.3.9 to add in your RIP routing table and advertise it and 150.100.1.0 to your topology. Also, advertise only the classful network 132.3.0.0 to your RIP domain.

Answer:
Distribute-list, mutual redistribute

Router rip
distribute-list x in ethernet 0
redistribute ospf 3 match internal external 1 external 2 route-map o2r
route-map o2r
match ip address y
set metric

Router ospf 3
redistribute rip subnet
9. OSPF

9.1 basic configuration (2 points)
Frame-relay interface in area 0; R4’s tokenring interface in area 4; serial interfaces between R3 and R2, R2’s
tokenring interface, VLAN A in area 3; VLAN B in area 5; make area 5 as NSSA area. Put all loopback
interface in the area.
Make all interfaces reach each other.

Answer:
Ip ospf network point-to-multipoint
Router ospf 3
Area 0 ...., area 3...........
Area 3 virtual-link 132.3.3.3, Area 3 virtual-link 132.3.2.2
Area 5 nssa

9.2 default-information (2 points)
Make R2 generate a default route to area 5, make the default route only appear on R5.

Answer:
At R2: Area 5 nssa default-information originate

9.3 external route (2 points)
Make another loopback interface in R5 (network 192.192.1.0) . make this network able to be reached by ospf
topology but you are not allowed to put it in any area. And it must appear as different metric at R3 and R1.

Answer:
Redistribute connected subnet metric-type 1 route-map c20
Route-map c20
Match ip address x

9.4 OSPF timers (2 points)
You are informed that R3 use much resource to run the ospf process, tune the R3 to run not less than 30 seconds
between two processed.

Answer:
Timers spf 5 30
Make sure you know the difference between the two SPF timers.

10. **frame-relay QoS (3 points)**
You are requested to run the frame relay include mincir,cir,fc,be as below:
mincir 16kbps; measure interval is 125ms;set DE when 48kbps; drop when 64 kbps

Answer:
frame-relay traffic shaping
fram-relay class QoS
map-class frame-relay QoS
mincir 1600
cir 48000
bc 6000
be 2000

11. **ISDN**

11.1 **DDR (2 points)**
Traditional DDR between R3 and R5, not mentioned about ppp or authentication.
Isdn switch-type is basic-5ess, no spids. Number is 68020X01 and 68020X02, where X is your rack number.

Answer:
Username R3 password cisco
Username R5 password cisco
Encapsulation ppp
PPP authentication chap
Dialer map ip 132.3.100.3 name R3 68020301
Dialer map ip 132.3.100.5 name R5 68020302
Isdn switch-type basic-5ess
Dialer-group 1
Dialer-list 1 protocol ip permit

11.2 **Toll avoidance (2 points)**
When R5 generate a call, R3 will drop it and call back (ppp callback).
11.3 routing backup (floating static) (2 points)
Put some specific static route at R3 and a default route at R5 to: when R3 or R5 lose some route from ospf, both
them can generate a call to each other; any router in your topology can reach the active interface of R5;
Network 192.192.1.0 must still appear as different metric at R3 and R1. When R5’s ethernet interface is still up,
R5 is not allowed to generate the call???

Answer:
They would not tell you use which method, you must decide by yourself. Use floating static
At R3:
Ip route 132.3.5.5 255.255.255.0 132.3.100.5 150
Ip route 192.192.1.0 255.255.255.0 132.3.100.5 150
Router ospf 3
Redistribute static subnet route-map BACKUP
Route-map BACKUP permit 10
Match metric-type 1
Access-list 50 permit 192.192.1.0 255.255.255.0

At R5
Ip route 0.0.0.0 0.0.0.0 132.3.100.3 150

12. BGP

12.1 IBGP, EBGP (2 points)
R1 in AS 1031, R4 in AS 1034, R3, R2, R5 in AS 1099; IBGP must be fully meshed.

Answer: Straight forward
Use loopback interface as update-source in AS 1099 is better (for the sake of keeping the BGP peering
stable when ISDN backup is functioning, see previous and below).

12.2 Confederation and filters (2 points)
There is an external AS 254 on backbone 2 (which peer address is 150.100.2.254, and yours is 150.100.2.X, where X is your rack number). You are requested to send your topology’s route to that AS an appear as from only AS 3.

AS 254 will advertise several route to your topology, you are requested to only permit 197.68.x.0 to be put into your topology, where x is any number. The proctor said that mask had no limit.

Answer:
The question has no word such as ‘confederation’, you must decide by yourself to implement confederation.

Bgp confederation identifier 3
Bgp confederation peer-id 1031 1099

....
Neighbor 150.100.2.254 distribute-list 2 in
Access-list 2 permit 197.68.0.0 0.0.255.255

12.3 route advertisement (2 points)
Make another loopback interface in R5 (network 192.192.2.0). Make this network the only route to advertise to the AS 254 and make it as the BGP route at R1’s routing table.

Answer:
‘No synchronous’ at every router
Neighbor 150.100.2.254 distribute-list 1 out
Access-list 1 permit 192.192.2.0 0.0.0.255

12.4 reduce route (2 points)
For some memory consume problem, you are requested to change the 197.68.x.0 network to a supernet 197.68.0.0 to except 197.68.22.0, advertise them in your topology and do not send them back to AS 254.

Answer:
There are four network incoming: 197.68.1.0, 197.68.4.0, 197.68.5.0, 197.68.22.0, so use suppress-map and AS-SET
Because network 150.100.2.0 is not seen by ospf, all router except R4 consider the 197.68.x.0’s next hop as unreachable, they don’t put them in their routing table since the BGP routes are not the best. I have to put the 150.100.2.0 into ospf, I don’t know whether it is acceptable, but the proctor seem to not mind it.

(or use next-hop self)

Aggregate-address 197.68.0.0 255.255.0.0 as-set suppress-map SPECIFIC
Route-map SPECIFIC permit 10
Match ip address 1
Access-list 1 permit 197.68.1.0 0.0.0.255
Access-list 1 permit 197.68.4.0 0.0.0.255
Access-list 1 permit 197.68.5.0 0.0.0.255

13. dlsw+

13.1 Normal setting (2 points)
Hosts on R2’s ring 1 and VLANB want to communicate with hosts on R3’s VLAN A.

Answer:
Dlsw local-peer peer-id 132.3.2.2
Dlsw remote-peer 0 tcp 132.3.3.3
Dlsw bridge-group 1
Source-route ring-group 1000
Source-route transparent 1000 500 1 1
Bridge-group 1 protocol ieee
Interface ethernet 0
Bridge-group 1
Interface tokenring 0
Source-route 200 1 1000

13.2 Additional peer (2 points)
Hosts on R4’s ring2 want to communicate with VLAN A and VLAN B’S hosts.
You are asked to add only one new peer connection, border peer is not allowed.

Answer:
Maybe rif passthrough, 3920 config

13.3 Source-route bridge tuning (2 points)
Ring 1 in R2 experience a explore storm and cause packet drop. Tune the R2 to let the tokenring interface to
deal with 100 packets (include data and explorer packets) at one time.

Answer: Hold-queue

13.4 SNA filter (2 points)
Set filter to make R4’s dlsw only allow test explorer (0x0000) and SNA traffic (0x0004, 0x0008, 0x000c) and
their response frames.
Answer:
Access-list 200 permit 0x0000 0x0d0d
Dlsw remote-peer 0 tcp 132.3.4.4 lsap-output-filter 200
Day 2:
Ip x and its filter
Appletalk and appletalk DDR
Mobile arp
Frame-relay broadcast queue

My experience:
- Be careful and serious. Pay attention to the words such as ‘only’, ‘allowed’, ‘permit’, etc. Do not make stupid mistakes.
- Be familiar with Documentation, know how to get the detail in the CD. Search the CD as fast as possible.
LAB 9.

Address

Use 135.YY.0.0/16
Frame relay between R3, R4 and use R6 use 29 bits sub mask, ring 100 use 27 bits sub mask. Others use 24 bit sub mask.

Frame relay

Use multipoint subinterface on R4, you can not use subinterface on other routers. You can use only the PVC provided in the figure.

Switch

1 VLAN

VLAN A: 10
VLAN B: 20
VLAN C: 30
VLAN_CAT: 30
BACKBONE 1: 11
BACKBONE 2: 12
Cat 500 sc0 interface in VLAN_CAT, ip is 135.YY.36.30
All routers can access the switch.

2 VTP pruning

Enable VTP pruning except VLAN B and VLAN C.

3 link fast

The Ethernet interface of R3, R5, R2, R6 should be up immediately when boot. All the interfaces are 10M and half duplex.

4 trunk

Set link to R6 as trunk, and only traffic of VLANA, VLANB and VLAN_CAT be allowed on the trunk.

CAT 3920

Ring 100 belong to bridge 1 and ring 200 belongs to bridge 15.
**CCIE LAB**

**IRB**
R6 bridges between VLAN B and VLAN_CAT, route between VLANA and other VLANs.

**RIP**
On link between R1 and R3, only version 2 update is allowed.
R1 receives route 199.172.z.0 (z is any number) from backbone, only permit odd routes into your rack, and with the least commands to do this.
Only 135.YY.0.0/16 can be advised to bb1. You can not use summary.

**OSPF**
Ring 100 is area 0, frame relay between R3, R4 and R6 is area 1, ring 100 is area 2, vlan B is area 33.
Area 0 us simple text authentication, area 1 use MD5 authentication.
Area 2 is NSSA.
Redistribute between OSPF and RIP on R3. 199.172.z.0 should appear on R2.

**EIGRP**
AS number is 100.
Distribute between EIGRP and OSPF.
R2 should forward packet through to0 and you can not use policy routing.
You should accept only some of the routes from ATM backbone and advertise nothing to ATM backbone.

**IGRP**
VLAN A uses IGRP, AS number 10.
When calculating metric, load should be used.
Redistribute between OSPF and IGRP on R6.
R5 can communicate with all other routes.

**ATM**
R6 have atm interface 3/0. Do not use subinterface and should not learn IP through arp server.
Address of ATM interface is 192.1.YY.1, the other end ip add is 192.1.YY.254.
You should ping this ip address. All routers can ping the ATM interface.

**ISDN**
Only R5 can initial the call. Use chap as authentication method. R5 should not challenge R3.
ON R5, when traffic is more than 25%, bring up another B channel and split packet on 2 B channels.

