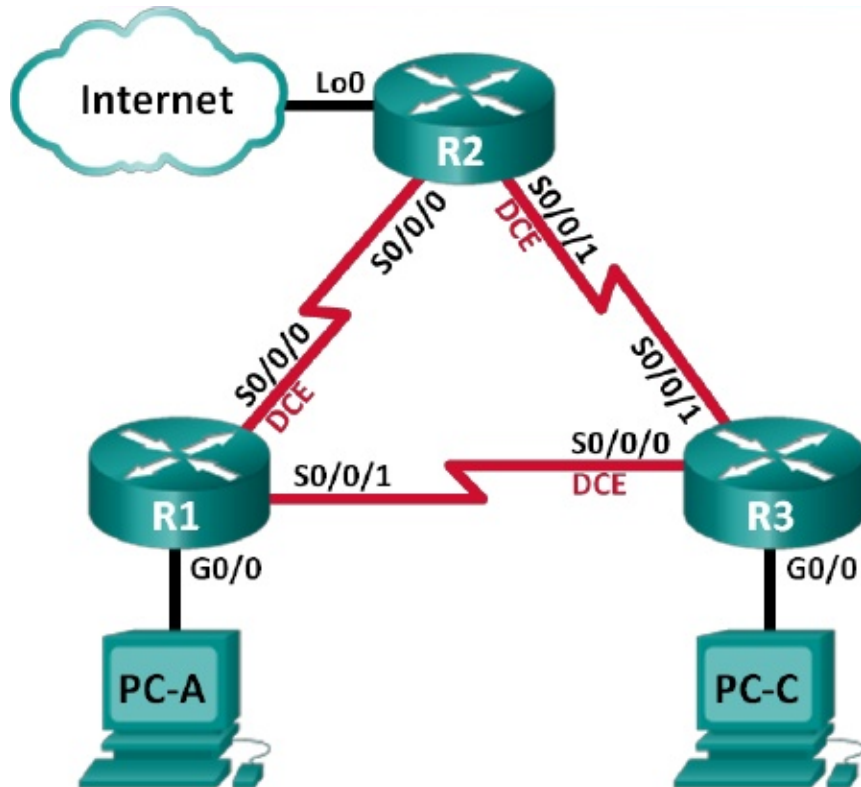


## Lab – Troubleshooting Advanced Single-Area OSPFv2 (Instructor Version)

**Instructor Note:** Red font color or Gray highlights indicate text that appears in the instructor copy only.

### Topology



## Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	G0/0	192.168.1.1	255.255.255.0	N/A
	S0/0/0 (DCE)	192.168.12.1	255.255.255.252	N/A
	S0/0/1	192.168.13.1	255.255.255.252	N/A
R2	Lo0	209.165.200.225	255.255.255.252	N/A
	S0/0/0	192.168.12.2	255.255.255.252	N/A
	S0/0/1 (DCE)	192.168.23.1	255.255.255.252	N/A
R3	G0/0	192.168.3.1	255.255.255.0	N/A
	S0/0/0 (DCE)	192.168.13.2	255.255.255.252	N/A
	S0/0/1	192.168.23.2	255.255.255.252	N/A
PC-A	NIC	192.168.1.3	255.255.255.0	192.168.1.1
PC-C	NIC	192.168.3.3	255.255.255.0	192.168.3.1

## Objectives

**Part 1: Build the Network and Load Device Configurations**

**Part 2: Troubleshoot OSPF**

## Background / Scenario

OSPF is a popular routing protocol used by businesses worldwide. A Network Administrator should be able to isolate OSPF issues and resolve those issues in a timely manner.

In this lab, you will troubleshoot a single-area OSPFv2 network and resolve all issues that exist.

**Note:** The routers used with CCNA hands-on labs are Cisco 1941 Integrated Services Routers (ISRs) with Cisco IOS Release 15.2(4)M3 (universalk9 image). Other routers and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and output produced might vary from what is shown in the labs. Refer to the Router Interface Summary Table at the end of this lab for the correct interface identifiers.

**Note:** Make sure that the routers have been erased and have no startup configurations. If you are unsure, contact your instructor.

