Cisco Routing Lab Book – Demo Version

*****Important Note*****
The enclosed sample pages are a random selection from the lab book and are not complete in their content. The actual lab book is over 100 pages in length and is provided as a PDF file.

Learn how to Setup, Manage & Troubleshoot Cisco Routers and Switches in a LAN/WAN Environment

Video CBT Lab 19

Cisco CCNA Routing & Switching

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Cisco Routers & Switches - Rack Rentals

Fast Track Lab 19, the **Cisco Routing & Switching Video Training Study Package**, was designed from the ground up with "Real-World" Experience in mind!

Working with live Cisco Routers & Switches is the best way to get the "Real-World" Experience you need on the job and to pass the CCNA exam. Train Signal has partnered with The Bryant Advantage to offer you rack rental service with REAL Cisco routers and 2950 switches. These racks have been created and priced especially for Train Signal customers using the lab books that are included with your Cisco CCNA Video Training Study Package.

For $10/day (or $20 for 3 days) you will have full, remote access to a full pod of Cisco routers and switches. **Each pod contains 5 Cisco Routers, 2 Cisco Catalyst 2950 Switches and access to an ISDN Simulator**; all updated with the latest version of IOS. This is close to **$3,000 worth of equipment!**

Not sure how it works? It is easy! Included with the Cisco Routing & Switching Video Training Study Package are detailed signup instructions, a lab book and a step-by-step walkthrough of how to connect to the Cisco pod. It's very easy to work with and you will gain valuable experience while working with REAL Cisco routers and switches.

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Look at all of the Cisco technologies you will gain firsthand knowledge of!

+ 2950 Switching: including root bridge election, viewing STP statistics, VLAN creation and modification, VTP configuration, creating access ports and trunk ports, and much more! You can even create your own Etherchannel, because each pod has TWO Cisco 2950 switches!

+ Frame Relay: A Frame Relay cloud is preconfigured for you, so you get firsthand experience configuring working Frame Relay map statements, checking LMI and PVC statistics, and more.

+ ISDN: Can't afford a $500 - $1500 ISDN simulator? No need to; it is included for you! R1 and R2 in each pod are connected by an ISDN simulator. Configure dialer map statements, define interesting traffic, important dial statistics (a MUST for the CCNA exams), and work with a REAL working ISDN connection! You'll see how each protocol works with ISDN, how to see what suddenly brought that ISDN connection up, and how to stop it!

+ PPP and Point-to-Point links: You can configure PAP and CHAP on your ISDN connection, and gain firsthand experience with configuring point-to-point Serial links. Run REAL debugs, not pretend ones!

+ IP Addressing: A must for the Intro exam, you'll be able to set your own IP addresses from scratch, and change them if you wish. It's your rack!

+ Passwords and services: Practice setting telnet, console, and enable passwords. The CCNA Lab Workbook will also show you valuable services that you must know how to turn off and on for your exams -- and just what they do! You'll be able to see their effect on REAL Cisco equipment!

+ RIP: You can configure both versions and practice your important RIP debugs.

+ IGRP: Don't just read about the variance command; see it in action, and see what setting it to too high a value can do. Again, you'll run real debugs on REAL Cisco equipment.

+ EIGRP: You can see how the variance command works, how to set up EIGRP neighbor relationships, how to debug them, and how to fix them.

+ OSPF: You can build your own fully functional OSPF network. Define areas, neighbor relationships, and use debugs to watch adjacencies form (or not form!).