**ISDN routing**
Configure IGRP on ISDN interface and redistribute between ospf and IGRP on R3.
When Ethernet interface of R5 is down, R5 can still communicate with all other routers. You can use snap shot routing or watch list.

**HSRP**
Configure HSRP on R3 and R6, R6 is preferred. IP is 135.YY.36.100.

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When R6’s frame relay or VLAN C is down, R3 is used as default router.

**Telnet**
On R2, other routers can telnet to it. You should see their host name, instead of IP address. The telnet users should not see the mapping between IP and host name.

**Access control**
Enable http server on R6.
On R3, deny users from BB1 to access the http server, but when they telnet to R3 and authenticated, they can access the http server.

**IPX**
Configure IPX on all routers except ISDN, ATM loopback interfaces and the link between R1 and R3. Use EIGRP on frame relay backbone.
On R6 token ring interface, configure IPX network FFFFFFFF.
R1 should learn route with next hop R5.

**DLSW**
VLAN A and ring 100 can communicate with each other. Peer should be connected only when traffic is forwarding.
R5 should prefer R2 to access ring 100 and you can not use “cost”.
When other routers want to access ring 100, they should prefer R4, without using backup peer.
R5 should wait 5 min before mark a SNA or Netbios resource as unreachable.

Bandwidth allocation
On R5 e0, DLSW traffic should use 50% bandwidth.

**Voice QOS**
On frame-relay PVC, allocate bandwidth for voicecall.

**Voice**
Two phones on R6 can call each other
Phone son R6 can call a phone 3002 through ATM, GW is 128.28.8.2
When phone on 1/0/0 dial 1, it can call to phone on 1/0/1.
Set ip precedence of voice to 5.

**BGP**
1 IBGP
R2, R4, R6 is AS YY.
R2 and R6 can not be peer.
You can not disable synchronization.
On R6, add a loop back interface with IP 200.200.1.x/24, and advertise it, you can not use network command.
You can put 200.200.1.x into IGP.
2 EBGP
R1 is in AS 65000+YY and R3 in AS 5000+YY.
R1 and R3 is peer, R3 and R6 is peer.
R4 is peer with BB2, AS 254.
There are some routes form BB2, you should only accept 197.68.x.0 and 200.200.YY.0.
On R1, add a loop back interface with IP add 199.199.1.x/24 and advertise it. On AS YY, this route should appear as originated from AS 5000+YY.
199.199.1.x should appear on BGP table of all routers and advertised to BB2.
Section B – Newer labs
8 Labs

Lab 1.
Forenoon

The following parts record the real whole course:

1. config terminal server:
   R1-R6,Cat3550

2. draw network topology map
   Update as soon as there are changes.

3. Configure ip addresses
   Use CIDR block 50.1.0.0/16 to assign all with /24 mask other than:
   3.1 isdn use /29
   3.2 VlanA use /24
   3.3 Framerelay use /28
   3.4 VlanB use /27
   3.5 Backbone 1 R1’s e0 has ip add: 150.2.1.x/24
   3.6 Backbone 2 R4’s e0 has ip add: 150.2.2.x/24
   3.7 R6’s ATM has add 172.2.2.x/24
   3.8 set VlanA, VlanB in Cat3550, sc0 with ip add 50.1.30/22.

4. Configure each router a loop interface
   ip add like 50.1.x.x (x is router number)

5. Config framerelay,
Even if there are many dlcis in framerelay switch, you can only use the diagram. You can not use subinterface on R1 and R2.

6. OSPF
6.1 area 0 include vlanB
6.2 area 1 include vlanA
6.3 area 3 include ISDN only
6.4 area 5 include framerelay
6.5 area 6 include R2’s token 0
6.6 put all router’s loopback is OSPF

7. RIP
7.1 put R1’s e0 in RIP
7.2 you can get many routes, you can only input 60.172.1.0, 60.172.3.0, 60.172.0.
7.3 On R1:redistribute between RIP on OSPF, let RIP only know 50.1.0.0/16, let ospf only see 60.172.12.0 and another route, it can reach 60.172.1.9 and 60.172.3.0.

8. IGRP
8.1 config IGRP between R3, R4, and R4’s all interfaces.
8.2 On R3:redistribute between ospf and igrp, let all ospf router can see all routes from igrp
8.3 On R3:product default-network to R4, let R4 can ping all ospf router.

9. Dlsw
9.1 build dlsw on R5, R2, R4.
9.2 let VlanB bridge to VlanA but not to ring1
9.3 on R4 it is can not send out any mac with 4000.8888.xxxx to ring1, but communication still ok.

10. VPN
10.1 R6’s atm interface have a pvc 0/100 to custom’s atm router 199.1.1.1
10.2 custom have some employee in vlanB want to access there source connect to atmrouter123.2.2.2, they use eigrp 100.
10.3 custom’s address, routes can not in any route except R5 and R6, and custom routers can not know any routes of your routes.
End of Forenoon
Afternoon

11. BGP
11.1 R5 in As 2, RI in As 3, R2, R3, R6 in As 1, R4 in As 4
11.2 build ebgp and ibgp relation, 3-1, 2-1, 4-1
11.3 1 has a connect to 150.2.2.254 which is As 100, you can receive many bgp route. Only send 200.200.1.0/24, 200.200.2.0/24, 200.200.9.0/24 to As1000
11.4 On R2: only send 200.200.9.0/24 and one bgp route include 200.200.1.0 and 200.200.2.0 to As2000, and let R5 find those route is original from As400.

12. config R4’s ethernet to Backbone2’s www server limited below 1.5Mbps.

13. config ethernet broadcast in CAT3550’s can not reach 20%

14. Multicast
14.1 config multicast on R1, R2, R3, R6, let R1 join a igmp group, you can ping it from others.
14.2 let R2, R6 support Cat3550s multicast function.

15. Access
15.1 only config outbound on R2’s framerelay.
15.2 deny smtp, pop3 from VlanB to VlanA
15.3 deny www from ring2 to vlan B
15.4 deny R3’s ping to R1
15.5 deny vlana’s any udp port great than 6000 to Backbone1

The End
Lab 2
Note: Some IP configuration might contain some small errors. Compare with the picture on the next page.
Forenoon

1. Commsserver (1 point)
Configure reverse telnet. line1-6 are R1-R6, line7 is CAT3550, line8 is 3900, line9 is backbone switch.

Answer: No exec, transport inout all

2. Physical connection (1 point)

3. Draw a topology diagram (1 point)
Include ip address, area number, VLAN, etc. Make it updated.

4. Loopback address (1 point)
Setup loopback address as 132.Y.X.X at your router, where Y is your rack number and X is your router number.
5.CAT3550 setup (1 point)
R3 in VLAN A, use 100, R5 in VLAN B, use 200. Set sc0 (132.3.9.9) in VLAN A, and make the switch able to reach all the topology through R3.

6.address (2 points)
All the interfaces use 132.Y.0.0 network as their addresses and use 24bits mask. The frame relay interface use 27 bits mask. Draw them on your diagram.

Answer:
Imply that the loopback address use 24bits mask, don’t use 32 bits mask.

7.frame-relay setup (2 points)
Setup frame-relay, the frame relay switch is a 4500 which also act as a backbone router. The switch is configured as fully meshed, but you are demanded to only use the pvc showed on the diagram they provide (see the diagram).

8.RIP setting (2 points)
R1 ethernet address is 150.100.1.Y. setup RIP in R1, several network will send to R1 from Backbone 1, you are requested to permit only 192.68.3.9 to add in your RIP routing table and advertise it and 150.100.1.0 to your topology. Also, advertise only the classful network 132.3.0.0 to your RIP domain.

Answer: Distribute-list, mutual redistribute

9.OSPF
9.1 basic config (2 points)
Frame-relay interface in area 0; R4’s tokenring interface in area4; serial interfaces between R3 and R2, R2’s interface, VLAN A in area 3; VLAN B in area 5; make area 5 as NSSA area.
Put all loopback interface in the area. Make all interfaces reach each other.

Answer: virtual-link, nssa

9.2 default-information (2 points)
Make R2 generate a default route to area 5, make the default route only appear on R5.

Answer:
At R2: Area 5 nssa default-information originate

9.3 external route (2 points)
Make another loopback interface in R5 (network 192.192.1.0). Make this network able to be reached by ospf topology but you are not allowed to put it in any area. And it must appear as different metric at R3 and R1.

Answer: metric-type 1

9.4 OSPF timers (2 points)
You are informed that R3 use much resource to run the ospf process, tune the R3 to run not less than 30 seconds between two process.

Answer: Timers spf 5 30
Make sure you know the difference between the two spf timers.

10. frame-relay QoS (3 points)
You are requested to run the frame relay include mincir,cir,bc,be as below: mincir 16kbps; measure interval is 125ms;set DE when 48kbps;dop when 64kbps

Answer:
frame-relay traffic-shaping
fram-relay class QoS
map-class frame-relay QoS
mincir 16000
cir 48000
bc 6000
be 2000

11.ISDN
11.1 DDR (2 points)
Traditional DDR between R3 and R5, not mentioned about ppp or authentication.
Iisd and switch-type is basic-5ess, no spids. numbers are 68020X01 and 68020X02, where X is your rack number.

11.2 Tool avoidance (2 points)
When R5 generate a call, R3 will drop it and call back (ppp callback).

Answer:
Ppp callback request
Ppp callback accept
Dialer map ip 132.3.100.5 name R5 class CALLBACK 68020302
Map-class dialer CALLBACK
Dialer call-back username

11.3 Routing backup (floating static) (2 points)
Put some specific static route at R3 and a default route at R5 to: when R3 or R5 lose some route from ospf, both
tem can generate a call to each other; any router in your topology can reach the active interface of R5;
Network 192.192.1.0 must still appear as different metric at R3 and R1. When R5’s ethernet interface is still up,
R5 is not allowed to generate the call???

Answer:
They don’t tell you use which method, you must decide by yourself. Use floating static At R3:
Ip route 132.3.5.5 255.255.255.0 132.3.100.5 150
Ip route 192.192.1.0 255.255.255.0 132.3.100.5 150
Router ospf 3
Redistribute static subnet route-map BACKUP
Route-map BACKUP permit 10
Match ip address 50
Set metric-type 1
Access-list 50 permit 192.192.1.0 255.255.255.0 At R5
Ip route 0.0.0.0 0.0.0.0 132.3.100.3 150

12. BGP

12.1 IBGP, EBGP (2 points)
R1 in AS 1031, R4 in AS 1034, R3, R2, R5 in AS 1099; IBGP must be fully meshed.

Answer:
Straight forward.
Use loopback interface as update-source in AS 1099 us better (for the sake of keeping the BGP peering stable when ISDN backup is functioning, see previous and below).