**Instructor Note:** Refer to the Instructor Lab Manual for the procedures to initialize and reload devices.

## Required Resources

- 3 Routers (Cisco 1941 with Cisco IOS Release 15.2(4)M3 universal image or comparable)
- 3 PCs (Windows 7, Vista, or XP with terminal emulation program, such as Tera Term)
- Console cables to configure the Cisco IOS devices via the console ports
- Ethernet and serial cables, as shown in the topology

## Part 1: Build the Network and Load Device Configurations

In Part 1, you will set up the network topology and configure basic settings on the PC hosts and routers.

**Step 1: Cable the network as shown in the topology.**

**Step 2: Configure PC hosts.**

**Step 3: Load router configurations.**

Load the following configurations into the appropriate router. All routers have the same passwords. The privileged EXEC password is **class**. The password for console and vty lines is **cisco**.

**Router R1 Configuration:**

```
conf t
hostname R1
enable secret class
no ip domain lookup
interface GigabitEthernet0/0
 ip address 192.168.1.1 255.255.255.0
 duplex auto
 speed auto
 no shut
interface Serial0/0/0
 bandwidth 128
 ip address 192.168.12.1 255.255.255.252
 ip ospf message-digest-key 1 md5 MD5LINKS
 clock rate 128000
 no shut
interface Serial0/0/1
 bandwidth 64
! bandwidth 128

 ip ospf message-digest-key 1 md5 MD5LINKS
 ip address 192.168.13.1 255.255.255.252
 no shut
router ospf 1
 auto-cost reference-bandwidth 1000
! router-id 1.1.1.1
 area 0 authentication message-digest
 passive-interface g0/0
 network 192.168.1.0 0.0.0.255 area 0
 network 192.168.12.0 0.0.0.3 area 0
 network 192.168.13.0 0.0.0.3 area 0
banner motd ^
  Unauthorized Access is Prohibited!
^
line con 0
 password cisco
 logging synchronous
 login
line vty 0 4
```

```
password cisco
login
transport input all
end
```

### Router R2 Configuration:

```
conf t
hostname R2
enable secret class
no ip domain lookup
interface Loopback0
 ip address 209.165.200.225 255.255.255.252
interface Serial0/0/0
 bandwidth 182
! bandwidth 128
 ip ospf message-digest-key 1 md5 MD5LINKS
 ip address 192.168.12.2 255.255.255.252
 no shut
interface Serial0/0/1
 bandwidth 128
 ip ospf message-digest-key 1 md5 MD5LINKS
 ip address 192.168.23.1 255.255.255.252
 clock rate 128000
 no shut
router ospf 1
 router-id 2.2.2.2
 auto-cost reference-bandwidth 1000

 area 0 authentication message-digest
 passive-interface g0/0
 network 192.168.12.0 0.0.0.3 area 0
 network 192.168.23.0 0.0.0.3 area 0
! default-information originate
 ip route 0.0.0.0 0.0.0.0 Loopback0
 banner motd ^
   Unauthorized Access is Prohibited!
 ^
line con 0
 password cisco
 logging synchronous
 login
line vty 0 4
 password cisco
 login
 transport input all
end
```

### Router R3 Configuration:

```
conf t
hostname R3
enable secret class
no ip domain lookup

interface GigabitEthernet0/0
 ip address 192.168.3.1 255.255.255.0
 duplex auto
 speed auto
 no shut
interface Serial0/0/0
 bandwidth 128
 ip ospf message-digest-key 1 md5 MD5LINKS
 ip address 192.168.13.2 255.255.255.252
 clock rate 128000
 no shut
interface Serial0/0/1
 bandwidth 128
 ip address 192.168.23.2 255.255.255.252
 ! ip ospf message-digest-key 1 md5 MD5LINKS
 no shut
router ospf 1
 router-id 3.3.3.3
 ! auto-cost reference-bandwidth 1000
 area 0 authentication message-digest
 passive-interface g0/0
 network 192.168.3.0 0.0.0.255 area 0
 network 192.168.13.0 0.0.0.3 area 0
 network 192.168.23.0 0.0.0.3 area 0
banner motd ^
    Unauthorized Access is Prohibited!
^
line con 0
 password cisco
 logging synchronous
 login
line vty 0 4
 password cisco
 login
 transport input all
end
```

### Step 4: Test end-to-end connectivity.

All interfaces should be up and the PCs should be able to ping the default gateway.

## Part 2: Troubleshoot OSPF

In Part 2, verify that all routers have established neighbor adjacencies, and that all network routes are available.