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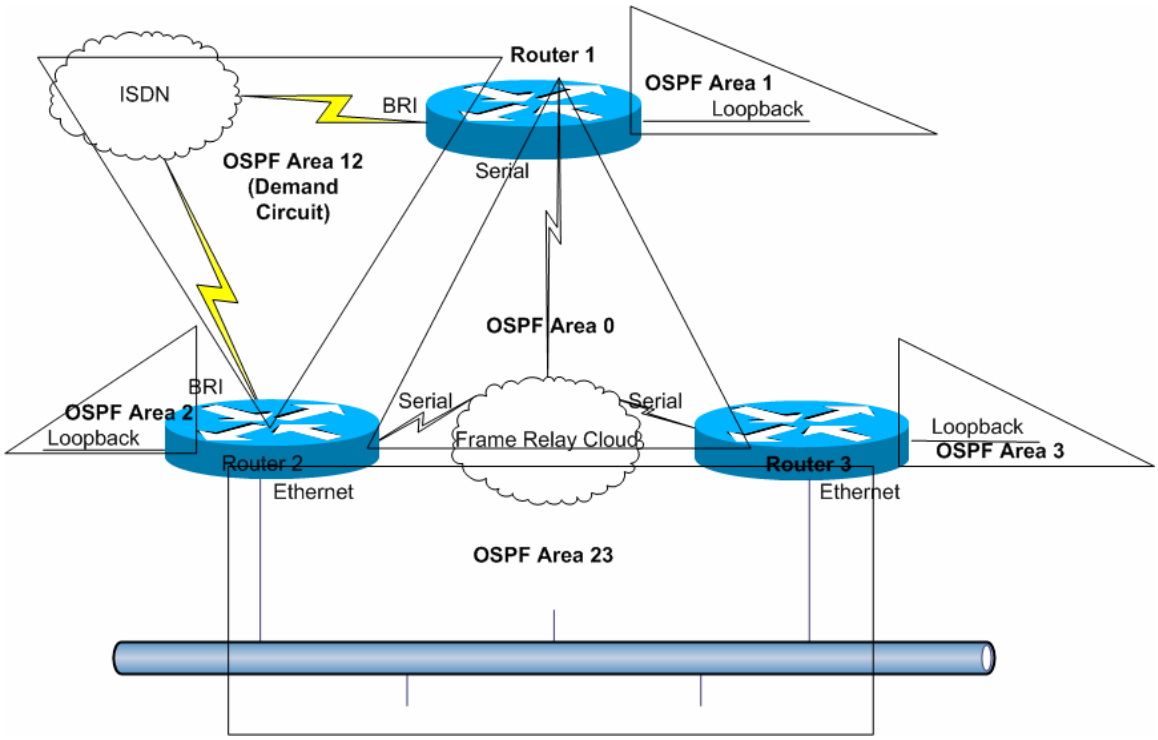
+ Route redistribution: One of the most difficult features to master, no simulator is going to show you all the effects of route redistribution. Master this feature on real Cisco routers and switches.

OSPF Lab

Configuring OSPF areas, stub areas, and ISDN demand circuit.

Remove any existing routing protocol configuration.

This is the OSPF network you will build:



Configure OSPF Area 0 on each router interface connected to the Frame Relay cloud with the **router ospf 1** and **network** commands. Run **show ip ospf interface** on each router to see what OSPF network type the interfaces are running.

Configuring OSPF on the Frame Relay cloud interfaces on R1, R2, and R3.

R1#conf t
R1(config)**#router ospf 1**
R1(config-router)**#network 172.12.123.0 0.0.0.255 area 0**

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R2#conf t
R2(config)#**router ospf 1**
R2(config-router)#**network 172.12.123.0 0.0.0.255 area 0**

R3#conf t
R3(config)#**router ospf 1**
R3(config-router)#**network 172.12.123.0 0.0.0.255 area 0**

R1#**show ip ospf interface serial0**
Serial0 is up, line protocol is up
  Internet Address 172.12.123.1/24, Area 0
  Process ID 1, Router ID 1.1.1.1, **Network Type NON_BROADCAST**, Cost: 64

R2#**show ip ospf interface serial0.123**
Serial0.123 is up, line protocol is up
  Internet Address 172.12.123.2/24, Area 0
  Process ID 1, Router ID 2.2.2.2, **Network Type NON_BROADCAST**, Cost: 64

R3#**show ip ospf interface serial0.31**
Serial0.31 is up, line protocol is up
  Internet Address 172.12.123.3/24, Area 0
  Process ID 1, Router ID 3.3.3.3**, Network Type POINT_TO_POINT**, Cost: 64

R3's point-to-point interface is defaulting to OSPF network type point-to-point. The timers will be different between R3 and R1, requiring that the network type be changed before an adjacency can occur.