12.2 Confederation and filters (2 points)
There is an external AS 254 on backbone 2 (which peer address is 150.100.2.254, and yours is 150.100.2.X, where X is your rack number). You are requested to send your topology’s route to that AS and appear as from only AS 3. AS 254 will advertise several route to your topology, you are requested to only permit 197.68.x.0 to be put into your topology, where x is any number. The proctor said that the mask had no limit.

Answer:
The question has no word such as confederation, you must decide by yourself to implement confederation.
Bgp confederation identifier 4
Bgp confederation peer-id 1031 1099.

12.3 Route advertisement (2 points)
Make another loopback interface in R5 (network 192.192.2.0). Make this network the only route to advertise to the AS 254 and make it as the BGP route at R1 routing table.

Answer: No synchronous at every router

12.4 Reduce route (2 points)
For some memory consume problem, you are requested to change the 197.68.x.0 network to a supernet 197.68.0.0 except 197.68.22.0, advertise them in your topology and do not send them back to AS 254.

Answer:
There are four network incoming: 197.68.1.0, 197.68.4.0, 197.68.5.0, 197.68.22.0, so use suppress-map and AS-SET. Because network 150.100.2.0 is not seen by ospf, all router except R4 consider the 197.68.x.0’s next hop as unreachable, they don’t put them in their routing table since the BGP routes are not the best.
I have to put the 150.100.2.0 into ospf, I don’t know whether it is acceptable, but the proctor seem to not min it.
(or use next-hop-self)
Aggregate-address 197.68.0.0 255.255.0.0 as-set suppress-map SPECIFIC
Route-map SPECIFIC permit 10
Match ip address 1
Access-list 1 permit 197.68.1.0 0.0.0.255
Access-list 1 permit 197.68.4.0 0.0.0.255
Access-list 1 permit 197.68.5.0 0.0.0.255

13 dlsw+

13.1 Normal setting (2 points)
Hosts on R2’s ring 1 and VLANB want to communicate with hosts on R3’S VLANA.

13.2 Additional peer (2 points)
Hosts on R4’s ring2 want to communicate with VLAN A and VLAN B’s hosts. You are asked to add only one new peer connection, border peer is not allowed.

Answer:
Maybe rif passthrough, 3920 config???

13.3 Source-route bridge tuning (2 points)
Ring 1 in R2 experience a explore storm and cause packet drop. Tune the R2 to let the tokenring interface to deal with 100 packets (include data and explorer packets) at one time.

Answer:
Hold-queue

13.4 SNA filter (2 points)
Set filter to make R4’s dlsw only allow test explorer (0x0000) and SNA traffic (0x0004, 0x0008, 0x000c) and their response frames.

Answer:
Access-list 200 permit 0x0000 0x0d0
Dlsw remote-peer 0 tcp 132.3.4.4 lsap-output-filter 200

Afternoon
Appletalk
- Only Eigrp on FR. Enable apple on all interfaces except ISDN, BB1 and BB2. The zone of Vlan A and Vlan B is ether.
- Config R1 such that is cannot see the network of VLAN A, but it can see the network of VLAN B.
- Enable Apple on ISDN.
- The ISDN is only activated when R3-R2 link fails.
- Disable IP on ISDN
- Static route is permitted.
- Vlan A can access R2(Ring 1) and Vlan B, when R3-R2 fails.
- Callback is used.

Note: After test – Even config is correct, appletalk callback will not work until reboot.

IOS feature
----------
- Mobile ARP
- When VLAN A user is roamed to VLAN B and BB1, it still can be accessed.
  --> Configure as the document.
- Router Access
- A specific IP address is allowed to configure R3 by a web browser
  --> http server with access-list
- Privilege Control
- A user with a specific password can only be allowed to enter “show” command
- Broad-Control on FR
- Exact the same as command reference, pay attention to the byte or the bit.

Catalyst
- Span
- Change spanning tree Maxage, you must ‘set spantree router’ too, because the spanning tree maxage will follow the routers config when a router is connected to the switch
Lab 3

2503: R3, R5
2611: R1
3640: R2, R4, R6
3550: Cat5
Forenoon

1. Comm server (1 point)

2. Diagram (1)
Include ip address, area number, interface, make your diagram update. Remember to mark FRSW’s interface number too, you will need it on troubleshooting.

3 Physical connection (1)

4. cat3550 setup (1)
Two VLANs, VLANA:50; VLANB:75

5 cat5 address (1)
sc0 address on VLANA, 135.x.30.30/22, where x is the rack number, make it be reached by your topology

6. IRDP (2)
Vlana’s host use irdp, male R6 most preferred and R3 least preferred.
ip irdp preference 100

7. Framerelay (2)
28 bits subnet. Only use the dlci showed on the given diagram (hub & spoke, not fully meshed).

no frame-relay inverse-arp
frame map ip …

8. Loopback address (1)
All of the routers has loopback interface. 135.y.x.x, where y is the rack num. And x is the router num.

9. Address (1)
vlana:/22; vlanb:/26; framerelay int:/28; isdn:/30; others:/24 use 135.x.0.0 to setup all interfaces except explicitly asked.
e0/0 o R1 is 150.100.1.x (BB1); e0/0 on R4 is 150.100.2.x (BB2).

10. OSPF (3)
Frame relay cloud on area 1, vlana on area 0, R2’s ring on area 2, vlanb on area 5, isdn on area 6.
Make loopbacks on existing area.
11. OSPF cost (2)
Change the ospf cost, should not use ‘ip ospf cost …’ on interface. Make cost on ethernet as 90.

auto-cost-reference-bandwidth 900

12. Rip (2)
Rip on R1 e0/0, mutual redistribution with ospf. Should receive only 199.172.x.0, make 199.172.1.0 and 199.172.3.0 as one network on your ospf topology, also advertise 150.100.1.0.
Only class B 135.x.0.0/16 can be advertised from ospf to rip.
There are 4 networks received by rip: 199.200.1.0, 199.172.1.0, 199.172.3.0, 199.172.12.0

router rip
redistribute ospf 3 metric 2
network 150.100.0.0

router ospf 3
redistribute rip subnet
summary-address 199.172.0.0 255.255.240.0
distribute-list 1 out rip

access-list 1 permit 199.172.0.0 255.255.0.0

13. SAP (2)
vlana’s sap is interferenced by something, assume that there is no servers on vlana, make the sap advertise only when it changed.

At R2, R3, R6, set on interface:
ipx sap-incremental eigrp 3

14. ISDN (4)
Only R5 can generate the call, use chap authentication, but R5 should not challenge R3, R5 should not use its own name to authenticate, must use userx.

Oneway authentication. Oneway dialer map
At R5:
user user3 password cisco
user R3 password cisco
ini bri0
dialer map ip 135.3.9.1 broadcast 68020301
ppp chap hostname user3
At R3:
user user3 password cisco
user R3 password cisco
int bri0
ppp authentication chap

15. ISDN routing (2)
Setup R3 and R5 such that when R5 can access the topology when its serial interface is down.

At R5
router ospf 3
network 135.5.5.0 0.0.0.255 area 5
network 135.5.55.0 0.0.0.255 area 5
area 1 virtual-link 135.5.2.2
area 1 virtual-link 135.5.3.3
int bri0
ip ospf demand-circuit

I use backup interface also, but the protor said its wrong (if interface is up, but the duci mapping in telecom is wrong, the isdn will not up). So just demand-circuit is ok.
Make the loopback interface at area 5, and setup two virtual-link to make sure the area5 and the loopback interface is seen by the topology when serial is down and isdn is up.

16 ATM (2)
R6, no subinterface, no autolearn ip address from client. vpi: 0, vci: 10x. ip address: 192.1.x.1,
remote ATM router ip: 192.1.x.254
int atm 3/0
pvc 0/103
protocol ip 192.1.3.254 broadcast
no inarp

17. VPN (2)
You have a VPN client, they use CIDR 192.1.32.0/20, some of your client’s employees are connected at R5’s ethernet, their gateway is 192.1.32.175. You can use any network in 192.1.32.0/20 to build the VPN. VPN still on function when R5’s serial is down.
Setup tunnel between R5 and R6’s secondary ip address at R5’s e0:

R6:
int tunnel 0
ip address 192.1.33.1 255.255.255.0
tunnel source loopback 0
tunnel destination 135.3.5.5

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R5:
int tunnel 0
ip address 192.1.33.2 255.255.0
   tunnel source loopback0
tunnel destination 35.3.6.6
interface e0
ip address 192.1.32.175 255.255.255.0 secondary

18. VPN routing (2)
Your client are using eigrp 100, setup eigrp such that your clients employees at R5 can be reached by their remote network, also advertise the route received from the remote ATM router to the employees. All the routes of your client are not allowed to be advertised out of R5 and R6.

   router eigrp 100
   network 192.1.33.0
   network 192.1.32.0
   passive-interface …

19. VPN routing (2)
All traffic from your client’s employees at R5 to outside, either traffic to their networks or to your networks, should be route to the remote ATM router first (assume they don’t need to telnet to R5 or R6). Setup R5 and R6 to comply this policy.

   policy routing:
   R5:
   interface e0
   ip policy route-map VPN
   route-map VPN
   match ip address 2
   set ip next-hop 192.1.33.1
   access-list 2 permit 192.1.32.0 0.0.0.255

   R6:
   interface tunnel 0
   ip policy route-map VPN
   route-map VPN
   match ip address 2
   set ip next-hop 192.1.3.254
   access-list 2 permit 192.1.32.0 0.0.0.255

20. Dlsw
R2’s ring 1 to R4’s ring 2; R2’s vlana to R5’s vlanb. Others are not allowed.
use brgoup-list and ring-list
21. Dlsw efficiency
R4’s host can reach R2’s hosts which mac address are 4000.2200.xxxx, but they would not send any explores.

R2:
dlsw i-can-reach mac 4000.2200.0000 mask ffff.ffff.0000
**Afternoon**

1. **BGP (3)**
   
   R4 in AS x, R2, R3, R6 in AS 100x, R1 in AS 200x, R5 in AS 300x. x, 200x, and 300x should peer with 100x.300x still peer to 100x when R5’s serial is down.