### Additional OSPF Requirements:

- Each router should have the following router ID assignments:
  - R1 Router ID: **1.1.1.1**
  - R2 Router ID: **2.2.2.2**
  - R3 Router ID: **3.3.3.3**
- All serial interface clocking rates should be set at 128 Kb/s and a matching bandwidth setting should be available to allow OSPF cost metrics to be calculated correctly.
- The 1941 routers have Gigabit interfaces, so the default OSPF reference bandwidth should be adjusted to allow cost metrics to reflect appropriate costs for all interfaces.
- OSPF should propagate a default route to the Internet. This is simulated by using Loopback interface 0 on R2.
- All interfaces advertising OSPF routing information should be configured with MD5 authentication, using **MD5LINKS** as the key.

List the commands used during your OSPF troubleshooting process:

---

---

---

---

Answers may vary, but the list of commands can include:

- **clear ip ospf process**
- **show interface *interface***
- **show ip ospf neighbor**
- **show ip route**
- **show ip route ospf**
- **show ip protocols**
- **show ip ospf interface *interface***
- **show ip ospf interface brief**
- **show ip ospf database**
- **show ip ospf route**
- **show run**
- **show run | include router ospf**

List the changes made to resolve the OSPF issues. If no problems were found on the device, then respond with “no problems were found”.

### R1 Router:

---

```
router ospf 1
  router-id 1.1.1.1
interface s0/0/1
  bandwidth 128
end
clear ip ospf process
```

**R2 Router:**

```
router ospf 1
  default-information originate
interface s0/0/1
  bandwidth 128
end
clear ip ospf process
```

**R3 Router:**

```
router ospf 1
  auto-cost reference-bandwidth 1000
interface s0/0/1
  ip ospf message-digest-key 1 md5 MD5LINKS
end
clear ip ospf process
```

### Reflection

How would you change the network in this lab so all LAN traffic was routed through R2?

Answers may vary, but through the use of the **ip ospf cost** command the cost for the link between R1 and R3 could be adjusted to a number larger than the accumulated cost of the two serial links between R1 - R2, and R2 - R3. This adjusted cost would need to be applied to both sides of the R1 – R3 serial link.

## Router Interface Summary Table

Router Interface Summary				
Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2
1800	Fast Ethernet 0/0 (F0/0)	Fast Ethernet 0/1 (F0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
1900	Gigabit Ethernet 0/0 (G0/0)	Gigabit Ethernet 0/1 (G0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
2801	Fast Ethernet 0/0 (F0/0)	Fast Ethernet 0/1 (F0/1)	Serial 0/1/0 (S0/1/0)	Serial 0/1/1 (S0/1/1)
2811	Fast Ethernet 0/0 (F0/0)	Fast Ethernet 0/1 (F0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
2900	Gigabit Ethernet 0/0 (G0/0)	Gigabit Ethernet 0/1 (G0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)

**Note:** To find out how the router is configured, look at the interfaces to identify the type of router and how many interfaces the router has. There is no way to effectively list all the combinations of configurations for each router class. This table includes identifiers for the possible combinations of Ethernet and Serial interfaces in the device. The table does not include any other type of interface, even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in Cisco IOS commands to represent the interface.

## Device Configs

### Router R1 (Final)

```
R1#sh run
Building configuration...

Current configuration : 1760 bytes
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
memory-size iomem 15
!
ip cef
!
no ip domain lookup
```



## Lab – Troubleshooting Advanced Single-Area OSPFv2

---

```
no ipv6 cef
multilink bundle-name authenticated
!
interface Embedded-Service-Engine0/0
no ip address
shutdown
!
interface GigabitEthernet0/0
ip address 192.168.1.1 255.255.255.0
duplex auto
speed auto
!
interface GigabitEthernet0/1
no ip address
shutdown
duplex auto
speed auto
!
interface Serial0/0/0
bandwidth 128
ip address 192.168.12.1 255.255.255.252
ip ospf message-digest-key 1 md5 MD5LINKS
clock rate 128000
!
interface Serial0/0/1
bandwidth 128
ip address 192.168.13.1 255.255.255.252
ip ospf message-digest-key 1 md5 MD5LINKS
!
router ospf 1
router-id 1.1.1.1
auto-cost reference-bandwidth 1000
area 0 authentication message-digest
passive-interface GigabitEthernet0/0
network 192.168.1.0 0.0.0.255 area 0
network 192.168.12.0 0.0.0.3 area 0
network 192.168.13.0 0.0.0.3 area 0
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
control-plane
!
banner motd ^C
  Unauthorized Access is Prohibited!
^C
!
```

```
line con 0
password cisco
login
logging synchronous
line aux 0
line 2
no activation-character
no exec
transport preferred none
transport input all
transport output pad telnet rlogin lapb-ta mop udptn v120 ssh
stopbits 1
line vty 0 4
password cisco
login
transport input all
!
scheduler allocate 20000 1000
!
end
```