This is a hub-and-spoke OSPF network, requiring that the hub router, R1, be the Designated Router. Additionally, since all three interfaces will be OSPF network type non-broadcast after changing R3, "neighbor" statements will need to be configured on the hub router.

Change R3's serial 0.31 interface to OSPF network type non-broadcast with the **ip ospf network** interface-level command. Prevent R2 and R3 from possibly becoming the Designated Router by configuring **ip ospf priority 0** on the interfaces connected to the Frame Relay cloud.

R3#conf t
R3(config)#int s0.31
R3(config-subif)#**ip ospf network non-broadcast**
R3(config-subif)#**ip ospf priority 0**

R2#conf t

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R2(config)#int s0.123
R2(config-subif)**#ip ospf priority 0**

Allow R1 to discover its OSPF neighbors over the OSPF nonbroadcast network with two **neighbor** commands, naming the remote Frame Relay cloud neighbors. Run **show ip ospf neighbor** on R1 to verify adjacencies. (The adjacency won't take effect immediately; continue to run this command to see the various stages of adjacency.)

R1#conf t
R1(config)#router ospf 1
R1(config-router)**#neighbor 172.12.123.2**
R1(config-router)**#neighbor 172.12.123.3**

R1**#show ip ospf neighbor**

Neighbor ID	Pri	State	Dead Time	Address	Interface
3.3.3.3	0	**FULL/DROTHER**	00:01:57	172.12.123.3	Serial0
2.2.2.2	0	**FULL/DROTHER**	00:01:57	172.12.123.2	Serial0

Notice the Neighbor ID of each remote address is the loopback address. How can that be if you didn't configure OSPF on those loopbacks?

When determining the Router ID (RID) of an OSPF-enabled router, OSPF will always use the numerically highest IP address on the router's loopback interfaces, **regardless of whether that loopback is OSPF-enabled.**

What if there is no loopback? **OSPF will then use the numerically highest IP address of the physical interfaces, regardless of whether that loopback is OSPF-enabled.**

BOTTOM LINE: An interface does not have to be running OSPF to have its IP address used as the OSPF RID.

The OSPF RID can be changed, but it requires a restart or to reinitialize the OSPF routing process. Use the **router-id** command to change the default RID of each router as shown, and clear the OSPF process to do so.

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R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#router ospf 1

R1(config-router)#router-id 11.11.11.11
Reload or use "clear ip ospf process" command, for this to take effect
R1#clear ip ospf process
Reset ALL OSPF processes? [no]: yes
1d05h: %OSPF-5-ADJCHG: Process 1, Nbr 3.3.3.3 on Serial0 from 2WAY to DOWN, Neighbor Down: Interface down or detached
1d05h: %OSPF-5-ADJCHG: Process 1, Nbr 2.2.2.2 on Serial0 from 2WAY to DOWN, Neighbor Down: Interface down or detached

After entering the **router-id** command, the router console informed you that you have to reload the router or reset the OSPF processes for this to take effect. You enter the **clear ip ospf process** command to do this; notice that when you're asked if you really want to do this, the prompt is "no"? That's because all the OSPF adjacencies on this router will be lost and will have to begin the process again. That's OK on a practice rack, not good in a production network. Don't use that one at work.

Run this command on R2 and R3, and wait for the adjacencies to come back before continuing with the lab. You can check the adjacency stage with **show ip ospf neighbor**.

R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#router ospf 1
R2(config-router)#router-id 22.22.22.22
Reload or use "clear ip ospf process" command, for this to take effect
R2(config-router)#^Z
1d05h: %SYS-5-CONFIG_I: Configured from console by console
R2#clear ip ospf process
Reset ALL OSPF processes? [no]: yes
R2#
1d05h: %OSPF-5-ADJCHG: Process 1, Nbr 11.11.11.11 on Serial0.123 from FULL to DOWN, Neighbor Down: Interface down or detached

1d05h: %OSPF-5-ADJCHG: Process 1, Nbr 11.11.11.11 on Serial0.123 from LOADING to FULL, Loading Done

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R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#router ospf 1
R3(config-router)#router-id 33.33.33.33
Reload or use "clear ip ospf process" command, for this to take effect
R3(config-router)#^Z
1d05h: %SYS-5-CONFIG_I: Configured from console by console
R3#clear ip ospf process
Reset ALL OSPF processes? [no]: yes
1d05h: %OSPF-5-ADJCHG: Process 1, Nbr 11.11.11.11 on Serial0.31 from FULL to DOWN, Neighbor Down: Interface down or detached

Run **show ip ospf neighbor** on R1 to see the changes.