   Use ebgp-multihop on the 100x and 300x peering by loopback interface.

   peer to R2 or R3

2. **EBGP (2)**
   
   AS 254 at backbone 2, peer 150.100.2.254. Setup R4 to peer with it. Only received network 172.68.y.0, where y is any number.

   ```
   neighbor 150.100.2.254 distribute-list 1 in
   access-list 1 permit 172.68.0.0 0.0.255.255
   ```

3. **Aggregation (2)**
   
   Aggregate networks 172.68.y.0, such that R5 can only see the aggregated route and see it come from AS x. Other routers should see the specific routes, also, they can see the aggregate route or not.

   AS-SET maybe reasonable ??

4. **Default information (2)**
   
   New loopback interface 192.192.4.0 at R4. Advertise it only by BGP throughout the topology, AS 254 are asked to receive it only. R2 generate a default route to R1 as long as it receive this route.

   ```
   R2:
   neighbor 135.3.1.1 default-information originate route-map DEFAULT
   route-map DEFAULT
   match ip address 1
   access-list 1 permit 192.192.4.0 0.0.0.255
   ```

   ```
   R4:
   distribute-list out
   ```

5. **Appletalk (3)**
   
   Setup appletalk at all interface except ATM, loopback, ISDN, backbone. VLANA zone is vlana, only eigrp on framerelay cloud.

   ```
   appletalk route-redistribute
   no appletalk eigrp split-horizon
   appletalk local-routing
   ```
appletalk protocol eigrp (framerelay int)
no appletalk protocol rtmp (framerelay int)
frame-relay map appletalk ...
setup vlan on tokenring switch 3920 to separate the two rings so that appletalk can be active on each ring.

6. Appletalk filter (2)
R4 can see all the appletalk cable-range, but others cannot see the cable-range of R4’s ring2.
No filter is allowed.
No appletalk send-rtmp on R4’s serial 0/0 (appletalk on R3’s serial 1 maybe inactive)
or
appletalk eigrp on R4’s ring2, rtmp on R4’s serial 0/0 and no appletalk route-redistribute

7. Appletalk filter (2)
R5 can’t see zone vlana and the cable-range associate with it.
distribute-list on R5’s serial 0
Pay attention to the setup steps, you had better setup distribute-list first and enable appletalk eigrp last, or the zone “vlana” would appear at R5’s zone table.

8. Access-list (3)
Only setup one output access-list on R2’s serial 0/0 to:
Mail traffic from ring1 to vlanb is not allowed;
R3 can ping R1, R1 can’t ping R3. (just the nearest interface is enough);
Users on ring1 is allowed to use udp port 6000 to 7000 (inclusive) to access vlanb;
No snmp traffic is allowed;
Users on backbone1 can’t use ring2’s tacacs service;
Any other traffic is allowed.

access-list 100 deny tcp 135.3.22.0 0.0.0.255 135.3.55.0 0.0.0.127 eq smtp
access-list 100 deny tcp 135.3.22.0 0.0.0.255 135.3.55.0 0.0.0.127 eq pop2
access-list 100 deny tcp 135.3.22.0 0.0.0.255 135.3.55.0 0.0.0.127 eq pop3
access-list 100 deny icmp 135.3.30.3 0.0.0.0 135.3.0.1 0.0.0.0 eq echo-reply
access-list 100 permit udp 135.3.22.0 0.0.0.255 range 6000 7000 135.3.35.0 0.0.0.127
access-list 100 deny ip 135.3.22.0 0.0.0.255 135.3.55.0 0.0.0.127
access-list 100 deny udp any any eq snmp
access-list 100 deny udp any any eq snmp-trap
access-list 100 deny tcp 135.3.44.0 0.0.0.255 eq tacacs 150.100.1.0 0.0.0.255
access-list 100 permit ip any any

9. Broadcast control (2)
Configure vlanb on CAT5, make the broadcast traffic under 20%, assume that the frame size is 768 bytes, including preamble.
Set port broadcast 2/4 20%
10. Traffic control (2)
Webservers on ring2, configure R4 such that output rate to the webserver is under 1.5Mbps, any traffic higher than 1.5Mbps is dropped.
I use CAR, but the professor said rate-limit is the wrong solution.
Maybe: general traffic-shaping.

11. Multicast (2)
Setup R1 to join a multicast group 224.0.5.5, R2, R3, R6 can ping this group but shouldn’t be explicitly setup to join it.
ip igmp join-group 224.0.0.5
Either dense-mode or sparse-mode is ok.

12. cgmp (3)
R2 and R6 can inform CAT5 the multicast group, CAT5 can send it to R3 even if it is rebooting.
At R2 and R6:
ip cgmp
at CAT5
set cgmp enable
set cam permanent 01-00-5e-00-05-05 2/2 (2/2 connect to R3)

13. Netbios filter (2)
Setup a output filter on R4’s tokenring interface such that:
Access to host SERVxNR is not allowed, which x is any character.
netbios output-access-list host ABC
netbios access-list host ABC deny SERV?NR (^v first to input the “?”)
etbios access-list host ABC permit*
Lab 4.
Note: Compare Section A, Lab 2
Forenoon

1. Diagram (1)
Draw diagram, including ip addresses of all interfaces, ospf area, BGP AS number, number, physical links. Make sure your diagram update.

Answer:
Mark as many as you can, include the serial ports of the FRSW, esi or PVC of ATM, ip addresses outside your topology, routes from outside, the addresses you need to filter, summarize or aggregate. Its very important for your troubleshooting.

2. Physical connection (1)

3. Names & password (1)
Names are: RackYYRX, which YY is your rack num, X is the router num. (for example, rack4 router3 is Rack04R3)
Set password: cisco, set excec-timeout never, users can access on con, aux, ttys.

Answer:
You should add ‘login’ command on line con 0, line aux 0, line vtys.

4. Framerelay (3)
Same as the diagram, not fully mesh.

Answer: disable the inverse-arp.

5. Address (1)
Loopback address is 138.Y.0.0 as your topology address scheme. Framerelay cloud is /29, isdn is /30, ring 10 has 10 hosts, make your subnet mask decision. (that means /28), others are /24.

7. Vlan (2)
VLANA(20), VLANB(30), VLANC(50), VLAND(70), VLANE(80)

8. CAT3550
Setup two Trbrf, use bridge number as 1 and 2, ring number as 10(R2&R6) and 20(R4).
Answer:
Note that the ring number in question and routers is decimal, but in 3550 is hexadeximal.

9. Trunk (2)
Setup trunk at CAT5, VLANE is not allowed in trunk. R6 connect to trunk. Be careful that not all switch ports are able to be a trunk.

10. OSPF (3)
Framerelay at area 0, ethernet at area 3, ring20 at area 4. No additional area is allowed. Routers in area 4 have not enough memory to handle lots routes, configure R4 to adjust it.

Answer: Make area 4 totally stub area.

11. RIP (3)
R5’s serial port and R1 run RIP, inject the specific routes from ospf into RIP, but only advertise 138.Y.0.0 to BB1, no summary and static route are permitted. Only permit one route 193.67.15.0/24 received from BB1. Mutual redistribute between RIP and OSPF.

Answer:
Use rip version 2 but send and receive version 1 on R1’s ethernet. Distribute-list out on R1’s ethernet. Remember to use debug to check the route update whether it is right. Make a redistribute-list at R5’s OSPF, just permit the routes belongs to rip to be redistributed from rip to ospf, or the idsn will flap. Bri as passive interface.

12. ISDN (2)
Just R5 can initiate the call, use pap authentication with different passwords at each side.

Answer:
‘dialer map’ at R5 only, ppp pap sent ….

13. ISDN routing (3)
BRI interface at area 3, when ethernet down, keep topology consistent. Flapping is not allowed.

Answer: demand-circuit

14. ATM (3)
PVC 0/10Y, autolearn is not allowed, ip address 192.1.1.Y. pvc peak rate 100M, minimum rate 10M
Answer: Use static map, & ubr+

15. EIGRP (3)
ATM, tokenring on R2 and R6 run EIGRP, only configure R6, permit 128.28.0.0 and 4.1.1.0 into R6, permit 128.28.0.0, 4.1.1.0, 192.1.1.0 into R2 by EIGRP.
Configure R2 or R6, such that OSPF and EIGRP can redistribute each other.

Answer:
No auto-summary, set distribute-list at ‘atm in’, ‘tokenring out’, also set ‘tokenring in’ to deny all eigrp update from R2, to prevent R2 advertising the 138.Y.0.0 by EIGRP instead of OSPF. (because of its lower distance).

16. DHCP (2)
R6 as a dhcp server and you shouldn’t define a database agent.

Answer:
no ip dhcp conflict logging
ip dhcp exclude
ip dhcp pool
...

17. HSRP (2)
Define HSRP on R2 and R6 ring 10, R6 as the primary, when tokenring or Ethernet interface of R6 fail, R2 as the primary.

Answer: Use ‘track interface’ at R6

18. BGP (4)
R3, R4, R5, R6 in AS Y, BB2 in AS 254, R1 in AS 10Y. AS Y are not full mesh, when R4 or R6 failed, other routers can still receive all the other BGP routes. Just allow 192.200.0.0 receive from BB2.

Answer:
R4 and R6 act as Route Reflector.
Input prefix list at R4 is the best.

19. BGP advertisement (2)

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Another loopback interface at R1(195.82.Y.Y/32), advertise it throughout the network. Another loopback interface at R3(195.83.Y.Y/32), advertise these two route only to BB2.

**Answer:**
Assign distribute-list out of R4 although eventually there are just two BGP routes advertise to BB2. Do what they ask you to do perfectly and accurately.

### 20. BGP filter (3)
Configure R5 such that 195.83.Y.Y is not seen on R1, but you can’t use any filter base on ip address.

**Answer:**
Use filter-list (as-path). Don’t use community, because you have to change community based on ip address.

### 21. Voice (1)
R6: port 2/0/0 is 50YO, port 2/0/1 is 50Y2, remote hone is 3002, remote peer 128.28.2.8 (behind ATM cloud). Make you voice able to call each other and 3002.

**Answer:**
Make sure you can reach 128.28.2.8 and 128.28.2.8 can reach your topology (not just the ATM int). Redistributing OSPF to EIGRP is important.