### Router R2 (Final)

```
R2#sh run
Building configuration...

Current configuration : 1804 bytes
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R2
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH6lwAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
memory-size iomem 15
!
ip cef
!
no ip domain lookup
no ipv6 cef
multilink bundle-name authenticated
!
interface Loopback0
```

## Lab – Troubleshooting Advanced Single-Area OSPFv2

---

```
ip address 209.165.200.225 255.255.255.252
!
interface Embedded-Service-Engine0/0
no ip address
shutdown
!
interface GigabitEthernet0/0
no ip address
shutdown
duplex auto
speed auto
!
interface GigabitEthernet0/1
no ip address
shutdown
duplex auto
speed auto
!
interface Serial0/0/0
bandwidth 128
ip address 192.168.12.2 255.255.255.252
ip ospf message-digest-key 1 md5 MD5LINKS
!
interface Serial0/0/1
bandwidth 128
ip address 192.168.23.1 255.255.255.252
ip ospf message-digest-key 1 md5 MD5LINKS
clock rate 128000
!
router ospf 1
router-id 2.2.2.2
auto-cost reference-bandwidth 1000
area 0 authentication message-digest
network 192.168.12.0 0.0.0.3 area 0
network 192.168.23.0 0.0.0.3 area 0
default-information originate
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
ip route 0.0.0.0 0.0.0.0 Loopback0
!
control-plane
!
banner motd ^C
  Unauthorized Access is Prohibited!
^C
```

```
!  
line con 0  
password cisco  
login  
logging synchronous  
line aux 0  
line 2  
no activation-character  
no exec  
transport preferred none  
transport input all  
transport output pad telnet rlogin lapb-ta mop udptn v120 ssh  
stopbits 1  
line vty 0 4  
password cisco  
login  
transport input all  
!  
scheduler allocate 20000 1000  
!  
end
```

### Router R3 (Final)

```
R3#sh run  
Building configuration...  
  
Current configuration : 1760 bytes  
!  
version 15.2  
service timestamps debug datetime msec  
service timestamps log datetime msec  
no service password-encryption  
!  
hostname R3  
!  
boot-start-marker  
boot-end-marker  
!  
enable secret 4 06YFDUHH6lwAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2  
!  
no aaa new-model  
memory-size iomem 15  
!  
ip cef  
!  
no ip domain lookup  
no ipv6 cef  
multilink bundle-name authenticated  
!
```

## Lab – Troubleshooting Advanced Single-Area OSPFv2

---

```
interface Embedded-Service-Engine0/0
no ip address
shutdown
!
interface GigabitEthernet0/0
ip address 192.168.3.1 255.255.255.0
duplex auto
speed auto
!
interface GigabitEthernet0/1
no ip address
shutdown
duplex auto
speed auto
!
interface Serial0/0/0
bandwidth 128
ip address 192.168.13.2 255.255.255.252
ip ospf message-digest-key 1 md5 MD5LINKS
clock rate 128000
!
interface Serial0/0/1
bandwidth 128
ip address 192.168.23.2 255.255.255.252
ip ospf message-digest-key 1 md5 MD5LINKS
!
router ospf 1
router-id 3.3.3.3
auto-cost reference-bandwidth 1000
area 0 authentication message-digest
passive-interface GigabitEthernet0/0
network 192.168.3.0 0.0.0.255 area 0
network 192.168.13.0 0.0.0.3 area 0
network 192.168.23.0 0.0.0.3 area 0
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
control-plane
!
banner motd ^C
  Unauthorized Access is Prohibited!
^C
!
line con 0
password cisco
login
```

```
logging synchronous
line aux 0
line 2
no activation-character
no exec
transport preferred none
transport input all
transport output pad telnet rlogin lapb-ta mop udptn v120 ssh
stopbits 1
line vty 0 4
password cisco
login
transport input all
!
scheduler allocate 20000 1000
!
end
```