R1#show ip ospf neighbor

Neighbor ID	Pri	State	Dead Time	Address	Interface
33.33.33.33	0	FULL/DROTHER	00:01:58	172.12.123.3	Serial0
22.22.22.22	0	FULL/DROTHER	00:01:54	172.12.123.2	Serial0
3.3.3.3	0	FULL/DROTHER	00:00:33	172.12.123.3	Serial0
N/A	0	ATTEMPT/DROTHER	-	172.12.123.2	Serial0

You see the new adjacencies that reflect the changed OSPF RIDs. The old adjacencies are timing out and will soon disappear from the table.

Add R1's loopback address to Area 1, R2's loopback to Area 2, and R3's loopback to Area 3. Use a wildcard mask of **0.0.0.0** so that only the loopback interface will be part of the respective area.

R1#conf t
R1(config)#router ospf 1
R1(config-router)#**network 1.1.1.1 0.0.0.0 area 1**

R2#conf t
R2(config)#router ospf 1
R2(config-router)#**network 2.2.2.2 0.0.0.0 area 2**

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```
R3#conf t
R3(config)#router ospf 1
R3(config-router)#network 3.3.3.3 0.0.0.0 area 3
```

On R1, run **show ip route ospf**. A route to both R2's and R3's loopback should be present. Ping both interfaces to verify connectivity.

```
R1#show ip route ospf
    2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/65] via 172.12.123.2, 00:00:09, Serial0
    3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/65] via 172.12.123.3, 00:00:02, Serial0
```

Notice that the /32 masks are present; OSPF supports VLSM.

Note the "O IA" on the far left-hand side of the command output. The "O" indicates that this is an OSPF route; the "IA" means it is an InterArea route, or a route to a destination in another area.

```
R1#ping 2.2.2.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 68/73/96 ms

R1#ping 3.3.3.3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 68/69/72 ms
```

Run **show ip route ospf** on R2. Routes to the loopbacks of R1 and R3 should be present. Ping both loopbacks to verify connectivity.

```
R2#show ip route ospf
    1.0.0.0/32 is subnetted, 1 subnets
O IA    1.1.1.1 [110/65] via 172.12.123.1, 00:10:35, Serial0.123
    3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/65] via 172.12.123.3, 00:10:35, Serial0.123
R2#ping 1.1.1.1
```

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Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 1.1.1.1, timeout is 2 seconds:
!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 68/68/68 ms
R2#ping 3.3.3.3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 128/133/144 ms

Run **show ip route ospf** on R3. Routes to the loopbacks of R1 and R2 should be present. Ping both loopbacks to verify connectivity.

R3#**show ip route ospf**
1.0.0.0/32 is subnetted, 1 subnets
O IA 1.1.1.1 [110/65] via 172.12.123.1, 00:14:52, Serial0.31
2.0.0.0/32 is subnetted, 1 subnets
O IA 2.2.2.2 [110/65] via 172.12.123.2, 00:14:52, Serial0.31
R3#**ping 1.1.1.1**
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 1.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 64/66/68 ms

R3#**ping 2.2.2.2**
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 128/133/144 ms

Configure the Ethernet segment connecting R2 and R3 as Area 23. Area 23 will be made a stub area. Use the **area stub** command on R3, but not R2. Run **show ip ospf neighbor** to verify the adjacency.

R2#conf t
R2(config)#router ospf 1
R2(config-router)#**network 172.23.23.0 0.0.0.31 area 23**

R3#conf t
R3(config)#router ospf 1
R3(config-router)#**network 172.23.23.0 0.0.0.31 area 23**

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R3(config-router)#**area 23 stub**

R3#**show ip ospf neighbor**

Neighbor ID	Pri	State	Dead Time	Address	Interface
1.1.1.1	1	FULL/DR	00:01:32	172.12.123.1	Serial0.31

You can wait a few minutes, and you'll see the same thing. The adjacency to R2 is not even starting. To diagnose problems with OSPF adjacencies, run **debug ip ospf adjacency**.

R3#**debug ip ospf adj**
OSPF adjacency events debugging is on
OSPF: Hello from 172.23.23.2 with mismatched Stub/Transit area option bit

There's the problem! The Hello packet is coming in from 172.23.23.2, but the Stub option bit is mismatched. **For a stub area to form, all routers must agree that the area is a stub. The command "area stub" must be configured on all routers with an interface in that area.**

On R2, configure **area 23 stub** in router configuration mode. On R3, run **debug ip ospf adj** and **show ip ospf neighbor** to verify the adjacency.