### 22. Voice (2)
Configure R6 so that when port 2/0/1 offhook, you can reach 3002 without inputting any digits.

**Answer:**
‘connection plar’ at port 2/0/1.
Afternoon

1. Multicast (3)
R1, R5, R6. R5 as RP, RP join group 224.1.2.3, setup R1 and R6 so that R5 as the only RP for 224.1.2.3.

Answer:
I think I lost the points. Check this command: ip pim rp x.x.x.x [AC]; ip pim accept-rp x.x.x.x [ACL]

2. Multicast (2)
Inform Catalyst the multicast group.

Answer: CGMP at R5 and CAT.

3. IOS feature (2)
At VLANB, there are some users have not setup their gateways, configure VLANB such that these users can’t access your topology by anyway.

Answer: Disable proxy-arp at R3 and R6’s VLANB subinterface.

4. Menu (2)
Setup a menu, include ‘show interface’, ‘show ip route’, ‘show startup’, ‘exit menu’.

Answer: Search the document

5. Link efficiency (3)
Use compression method predict (software) to compress the link between R1 and R5.

Answer: Change encapsulation to PPP, and you can use preditor now.

6. Dlsw (3)
Bridge connectivity between ring10 and ring20, ring10’s hosts communicate with ring20’s host through R6, when R6’s tokenring interface fail, they will use R2 instead. When R6 resume, R2’s connection must be
 undone, but should be maintained 6 minutes before disconnect. R2 and R6 should not be configured a remote peer. Source-bridge number must be consistent with tokenring switch.

Answer:
Backup peer, linger as 6. R4’s remote peer must be R6 and R6’s tokenring interface. Promicous. Redistribute eigrp into ospf in R2 but not R6, because if the redistribution is in R6, when R6’s tokenring down, the network of the ring will be down, and can’t be distribute into ospf, R4 will not have the ip routing connectivity to R2’s tokenring interface.

7. Dlsw (2)
A mainframe in ring10, make R4 have this mainframe’s mac address in its cache, and can only reach this host.

Answer: icanreach, icanreach mac-exclude.

8. Catalyst feature (1)
VLANE have end station only, and have heavy traffic, configure it to reduce the BPDU traffic.

Answer: Disable the spanning tree on VLANE.

9. Catalyst feature (1)
Port 2/11 belongs to VLANE, and connect to a host with a mac address, configure the switch so that it need not learn the host’s mac address event at bootup period.

Answer: Set cam peranent. Set the port belongs to VLANE.

10. Catalyst feature (1)
Port 2/12 connect to a host, and belongs to VLANE, configure the switch so that only this host can use this port.

Answer: Set port security. Set the port belongs to VLANE.

11. Autoinstall (3)
A TFTP server with address 150.100.2.17 on BB2, a router with no startup-config in FR cloud, configure R4 such that the router can bootup with a startup-config which in the TFTP server, use DLCI 110.

Answer:
frame-relay map ip 138.5.234.6 110 (the ip address must be in your FR cloud’s subnet)
ip help-address 150.100.2.17
Lab 5.
Note: Compare Lab3, Section A
Forenoon

framerelay
R5 as hub, 2 subinterface, point-to-point subinterface connect to R4, point-to-multipoint subinterface
Connect to R2 and R3.

addressing
BB1 150.100.1.Y; BB2, 150.100.2.Y; framerelay cloud(R2, R3, R5) /28; VLANE /25;
Ring1 /27; VLANC /29; ISDN /30.
others /24

OSPF
Framerelay cloud (2, 3, 5), ISDN in area 0; VLANA and ring1 in area 3; R5 and R6’s serial interface in area 5;
VLANC in area 6.
--> R2 and R3 need to establish virtual-link for area 0, prevent the inconsistence of backbone once the framerelay pvc is down. (ask the proctor whether you need to do this) use the mist secure method to authenticate ospf neighbor in backbone and ethernet.
--> MD5 authentication, note that level 7 may have problem.
Change the dead-interval, but you are not allowed to explicitly change the dead-interval timer.
--> Change the hello-interval.

EIGRP
R1 and R2’s serial interface run EIGRP, 4 loopback interfaces in R2, place them in EIGRP, summarize them into one network and advertise it to R2. --> Summary in interface.
Redistribute OSPF and EIGRP mutually in R2, cost of routes redistributed to OSPF should have a fix value.
--> Metric type.

RIP
R1’s ethernet interface run RIP, redistribute even network into EIGRP. --> wildcard mask!

IGRP
R4 and R5’s link(p2p framerelay), Ring2, VLANB run IGRP. Redistribute OSPF and IGRP mutually in R5.
Loopback of R4 shouldn’t be placed in IGRP, should be redistribute in it???
You are permitted to add a static route but not a default-route in R4 pointing to BB1.
--> Because IGRP is a classful protocol, you must add a static route ‘ip route 133.Y.0.0 255.255.0.0
150.100.1.Y’ (for example)
In R4, so that R4 can reach all the subnets in ospf topology.
ISDN
Only R5 can make a call, chap authentication, R5’s hostname should not be itself.
ospf routing. --> demand-circuit (be careful for the redistribution)

ATM
PVC, you are 192.1.1.Y, remote peer 192.1.1.254.
Should not add a default-route, networks behind ATM can reach your topology?
--> ATM run EIGRP? then use summary in ATM interface?

BGP
R1, 2, 3, 4, 5, 6 are in AS Y. --> IBGP
All the routers in IBGP must receive bgp routes from R5. --> R5 as a RR.
BB1 and BB2 are both in AS 254, setup R1 and R4 so that the bgp routes from AS254 have weight 1000.
--> route-map in
AS Y shouldn’t be a transit AS, but you are not allowed to use AS-path to filter it.
--> Apply no-export community to the BGP routes coming from AS254.
R1 and R4 advertise networks of Ring1, Ring2, VLANA, VLANB such that outside world reach Ring1.
VLANA through R1, reach Ring2, VLANB through R2. --> route-map out with different metrics. Configure R1 and R4 so that only the new routes from AS254 are received?
Afternoon

DLSW
Ring1, VLAN A of R2 and RING2 have bridge connectivity, R2 should not add a remote-peer. --> promiscuous
R3 acts as backup of VLAN peering to R4; LLC of R4 use R2 to deliver SNA traffic when R2 isn't down.
--> cost.
A SNA host in VLAN A, configure R4’s Ring2 so that R4’s explorer for this host should not cross the FR cloud,
at CAT5 you can see the host’s mac address is X.X.X.
--> proxy-explorer, pay attention to canonical and noncanonical address style.

Other questions:
1. ospf non-broadcast type
--> Use neighbor

2. bgp
Set origin IGP
prefix-list

3. CAT5
Set spanning tree root

IP Address
Only use 132.X.0.0 X is your Rack Number
Each Router establish a Loopback address 132.X.Y.Y
Frame Relay is Full Mesh but you can only use the PVC drawn on the picture
Lab 6
Note: Compare Lab 4, Section A
Forenoon

OSPF
Area 0 Frame Relay
Area 3 the Serial Port link between R2 and R3 Vlan A Ring 10
Area 4 the Token Ring Port of R4
Area 5 Vlan B
Loopback Address belong to appropriate Area
They could connect each other after the setup is accomplished.
Area5 is NSSA Section set up a Loopback address 192.192.1.0 on R5, this address comes into OSPF in the form of exterior Router at the same time R1 and R3 should see different Metric
Set up the default Router for NSSA on R2;
R3 is quite busy, not to allow the routing process exhaust the power of CPU, config the OSPF routing less frequent than once per 30 sec.

RIP
R1 is joined Backbone1 only allow one Router enter and broadcast out to ospf.
Backbone1 can only see 132.1.0.0/16 from R1

ATM
R6 has an ATM Port IP address is 192.1.Y.0 the address of ATM Router is 192.1.Y.254 PVC use VPI=0
VCI=100+Y
Not allowed to use inverarp
define ATM Qos the maximal speed is 100M minimum is 10M
interface ATM 1/0
 ip addr 192.1.6.1 255.255.255.0
 pvc 10 0/106
 ubr+ 100000 10000
 protocol ip 192.1.6.254 broadcast

BGP
R4 belongs to AS1034 R1 belongs to AS1031 R3 R2 R5 belongs to AS1099 Backbone2 belongs to AS254
AS1034 set up the Neighbor relation with the other three AS
AS1034 AS1099 AS1031 unify as AS1 for external
Establish Loopback address 192.192.2.0/24 on R5 only this address can send to AS254 only allow 197.68.2.0/16 come in from BB2
For preventing the Router Table become too big, set ip gater on R4 the Router come in from AS254 was gathered as 197.68.0.0/16 only 192.68.22.0/24 and 197.68.0.0/16 could be acquired by AS1099 AS1031 overpass EBGP

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DLSW+
Set up the peer relationship R3 and R3 make sure that the host computer of VLAN A could communicate with VLANB Ring 10

Ring 10 has a lot of traffic so configure the token ring interface to allow AT LEAST 100 packets/sec to be processed.

Set up the filtration on R2 only allow Explorer and 04 08 0C get across
access-list 200 permit 0x0000 0x0D0D
dlsw remote-peer 1 tcp x.x.x.x lsap-output-list 200

ISDN
R3 and R5 dial-up each other successfully:
When dial-up from R5 to R3 considering the change R3 should Callback R5 can not use PPP Callback
Use static Router realize the Router backup
isdn callerid xxxxxxx callback

Catalyst 3550 setting
Set up two bridge group
EIGRP
R6 is AS 100 only ATM Port support EIGRP acquire a great deal of Router from ATM just allow A Sort address enter
Afternoon

Voice
R6 connect with two telephones 2/0/0 is PhoneA Number 3010 2/0/1 is PhoneB Number 3011 make two telephones could call each other.
There is a ateway in the far Port Number 3002 PhoneA and PhoneB should dial-up this number, and could listen a record make sure even the uster say nothing, data still be transmit to the far Port.

Security
Ser up the out call control list on the Serial Port of R2
The Telnet in Vlan B is not allowed
Vlan B could only receive the mail from Ring 20
Both direction WWW is not allowed

Set up user group on R3 make the people who knows the Password CCIE Could use the show order
privilege exec level 2 show
enable password level 2 ccie

Catalyst setting
Set up maxage for Blan B on the PBX
set spantree maxage 30 100

Frame Relay Broadcast setting
Too many broadcasts on Frame Relay make only allow 80 normal broadcast ackages or 240K/sec pass most 160 packages.
frame-relay broadcast-queue 80 240000 160

The end
Lab 7

Note: Compare to Lab 6, Section A

1) Terminal server
address 137.rack.0.0 each router should also have a loopback address 137.2.x.x which x is your router number. The vty/aux/console should never timeout.

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2) **Rip**
   Config rip on r(e0,s0) and r5(s1), backbone will have a address 150.100.1.254, make r1 not broadcast rip in e0, (use passive interface and neighbor 150.100.1.254)
   config on r1 so only allowed route can get into r1 (filter-list)
   r1 must can connect to all other router but not allowed using any summary/static/default-route (RIPv2)

2. **Vlan and isl**
   1) Config catalyst 3550 and r2 r3 r5 according to the vlan (r2 e0-vlan20, r3vlan-vlan20 r5e0-vlan50, catalyst sc0-vlan70)
   2) Config trunk at r6 100M ethernet so that r5 r3 r2 can connect to each other (using trunk and irb)
   3) ospf security, make security when r3 r2 r5 make adjacency. Do not allowed to use ospf authentication and ip access-list (use the bridge access-list or static bridge let it not study other MAC address)
   4) Config ospf as map
   5) r4 tokenring area4 router want using less memory and process (using totally stub area)

6) **isdn -->4 point**
   Only r5 can initial the call to r3. There must not route flapping!!! (redistribute the necessary RIP route to OSPF and passive all other ospf interface in the RIP rout)
   config pap authentication, r3 and r5 should using different password (ppp pap send username xxx password xxx) if the error rate r3 bri port is bigger then 10%, autodisconnect the phone (ppp quality 90)

7) **hsrp and dhcp -->4 point**
   Config hsrp on tokenring interface of r2 and r6 make r2 is preferred than r6 and when either r2 ethernet and tokenring interface down, r6 should prefer (standby track)

8) **The DHCP server** any appeared on 12.xT version and no log conflict. (do not log any info to anyplace) there are some host on ring 1 make the can use dhcp to fet address, config r6 as dhcp (ios 12.0.5t) using ip dhcp local pool comment, remember to exclude r2 and r6 stokenring address and the hsrp address and remember to config default router.

9) **atm v7 and Eigrp -->7 point**
   Config lane using atm address as the prector tell you, use lane config config-atm-address command.
   The R6 ATM connected to the EIGRP clouds and the R6/R2 tokenring interface run Eigrp.
   Let the R6 redistribute Eigrp to ospf but not allowed for OSPF to be redistributed to EIGRP. Again have all the connection.
   ATM v71
It use RFC1483 PVC and the QoS (vc-class and UBR+) to define the rate.

10) Bgp
(1) config r1 as as12, r3 r4 r5 r6 as as2, backbone is as 254
(2) bgp filter filter route from backbone 2
(3) R4 and R6 as RR, R3 and R5 is the client.
VOIP -->4 POINT

11) Voice config r6 call backbone at a phone number given to you, r6 fxs has twp phone using one phone number 22 21 two extension. They should both be called and can calling backbone.

12) Config auto dial at once of r6 extension, when it picked up, it should auto call a phone number.
Attached is map by r1 e0 address 150.100.1.Rack r4 e0 address 150.100.2,Rack

13) Multicast-->4 point
R2/R3/R4 run multicast (V7), should use access-list to permit the RP only be the 243.1.2.3’s RP.
Set cgmp properly on the r6 and Catalyst.
Note: R1 and R5 run multicast for V7.1 and no trick here.

14) DLSW --->9 point
   1. DLSW backup of R6’s tokenring with R2 from R4 side
   2. Border peer
   3. icanreach
   4. dlsw bridge-group x for R3

15) Autostart from R4’s F/R interface --->3 point

16) Set cam, set spantree disable vlan80 and port security on cat3550 --->3 point
Lab 8

Cat3550

Console> (enable) sh config

.....
........
........
begin
set password $1$FMFQ$HfZR5DUszVHlRhrz4h6V70
set enablepass $1$FMFQ$HfZR5DUszVHlRhrz4h6V70
set prompt Console>
set length 24 default
set logout 20
set banner motd ^C^C
!
#system
set system baud 9600
set system modem disable
set system name
set system location
set system contact
!
#snmp
set snmp community read-only public
set snmp community read-write private
set snmp community read-write-all secret
set snmp rmon disable
set snmp trap disable module
set snmp trap disable chassis
set snmp trap disable bridge
set snmp trap disable repeater
set snmp trap disable vtp
set snmp trap disable auth
set snmp trap disable ippermit
set snmp trap disable vmps
set snmp trap disable entity
set snmp trap disable config
set snmp trap disable stpx
!
#ip
set interface sc0 1 150.100.14.242 255.255.255.240 150.100.14.255
set interface sc0 up
set interface sl0 0.0.0.0 0.0.0.0
set interface sl0 up
set arp agingtime 1200
set ip redirect enable
set ip unreachable enable
set ip fragmentation enable
set ip route 0.0.0.0 150.100.14.241 1
set ip alias default 0.0.0.0
!
#Command alias
!
#vmps
set vmps server retry 3
set vmps server reconfirminterval 60
set vpms tfpserver 0.0.0.0 vmps-config-database.1
set vmps state disable
!
#dns
set ip dns disable
!
#tacacs+
set tacacs attempts 3
set tacacs directedrequest disable
set tacacs timeout 5
set authentication login tacacs disable
set authentication login local enable
set authentication enable tacacs disable
set authentication enable local enable
!
#bridge
set bridge IP snaptoether 8023raw
set bridge IP 8022toether 9023
set bridge IP 8023rawtofddi snap
!
#vtp
set vtp domain ccie
set vtp mode server
set vtp v2 disable
set vtp pruning disable
set vtp pruneeligible 2-1000
clear vtp pruneeligible 1001-1005
set vlan 1 name default type ethernet mtu 1500 said 100001 state active
set vlan 2 name vlan2 type ethernet mtu 1500 said 100002 state active
set vlan 3 name back1 type ethernet mtu 1500 said 100004 state active
set vlan 4 name back2 type ethernet mtu 1500 said 100004 state active
set vlan 5 name other type ethernet mtu 1500 said 100005 state active
set vlan 1002 name fddi-default type fddi mtu 1500 said 101002 state active
set vlan 1004 name fddinet-default type fddinet mtu 1500 said 101004 state active bridge 0x0 stp iee
set vlan 1005 name trnet-default type trbrf mtu 1500 said 101005 state active bridge 0x0 stp ibm
set vlan 1003 name token-ting-default type trcrf mtu 1500 said 101003 state active parent 0 ring 0x0
mode srb aremaxhop 7 stemaxhop 7
!
#spantree
#uplinkfast groups
set spantree uplinkfast disable
#backbonefast
set spantree backbonefast disable
#vlan 1
set spantree enable 1
set spantree fwddeflay 15 1
set spantree hello 2 1
set spantree maxage 20 1
set spantree priority 32768 1
#vlan 2
set spantree enable 2
set spantree fwddelay 15 2
set spantree hello 2 2
set spantree maxage 20 2
set spantree priority 32768 2
#vlan 3
set spantree enable 3
set spantree fwddelay 15 3
set spantree hello 2 3
set spantree maxage 20 3
set spantree priority 32768 3
#vlan 4
set spantree enable 4
set spantree fwddelay 15 4
set spantree hello 2 4
set spantree maxage 20 4
set spantree priority 32768 4
#vlan 5
set spantree enable 5
set spantree fwddelay 15 5
set spantree hello 2 5
set spantree maxage 20 5
set spantree priority 32768 5
#vlan 1003
set spantree enable 1003
set spantree fwddelay 15 1003
set spantree hello 2 1003
set spantree maxage 20 1003
set spantree priority 32768 1003
set spantree portstate 1003 auto 0
set spantree portcost 1003 62
set spantree portpri 1003 4
set spantree portfast 1003 disable
#vlan 1005
set spantree disable 1005
set spantree fwddelay 15 1005
set spantree hello 2 1005
set spantree maxage 20 1005
set spantree priority 32768 1005
set spantree multicast-address 1005 ieee
!
#cgmp
set cgmp disable
set cgmp leave disable
!
#syslog
set logging console enable
set logging server disable
set logging level cdp 2 default
set logging level mcast 2 default
set logging level dtp 5 default
set logging level dvlan 2 default
set logging level earl 2 default
set logging level fddi 2 default
set logging level ip 2 default
set logging level pruning 2 default
set logging level snmp 2 default
set logging level spantree 2 default
set logging level sys 5 default
set logging level tae 2 default
set logging level tcp 2 default
set logging level telnet 2 default
set logging level tftp 2 default
set logging level vtp 2 default
set logging level vmms 2 default
set logging level kernel 2 default
set logging level filesys 2 default
set logging level drip 2 default
set logging level pagp 5 default
set logging level mgmt 5 default
set logging level mls 5 default
set logging level protfilt 2 default
set logging level security 2 default
!
#ntp
set ntp broadcastclient disable
set ntp broadcastdelay 3000
set ntp client disable
clear timezone
set summertime disable
!
#permit list
set ip permit disable
!
#drip
set tokenring reduction enable
set tokenring distrib-crf disable
!
#igmp
set igmp disable
!
#module 1 :2-port 100BaseTX Supervisor
set module name 1