```
R3#debug ip ospf adj
OSPF adjacency events debugging is on
R3#show debug  <  Bonus! This shows your current debugs. >
IP routing:
  OSPF adjacency events debugging is on
< Only some of the debug output is shown here.>
d06h: OSPF: 2 Way Communication to 22.22.22.22 on Ethernet0, state 2WAY
d06h: OSPF: Backup seen Event before WAIT timer on Ethernet0
d06h: OSPF: DR/BDR election on Ethernet0
d06h: OSPF: Elect BDR 33.33.33.33
d06h: OSPF: Elect DR 22.22.22.22
d06h: OSPF: Elect BDR 33.33.33.33
d06h: OSPF: Elect DR 22.22.22.22
```

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d06h: DR: 22.22.22.22 (Id) BDR: 33.33.33.33 (Id)
d06h: OSPF: Send DBD to 22.22.22.22 on Ethernet0 seq 0x21F5 opt 0x40 flag 0x7n 32

d06h: OSPF: Rcv DBD from 22.22.22.22 on Ethernet0 seq 0x1283 opt 0x40 flag 0x7en 32 mtu 1500 state EXSTART
R3PF: Rcv DBD from 22.22.22.22 on Ethernet0 seq 0x21F6 opt 0x40 flag 0x0 len 32 mtu 1500 state EXCHANGE
1d06h: OSPF: Send DBD to 22.22.22.22 on Ethernet0 seq 0x21F7 opt 0x40 flag 0x1 l en 32
1d06h: OSPF: Rcv DBD from 22.22.22.22 on Ethernet0 seq 0x21F7 opt 0x40 flag 0x0
len 32 mtu 1500 state EXCHANGE
1d06h: OSPF: Exchange Done with 22.22.22.22 on Ethernet0
1d06h: OSPF: Synchronized with 22.22.22.22 on Ethernet0, state FULL
1d06h: %OSPF-5-ADJCHG: Process 1, Nbr 22.22.22.22 on Ethernet0 from LOADING to F ULL, Loading Done
1d06h: OSPF: Build router LSA for area 23, router ID 33.33.33.33, seq 0x80000003 #p
R3#
1d06h: OSPF: Neighbor change Event on interface Ethernet0
1d06h: OSPF: DR/BDR election on Ethernet0
1d06h: OSPF: Elect BDR 33.33.33.33
1d06h: OSPF: Elect DR 22.22.22.22
1d06h: DR: 22.22.22.22 (Id) BDR: 33.33.33.33 (Id)

R3#show ip ospf neighbor

Neighbor ID	Pri	State	Dead Time	Address	Interface
11.11.11.11	1	FULL/DR	00:01:58	172.12.123.1	Serial0.31
22.22.22.22	1	FULL/DR	00:00:35	172.23.23.2	Ethernet0

The adjacency has formed over the Ethernet segment.

On R3, run **show ip ospf interface** to compare the characteristics of the Serial and Ethernet interfaces running OSPF.

R3#**show ip ospf interface**
Serial0.31 is up, line protocol is up
  Internet Address 172.12.123.3/24, Area 0
  Process ID 1, Router ID 33.33.33.33, Network Type NON_BROADCAST, Cost: 64
  Transmit Delay is 1 sec, State DROTHER, Priority 0

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```
  Designated Router (ID) 11.11.11.11, Interface address 172.12.123.1
  No backup designated router on this network

  Timer intervals configured, Hello 30, Dead 120, Wait 120, Retransmit 5
    Hello due in 00:00:03
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 3
  Last flood scan time is 0 msec, maximum is 4 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 11.11.11.11  (Designated Router)
  Suppress hello for 0 neighbor(s)
Loopback0 is up, line protocol is up
  Internet Address 3.3.3.3/24, Area 3
  Process ID 1, Router ID 33.33.33.33, Network Type LOOPBACK, Cost: 1
  Loopback interface is treated as a stub Host
Ethernet0 is up, line protocol is up
  Internet Address 172.23.23.3/27, Area 23
  Process ID 1, Router ID 33.33.33.33, Network Type BROADCAST, Cost: 10
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 22.22.22.22, Interface address 172.23.23.2
  Backup Designated router (ID) 33.33.33.33, Interface address 172.23.23.3
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:03
  Index 1/3, flood queue length 0
  Next 0x0(0)/0x0(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 22.22.22.22  (Designated Router)
  Suppress hello for 0 neighbor(s)
```

Notice the differences in hello and dead times on a non-broadcast interface, such as a Serial interface and an Ethernet interface. No matter the hello timer, the default for the dead timer is 4 times the hello timer.

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On R3, run **show ip ospf.** Area 23 will be shown as a stub area.

```
R3#show ip ospf
 Routing Process "ospf 1" with ID 3.3.3.3
 Supports only single TOS(TOS0) routes
 It is an area border router
 Number of areas in this router is 3. 2 normal 1 stub 0 nssa
   Area BACKBONE(0)
       Number of interfaces in this area is 1
       Area has no authentication
   Area 3
       Number of interfaces in this area is 1
       Area has no authentication
   Area 23
       Number of interfaces in this area is 1
       It is a stub area
         generates stub default route with cost 1
       Area has no authentication
```

From R1, ping R2's and R3's Ethernet interfaces.

```
R1#ping 172.23.23.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.23.23.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 64/66/68 ms
R1#ping 172.23.23.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.23.23.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 64/66/68 ms
```

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Place the ISDN link into Area 12. Run **show ip ospf neighbor** to verify adjacency.

```
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#router ospf 1
R1(config-router)#network 172.12.21.0 0.0.0.3 area 12
R1(config-router)#
1d06h: %LINK-3-UPDOWN: Interface BRI0:1, changed state to up
1d06h: %LINEPROTO-5-UPDOWN: Line protocol on Interface BRI0:1, changed
state to up
1d06h: %ISDN-6-CONNECT: Interface BRI0:1 is now connected to 5552222 R2
```

The link comes up immediately. Why? Run show dialer to see the destination of the interesting traffic that caused the line to dial.

```
R1#show dialer

BRI0 - dialer type = ISDN

Dial String      Successes   Failures    Last DNIS   Last status
5552222                6          0    00:01:01       successful
0 incoming call(s) have been screened.
0 incoming call(s) rejected for callback.

BRI0:1 - dialer type = ISDN
Idle timer (120 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is data link layer up
Dial reason: ip (s=172.12.21.1, d=224.0.0.5)
Time until disconnect 118 secs
Connected to 5552222 (R2)

BRI0:2 - dialer type = ISDN
Idle timer (120 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is idle
```

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The OSPF Hello packets, destined for 224.0.0.5, brought the line up. As you'll soon see, OSPF has a built-in mechanism for handling this situation without using the passive-interface command.

In the meantime, configure OSPF on R2's BRI interface. Run show ip ospf neighbor to verify the adjacency over the ISDN link.

```
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#router ospf 1
R2(config-router)#network 172.12.21.0 0.0.0.3 area 12
1d06h: %OSPF-5-ADJCHG: Process 1, Nbr 11.11.11.11 on BRI0 from LOADING
to FULL, Loading Done
```

```
R2#show ip ospf neighbor

Neighbor ID     Pri   State          Dead Time   Address         Interface
11.11.11.11       1   FULL/DR        00:01:46    172.12.123.1    Serial0.123
11.11.11.11       1   FULL/  -       00:00:31    172.12.21.1     BRI0
33.33.33.33       1   FULL/BDR       00:00:34    172.23.23.3     Ethernet0
```

The good news is that the adjacency forms over the BRI interface very quickly. The bad news is that the ISDN link is going to stay up, since every OSPF Hello is going to reset the dialer idle-timeout.