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set vlan 5 1/1-2
set port channel 1/1-2 off
set port channel 1/1-2 auto
set port enable 1/1-2
set port level 1/1-2 normal
set port duplex 1/1-2 half
set port trap 1/1-2 disable
set port name 1/1-2
set port security 1/1-2 disable
set port broadcast 1/1-2 100%
set port membership 1/1-2 static
set cdp enable 1/1-2
set cdp interval 1/1-2 60
set trunk 1/1 auto isl 1-1005
set trunk 1/2 auto isl 1-1005
set spantree portfast 1/1-2 disable
set spantree portcost 1/1-2 19
set spantree portpri 1/1-2 32
set spantree portvlanpri 1/1 0
set spantree portvlanpri 1/2 0
set spantree portvlancost 1/1 cost 18
set spantree portvlancost 1/2 cost 18
!
#module 2: 12-port 10/100BaseTX Ethernet
set module name 2
set module enable 2
set vlan 1 2/3
set vlan 2 2/2,2/5
set vlan 3 2/1,2/11
set vlan 4 2/4,2/12
set vlan 5 2/6-8,2/10
set port enable 2/1-12
set port level 2/1-12 normal
set port speed 2/1-12 auto
set port trap 2/1-12 disable
set port name 2/3 vlan 1
set port name 2/1-2,2/4-12
set port security 2/1-12 disable
set port broadcast 2/1-12 0
set port membership 2/1-12 static
set cdp enable 2/1-12
set cdp interval 2/1-12 60
set trunk 2/1 auto isl 1-1005
set trunk 2/2 auto isl 1-1005
set trunk 2/3 auto isl 1-1005
set trunk 2/4 auto isl 1-1005
set trunk 2/5 auto isl 1-1005
set trunk 2/6 auto isl 1-1005
set trunk 2/7 auto isl 1-1005
set trunk 2/8 auto isl 1-1005
set trunk 2/9 auto isl 1-1005
set trunk 2/10 auto isl 1-1005
set trunk 2/12 auto isl 1-1005
set spantree portfast 2/1-12 disable
set spantree porcost 2/1-12 100
set spantree portpri 2/1-12 32
set spantree portvlanpri 2/1 0
set spantree portvlanpri 2/2 0
set spantree portvlanpri 2/3 0
set spantree portvlanpri 2/4 0
set spantree portvlanpri 2/5 0
set spantree portvlanpri 2/6 0
set spantree portvlanpri 2/7 0
set spantree portvlanpri 2/8 0
set spantree portvlanpri 2/9 0
set spantree portvlanpri 2/10 0
set spantree portvlanpri 2/11 0
set spantree portvlanpri 2/12 0
set spantree portvlanlancost 2/1 cost 99
set spantree portvlanlancost 2/2 cost 99
set spantree portvlanlancost 2/3 cost 99
set spantree portvlanlancost 2/4 cost 99
set spantree portvlanlancost 2/5 cost 99
set spantree portvlanlancost 2/6 cost 99
set spantree portvlanlancost 2/7 cost 99
set spantree portvlanlancost 2/8 cost 99
set spantree portvlanlancost 2/10 cost 99
set spantree portvlanlancost 2/11 cost 99
set spantree portvlanlancost 2/12 cost 99
!
#module 3 empty
!
#module 4 empty
!
#module 5 empty
!
#switch port analyzer
set span 2/8 2/9 both inpkts disable
FR
FR_SW#sh ru
Building configuration...
Current configuration:
!
version 11.2
no service password-encryption
no service udp-small-servers
no service tcp-small-servers
!
hostname FR_SW
!
enable secret 5 $1$ZHha$31Wqsz9TgXO6zdiiIpwaq0
!
no ip domain-lookup
ip host TES 150.100.1.154
ip host CGS 19 150.100.1.254
ip host ECS 7 150.100.1.254
ip host WWS 80 150.100.1.254
IP routing 0010.0010.0010
frame-relay switching
!
interface Loopback0
ip address 150.1.0.1 255.255.0.0
IP network AA00
!
interface Loopback1
ip address 150.2.0.1 255.255.0.0
IP network AA01
!
interface Loopback2
ip address 150.3.0.1 255.255.0.0
IP network CC01
!
interface Loopback3
ip address 150.4.0.1 255.255.0.0
interface Loopback4
ip address 199.172.5.1 255.255.255.0
!
interface Loopback5
ip address 199.172.1.1 255.255.255.0
!
interface Loopback6
ip address 199.172.10.10.1 255.255.255.0
!
interface Loopback7
ip address 199.172.20.1 255.255.255.0
!
interface Loopback20
ip address 197.68.2.1 255.255.255.0
!
interface Loopback21
ip address 197.68.3.1 255.255.255.0
!
interface Loopback22
ip address 197.68.4.1 255.255.255.0
!
interface Loopback100
ip address 150.100.251.1 255.255.255.0
!
interface Loopback101
ip address 150.100.252.1 255.255.255.0
!
interface Loopback102
ip address 150.100.253.1 255.255.255.0
!
interface Ethernet0
description This segment is known as Backbone_A
ip address 150.100.1.254 255.255.255.0
media-type 10BaseT
!
interface Ethernet1
description This segment is known as Backbone_B
ip address 150.100.2.254 255.255.255.0
media-type 10BaseT
IP network BB88
!
interface Ethernet2
no ip address

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shutdown
!
interface Ethernet3
no ip address
shutdown
!
interface Serial0
no ip address
encapsulation frame-relay
no fair-queue
clockrate 2000000
frame-relay lmi-type ansi
frame-relay intf-type dce
frame-relay route 100 interface Serial3 100
frame-relay route 101 interface Serial2 110
frame-relay route 102 interface Serial1 201
!
interface Serial1
no ip address
encapsulation frame-relay
clockrate 2000000
frame-relay lmi-type ansi
frame-relay intf-type dce
frame-relay route 201 interface Serial0 102
!
interface Serial2
no ip address
encapsulation frame-relay
clockrate 2000000
frame-relay lmi-type ansi
frame-relay intf-type dce
frame-relay route 110 interface Serial0 101
!
interface Serial3
no ip address
encapsulation frame-relay
clockrate 2000000
frame-relay lmi-type ansi
frame-relay intf-type dce
frame-relay route 100 interface Serial0 100
!
router ospf 6764
redistribute igrp 1000 subnets
network 150.100.1.254 0.0.0.0 area 10
router rip
network 197.68.2.0
network 197.68.3.0
network 197.68.4.0
network 150.100.0.0
default-metric 100

router igrp 1000
network 150.1.0.0
network 150.2.0.0
network 150.3.0.0
network 150.4.0.0

router bgp 254
network 199.172.5.0
network 199.172.1.0
network 199.172.10.0
network 199.172.20.0
neighbor 150.100.2.1 remote-as 1
neighbor 150.100.2.1 route-map InsertAS out
neighbor 150.100.2.2 remote-as 2
neighbor 150.100.2.2 route-map InsertAS out
neighbor 150.100.2.3 remote-as 3
neighbor 150.100.2.3 route-map InsertAS out
neighbor 150.100.2.4 remote-as 4
neighbor 150.100.2.4 route-map InsertAS out
neighbor 150.100.2.5 remote-as 5
neighbor 150.100.2.5 route-map InsertAS out

ip http server
no ip classless
access-list 2 permit 199.172.5.0 0.0.0.255
access-list 3 permit 199.172.1.0 0.0.0.255
access-list 3 permit 199.172.10.0 0.0.0.255
access-list 4 permit 199.172.20.0 0.0.0.255

IP router nlsp

TFTP server flash c4500-ds-ms_112-12
route-map InsertAS permit 10
match ip address 2
set as-patch prepend 100 200 300
!
route-map InsertAS permit 20
match ip address 3
set as-patch prepend 100 200
!
route-map InsertAS permit 30
match ip address 4
!
!
line con 0
line aux 0
line vty 0 4
password cisco
login
!
end

Router1

r1#sh ru
Building configuration…
Current configuration:
!
version 11.2
no service password-encryption
no service udp-small-servers
no service tcp-small-servers
!
hostname r1
!
enable password cisco
!
no ip domain-lookup
IP routing 0001.0001.0001
!
interface Loopback0
ip address 150.100.10.1 255.255.255.240
!
interface Ethernet0
ip address 150.100.1.3 255.255.255.0

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interface Serial0
ip address 150.100.14.1 255.255.255.252
IP network 15
no fair-queue
clockrate 64000
!
interface Serial1
no ip address
shutdown
!
router ospf 100
redistribute rip subnets
network 150.100.14.0 0.0.0.255 area 3
network 150.100.10.0 0.0.0.15 area 4
distribute-list 1 out rip
area 0 authentication message-digest
area 3 virtual-link 150.100.100.5 message-digest-key 1 md5 cisco
area 4 range 150.100.10.0 255.255.255.0
!
router rip
passive-interface Loopback0
passive-interface Serial0
network 150.100.0.0
distribute-list 1 in
!
router bgp 3
no synchronization
neighbor 150.100.100.4 remote-as 3
!
no ip classless
access-list 1 permit 197.68.3.0 0.0.0.255
!
!
IP router eigrp 3
network 15
!
!
IP router rip
no network 15
!
!
line con 0
line aux 0
line vty 0 4
password cisco
login
!
end

Router2

r2#sh ru
Building configuration…
Current configuration:
!
version 11.2
no service password-encryption
no service udp-small-servers
no service tcp-small-servers
!
hostname r2
!
netbios access-list host serverfit deny SERVER*
enable password cisco
!
username joecie password 0 cisco
no ip domain-lookup
ip multicast-routing
ip dvmrp route-limit 20000
appletalk routing eigrp 2
appletalk route-redistribution
IP routing 0002.0002.0002
source-bridge ring-group 100
dlsw local-peer peer-id 150-100.20.2
dlsw remote-peer 0 tcp 150.100.15.33 keepalive 0 lsap-output-list 200 timeout 12 00
dlsw remote-peer 0 tcp 150.100.14.241 keepalive 0 timeout 1200
!
interface Ethernet0
ip address 150.100.23.2 255.255.255.0
ip access-group 110 in
ip pim dense-mode
ip igmp join-group 224.1.1.1

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appletalk cable-range 23-23 23.2
appletalk zone vlan2
appletalk protocol eigrp
no appletalk protocol rtmp
IP network 23
!
interface Serial0
no ip address
shutdown
!
interface Serial1
no ip address
shutdown
!
interface TokenRing0
ip address 150.100.20.2 255.255.255.0
appletalk cable-range 20-20 20.2
appletalk zone ring1
appletalk protocol eigrp
no appletalk protocol rtmp
IP network 20
ring-speed 16
source-bridge 1 1 100
netbios output-access-filter host serverfit
!
router igrp 3
network 150.100.0.0
!
no ip classless
access-list 110 permit igrp any any
access-list 110 permit icmp any any echo
access-list 110 permit icmp any any echo-reply
access-list 110 permit tcp any any eq www
access-list 110 permit tcp any eq www any
access-list 110 dynamic joecie timeoute 5 permit ip any any
access-list 110 permit tcp any 150.100.20.0 0.0.0.255 eq telnet
access-list 110 permit tcp host 150.100.14.250 eq telnet host 150.100.23.1
access-list 110 permit tcp any eq 2065
access-list 110 permit tcp any eq 2065 any
access-list 200 permit 0x0404 0x0001
access-list 200 permit 0x0004 0x0001
!
IP route ABCD 20.0080.a.1b.1.c1d1
! IP sap 4 IPSERVER ABCD.0000.0000.0001 451 2
!
!
line con 0
line aux 0
line vty 0 4
password cisco
login local
autocommand access-enable host time-out 5
!
end