Also, note that there is no DR or BDR over the ISDN link. Point-to-point links have no DR or BDR.

OSPF allows us to suppress the sending of Hello packets over an ISDN link, which keeping the adjacency! This is done with one simple command, and you only need it on one side of the link. On R1, configure the command **ip ospf demand-circuit on the BRI interface.**

```
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#interface bri0
R1(config-if)#ip ospf demand-circuit
```

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1d06h: %OSPF-5-ADJCHG: Process 1, Nbr 22.22.22.22 on BRI0 from FULL to DOWN, Neighbor Down: Interface down or detached

1d06h: %OSPF-5-ADJCHG: Process 1, Nbr 22.22.22.22 on BRI0 from LOADING to FULL,Loading Done

In this example, the link was up when the command was entered. The adjacency came down immediately, and then came back up just as fast. Is the ISDN link still up? Is the OSPF adjacency really up? Run **show dialer** and **show ip ospf neighbor** to see.

```
R1#show dialer

BRI0 - dialer type = ISDN

Dial String      Successes   Failures    Last DNIS   Last status
5552222                7          0    00:07:15       successful
0 incoming call(s) have been screened.
0 incoming call(s) rejected for callback.

BRI0:1 - dialer type = ISDN
Idle timer (120 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is idle

BRI0:2 - dialer type = ISDN
Idle timer (120 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is idle
R1#show ip ospf neighbor

Neighbor ID     Pri   State                   Dead Time   Address         Interface
33.33.33.33       0   FULL/DROTHER    00:01:38    172.12.123.3    Serial0
22.22.22.22       0   FULL/DROTHER    00:01:37    172.12.123.2    Serial0
22.22.22.22       1   FULL/  -          -                    172.12.21.2     BRI0
R1#
```

The line is down, and the adjacency is still up! This is why OSPF is the protocol of choice to run over ISDN links. (If the link is still up when

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you run these commands, watch the idle-timeout value under **show dialer**; it's going to go down to zero and the line will drop.)

You've read about how every OSPF router must have a physical interface in area 0, and if it doesn't, a virtual link can solve the problem. You're now going to configure a virtual link, and see the routing problems that occur when one router doesn't have an interface in area 0.

First, on R1, add the point-to-point link to R3 into the OSPF configuration, placing it into area 13. On R3, do the same, and remove the frame-relay interface from Area 0. After doing so, clear the OSPF processes on R3. (When clearing OSPF processes, don't be surprised to see the ISDN link come back up.)

```
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#router ospf 1
R1(config-router)#network 172.12.13.0 0.0.0.255 area 13

R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#router ospf 1
R3(config-router)#network 172.12.13.0 0.0.0.255 area 13
R3(config-router)#no network 172.12.123.0 0.0.0.255 area 0

R3#clear ip ospf process
Reset ALL OSPF processes? [no]: yes
1d06h: %OSPF-5-ADJCHG: Process 1, Nbr 11.11.11.11 on OSPF_VL0 from
FULL to DOWN,  Neighbor Down: Interface down or detached
1d06h: %OSPF-5-ADJCHG: Process 1, Nbr 11.11.11.11 on Serial1 from FULL to
DOWN, Neighbor Down: Interface down or detached
1d06h: %OSPF-5-ADJCHG: Process 1, Nbr 22.22.22.22 on Ethernet0 from
FULL to DOWN, Neighbor Down: Interface down or detached
R3#
1d06h: %OSPF-5-ADJCHG: Process 1, Nbr 22.22.22.22 on Ethernet0 from
LOADING to FULL, Loading Done
1d06h: %OSPF-5-ADJCHG: Process 1, Nbr 11.11.11.11 on Serial1 from
LOADING to FULL, Loading Done
```

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R3's adjacencies come right back up.