Router3
r3#sh ru
Building configuration…
Current configuration:
!
version 11.2
no service password-encryption
no service udp-small-servers
no service tcp-small-servers
!
hostname r3
!
enable password cisco
!
username r3 password 0 cisco
username r5 password 0 cisco
no ip domain-lookup
ip multicast-routing
ip dvmrp route-limit 20000
appletalk routing eigrp 3
appletalk route-redistribution
IP routing 0003.0003.0003
isdn switch-type basic-net3
!
interface Tunnel0
no ip address
appletalk cable-range 35-35 35.3
appletalk zone r35
appletalk protocol eigrp

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no appletalk protocol rtmp
tunnel source Serial0.1
tunnel destination 150.100.100.5
!
interface Ethernet0
ip address 150.100.23.0 255.255.255.0
ip pim dense-mode
appletalk cable-range 23-23 23.3
appletalk zone vlan2
appletalk protocol eigrp
no appletalk protocol rtmp
IP input-sap-filter 1000
IP network 23
!
interface Serial0
no ip address
encapsulation frame-relay
frame-relay lmi-type ansi
!
interface Serial0.1 point-to-point
ip address 150.100.100.3 255.255.0
ip pim dense-mode
ip ospf message-digest-key 2 md5 cisco
ip ospf network point-to-multipoint
no arp frame-relay
IP network 345
frame-relay interface-dlci 110
!
interface Serial1
no ip address
shutdown
!
interface BRI0
ip address 150.100.14.6 255.255.255.252
encapsulation ppp
IP network 35
dialer idle-timeout 60
dialer map IP 35.0005.0005.0005 name r5 broadcast 81752310
dialer map ip 150.100.14.5 name r5 broadcast 81752310
dialer load-threshold 100 outbound
dialer-group 1
no fair-queue
ppp authentication chap
ppp multilink

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! router ospf 100
summary-address 150.100.23.0 255.255.255.255
summary-address 150.100.20.0 255.255.255.255
redistribute igrp 3 subnets
network 150.100.100.0 0.0.0.255 area 0
network 150.100.14.0 0.0.0.255 area 3
distribute-list 1 out igrp 3
area 0 authentication message-digest
!
router igrp 3
redistribute ospf 100 metric 10000 100 255 1 150
passive-interface BRI0
passive-interface Serial0.1
network 150.100.0.0
!
no ip classless
ip route 150.100.14.240 255.255.255.240 150.100.14.5 150
access-list 1 permit 150.100.23.0 0.0.0.255
access-list 1 permit 150.100.20.0 0.0.0.255
access-list 100 deny up any host 255.255.255.255
access-list 100 deny ospf any any
access-list 100 permit ip host 150.100.14.6 host 150.100.14.5
access-list 100 permit ip 150.100.23.0 0.0.0.255 150.100.14.240 0.0.0.15
access-list 900 deny sap any sap any sap
access-list 900 deny rip any rip any rip
access-list 900 deny any any any any 457
access-list 900 permit any 23 all 50 all
access-list 1000 deny ABCD 4 IPSERVER
access-list 1000 permit FFFFFFFF
!
IP route 50 35.0005.0005.0005 floating-static
!
IP router eigrp 3
network 345
!
!
IP router rip
no network 345
!
!
dialer-list 1 protocol ip list 100
dialer-list 1 protocol IP list 900
!
line con 0
line aux 0
line vty 0 4
password cisco
login
!
end

Router4

r4#sh ru
Building configuration…
Current configuration:
!
version 11.2
no service password-encryption
no service udp-small-servers
no service tcp-small-servers
!
hostname r4
!
enable password cisco
!
no ip domain-lookup
appletalk routing eigrp 4
appletalk route-redistribution
IP routing 0004.0004.0004
source-bridge ring-group 200
dlsw local-peer peer-id 150.100.15.33
dlsw remote-peer 0 tcp 150.100.14.241
dlsw remote-peer 0 tcp 150.100.20.2 keepalive 0 timeout 120
!
interface Loopback0
ip address 199.55.3.4 255.255.255.0
!
interface Tunnel0
no ip address
appletalk cable-range 45-45 45.4
appletalk zone r45
appletalk protocol eigrp
no appletalk protocol rtmp
tunnel source Serial0.1
tunnel destination 150.100.100.5
!
interface Ethernet0
ip address 150.100.2.3 255.255.255.0
media-type 10BaseT
!
interface Serial0
no ip address
encapsulation frame-relay
frame-relay lmi-type ansi
!
interface Serial0.1 point-to-point
ip address 150.100.100.4 255.255.255.0
ip ospf message-digest-key 1 md5 cisco
ip ospf network point-to-multipoint
no arp frame-relay
IP network 345
frame-relay interface dlci 100
!
interface Serial1
no ip address
shutdown
!
interface TokenRing0
ip address 150.100.15.33 255.255.255.224
appletalk cable-range 40-40 40.4
appletalk zone ring2
appletalk protocol eigrp
no appletalk protocol rtmp
IP network 40
ring-speed 16
source-bridge 2 1 200
!
router ospf 100
summary-address 150.100.2.0 255.255.255.0
summary-address 150.100.15.0 255.255.255.0
redistribute connected subnets
network 150.100.100.0 0.0.0.255 area 0
distribute-list 10 out connected
area 0 authentication message-digest
!
router bgp 3

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no synchronization
network 199.55.3.0
aggregate-address 199.0.0.0 255.0.0.0 summary-only
neighbor 150.100.2.254 remote-as 254
distribute-list 1 out
neighbor 150.100.2.254 filter-list 1 in
neighbor 150.100.14.1 remote-as 3

no ip classless
ip as-patch access-list 1 permit ^254$
deny 199.55.3.0 0.0.0.255
permit any
access-list 10 permit 150.100.15.32 0.0.0.31
access-list 10 permit 150.100.2.0 0.0.0.255
!
!
!
IP router eigrp 3
network 345
!
!
IP router rip
do network
!
!
!
!
!
!
!
!
!
line con 0
line aux 0
line vty 0 4
password cisco
login
!
end

Router5

r5#sh ru
Building configuration…
Current configuration:
!
version 11.2

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no service password-encryption
no service udp-small-servers
no service tcp-small-servers
!
hostname r5
!
enable password cisco
!
username r5 password 0 cisco
username r3 password 0 cisco
no ip domain-lookup
ip multicast-routing
ip dvmrp route-limit 20000
appletalk routing eigrp 5
appletalk route-redistribution
IP routing 0005.0005.0005
isdn switch-type basic-net3
dlsw local-peer peer-id 150.100.14.241
dlsw remote-peer 0 tcp 150.100.15.33
dlsw remote-peer 0 tcp 150.100.20.2 keepalive 0 timeout 1200
dlsw bridge-group 1
!
interface Tunnel0
no ip address
appletalk cable-range 35-35.5
appletalk zone r35
appletalk protocol eigrp
no appletalk protocol rtmp
tunnel source Serial0
tunnel destination 150.100.100.3
!
interface Tunnel1
no ip address
appletalk cable-range 45-45 45.5
appletalk zone r45
appletalk protocol eigrp
no appletalk protocol rtmp
tunnel source Serial0
tunnel destination 150.100.100.4
!
interface Ethernet0
ip address 150.100.14.241 255.255.255.240
appletalk cable-range 50-50 50.5
appletalk zone vlan 1

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appletalk protocol eigrp
no appletalk protocol rtmp
IP network 50
bridge group 1
!
interface Serial0
ip address 150.100.100.5 255.255.255.0
ip pim dense-mode
encapsulation frame-relay
ip ospf message-digest-key 1 md5 cisco
ip ospf network point-to-multipoint
ip igmp join-group 224.1.1.1
IP network 345
no IP split-horizon eigrp 3
custom-queue list 1
frame-relay interface-dlci 100
frame-relay interface-dlci 101
frame-relay lmi-type ansi
!
interface Serial1
ip address 150.100.14.2 255.255.255.252
IP network 15
!
interface Serial2
no ip address
shutdown
!
interface Serial3
no ip address
shutdown
!
interface Serial4
no ip address
shutdown
!
interface Serial5
no ip address
shutdown
!
interface Serial6
no ip address
shutdown
!
interface Serial7
no ip address
shutdown
!
interface Serial8
no ip address
shutdown
!
interface Serial9
no ip address
shutdown
!
interface BRI0
ip address 150.100.14.5 255.255.255.252
encapsulation ppp
IP network 35
dialer idle-timeout 60
dialer map ip 150.100.15.6 name r3 broadcast 81752322
dialer map ip 35.0003.0003.0003 name r3 broadcast 81752322
dialer-group 1
ppp authentication chap
!
router ospf 100
network 150.100.100.0 0.0.0.255 area 0
network 150.100.14.0 0.0.0.255 area 3
area 0 authentication message-digest
area 3 range 150.100.14.0 255.255.255.0
area 3 virtual-link 150.100.10.1 message-digest-key 1 md5 cisco
!
no ip classless
ip route 150.100.23.0 255.255.255.0 150.100.14.6 150
access-list 100 deny ip any host 255.255.255.255
access-list 100 deny ospf any any
access-list 100 permit ip host 150.100.14.5 host 150.100.14.6
access-list 100 permit ip 150.100.14.240 0.0.0.15 150.100.23.0 0.0.0.255
access-list 900 deny sap any sap any sap
access-list 900 deny rip any rip any
access-list 900 deny any any all any 457
access-list 900 permit any 50 all 23 all
queue-list 1 queue 1 byte-count 4000
queue-list 1 queue 2 byte-count 2000
queue-list 1 queue 3 byte-count 2000
queue-list 1 queue 4 byte-count 500
!
!
IP route 23 35.0003.0003.0003 floating-static
!
IP router eigrp 3
network 345
network 15
!
!
IP router rip
no network 345
no network 15
!
!
!
dialer-list 1 protocol ip list 100
dialer-list 1 protocol IP list 900
bridge 1 protocol ieee
!
line con 0
line aux 0
password cisco
login
!
end

Note: Section A contains 9 labs. Section B contains 8 Labs. Total number of labs is 17.