R3 now has no physical interface in Area 0. Checking R3's routing table, there doesn't seem to be a problem:

```
R3#show ip route ospf
     1.0.0.0/32 is subnetted, 1 subnets
O IA    1.1.1.1 [110/75] via 172.23.23.2, 00:01:44, Ethernet0
     2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/11] via 172.23.23.2, 00:01:44, Ethernet0
     172.12.0.0/16 is variably subnetted, 3 subnets, 2 masks
O IA    172.12.21.0/30 [110/1572] via 172.23.23.2, 00:00:52, Ethernet0
```

Ping both of the other loopbacks from R3, and they'll go through. So what's the big deal about Area 0? Here, R3 doesn't have a physical interface in Area 0, and there doesn't seem to be a problem… right?

Wrong. The problem is on R2. Check R2's OSPF routing table.

```
R2#show ip route ospf
     1.0.0.0/32 is subnetted, 1 subnets
O IA    1.1.1.1 [110/65] via 172.12.123.1, 00:02:37, Serial0.123
     172.12.0.0/16 is variably subnetted, 3 subnets, 2 masks
O IA    172.12.13.0/24 [110/259] via 172.12.123.1, 00:02:37, Serial0.123
```

R2 no longer has a route to R3's loopback, and pings to that loopback fail.

```
R2#ping 3.3.3.3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
```

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For full OSPF connectivity, a virtual link must be created between R1 and R3. Since R1 does have an interface in Area 0, that will give us full connectivity.

Configure the virtual link as shown. Notice that the command starts with the transit area; **a virtual link cannot be configured through a stub area.** Also, the IP address specified in the command is the remote router's OSPF RID, not the next-hop IP address.

```
R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#router ospf 1
R3(config-router)#area 13 virtual-link 11.11.11.11

R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#router ospf 1
1d06h: %OSPF-4-ERRRCV: Received invalid packet: mismatch area ID,
from backbone area must be virtual-link but not found from 172.12.13.3,
Serial1
R1(config-router)#area 13 virtual-link 33.33.33.33

1d06h: %OSPF-5-ADJCHG: Process 1, Nbr 33.33.33.33 on OSPF_VL1 from
LOADING to FULL, Loading Done
1d06h: %LINK-3-UPDOWN: Interface BRI0:1, changed state to up
1d06h: %LINEPROTO-5-UPDOWN: Line protocol on Interface BRI0:1, changed
state to up
1d06h: %ISDN-6-CONNECT: Interface BRI0:1 is now connected to 5552222 R2
```

There are several things to note when configuring this virtual link. First, the error message you'll see on R1 is normal; that just means that R3 wants to form a virtual link but R1 doesn't; that error message will not appear again after you configure the virtual link.

Again, the ISDN link comes up. That's normal when the OSPF network topology changes. The link will go down when the idle-timeout hits zero, and it will not come back up.

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```
R1#show ip ospf virtual-link
Virtual Link OSPF_VL1 to router 33.33.33.33 is up
  Run as demand circuit
  DoNotAge LSA allowed.
  Transit area 13, via interface Serial1, Cost of using 195
  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
    Adjacency State FULL (Hello suppressed)
    Index 2/4, retransmission queue length 0, number of retransmission 1
    First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
    Last retransmission scan length is 1, maximum is 1
    Last retransmission scan time is 0 msec, maximum is 0 msec
```

You must see the adjacency state as FULL to know that the virtual link is up and running. Check R2's OSPF routing table.

```
R2#show ip route ospf
     1.0.0.0/32 is subnetted, 1 subnets
O IA    1.1.1.1 [110/65] via 172.12.123.1, 00:03:50, Serial0.123
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/260] via 172.12.123.1, 00:03:50, Serial0.123
     172.12.0.0/16 is variably subnetted, 3 subnets, 2 masks
O IA    172.12.13.0/24 [110/259] via 172.12.123.1, 00:03:50, Serial0.123
R2#ping 3.3.3.3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 112/116/120 ms
```

R3's loopback interface is back R2's routing table, and pings succeed.

Make sure you know the basic rules for configuring a virtual link, the syntax of the command, and when one is necessary and not necessary before taking the CCNA exams.

Before moving on to another protocol lab, remove OSPF from each router with the global command **no router ospf 1.**

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