Lab 11 – OSPF

Instructions:

- Pre-lab is to be completed before your lab class.
- You will be working in groups of 2 for this lab
- Each student will be configuring at least one router.
- Make sure you obtain all required screen captures and router output for all PC's and routers in your group. You will need them to answer your post lab.
- You will need:
  - All of the patch cables from your kit: 3 straight-throughs, and a cross-over cable.
  - Your textbook for this term.

What you need to submit and when:

- Complete the "Pre-lab – Lab 11" exercise on Blackboard, before the start of your lab period. (1/3 mark)
- Complete the in-lab part of the exercise (see below), before the end of your lab period. (1/3 mark)
- Complete the "Post-lab – Lab 11" exercise on Blackboard, before your next lab period. (1/3 mark)

Pre-Lab: Part 1 -Reading and Prepping for the lab.

1.1 Read Lab 11 before coming to class.

1.2 Read Chapter 11.

1.3 Complete the subnetting below and submit your answers on Blackboard.

1.4 Answer the pre-lab questions in the Blackboard pre-lab quiz before you lab period begins.

Pre-Lab: Part 2 - Subnetting – Calculate and submit on Blackboard

Complete the IP addressing based on the requirements set out below.

2.1 The starting network for the LANs and loopback interfaces is 172.18.18.0 /24. Start subnetting from the largest host requirement to the smallest.

- Network A – 100 hosts
- Network B – 30 hosts
- Network C - 52 hosts

2.1.1 Assign the **last** usable IP address to the gateway.

2.1.2 Assign the first usable address to the workstations.

2.2 The Serial links have a starting address of 192.168.10.224/28.

2.2.1 Assign the 1st subnet (192.168.10.224 /30) to Network E.

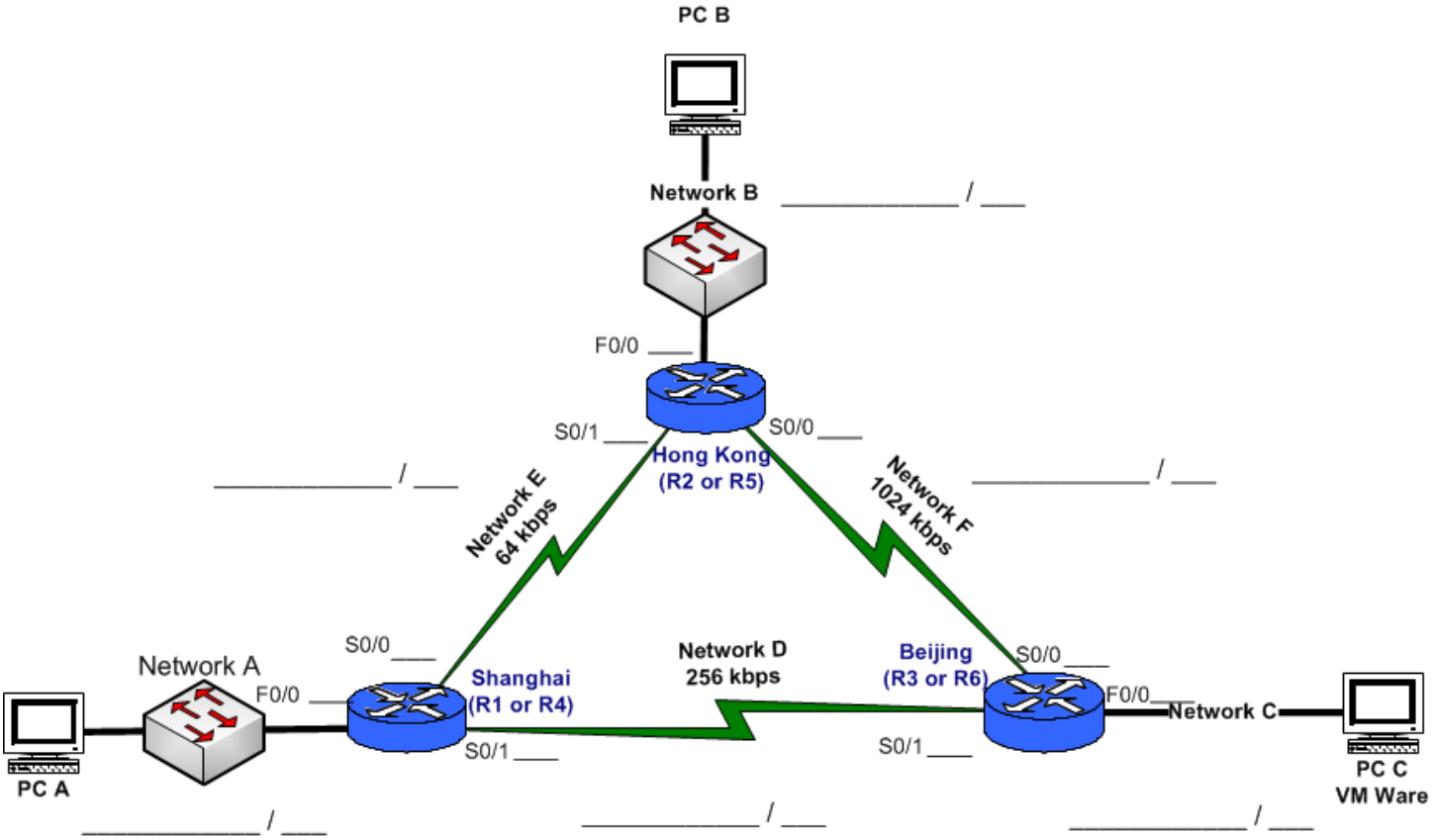
2.2.2 Assign the 2nd subnet to Network F.

2.2.3 Assign the 3rd subnet to Network D.

2.2.4 Assign the lower of the 2 IP addresses to the lower Router number (ex. R1 is lower than R2).

2.3 Add the addressing to the topology and fill-in the IP addressing chart on the next page.

2.4 Submit your answers to Pre-lab Subnetting Lab 11 found on Blackboard. This will allow you to check your subnetting.



IP Addressing Scheme

Device	Interface	IP address	Subnet Mask	Default Gateway
Shanghai (R1 or R4)	Serial 0/0			
	Serial 0/1			
	Fa 0/0			
Hong Kong (R2 or R5)	Serial 0/0			
	Serial 0/1			
	F0/0			
Beijing (R3 or R6)	Serial 0/0			
	Serial 0/1			
	Fa0/0			
WS A	NIC			
WS B	NIC			
WS C	NIC			

Scenario A

In this lab activity, there are two separate scenarios. In the first scenario, you will learn how to configure the routing protocol OSPF using the network shown in the Topology Diagram in Scenario A. The segments of the network have been subnetted using VLSM. OSPF is a classless routing protocol that can be used to provide subnet mask information in the routing updates. This will allow VLSM subnet information to be propagated throughout the network.

Part 1: Lab Setup

1.1 Cable the network according to the Topology Diagram.

1.2 Clear any existing configurations on the routers and switches.

1.3 Using the interface and the subnetting information that you have recorded, configure your router with the basic configuration tasks listed below:

1.3.1 Router hostnames

1.3.2 Configure the encrypted EXEC mode password as class

1.3.3 Disable DNS lookup.

1.3.4 Configure a message-of-the-day banner. **The banner must include your course number, section number and username… eg "pete0001 CST8270-013"**

1.3.5 Set the passwords on the Telnet (VTY) lines and console as cisco

1.3.6 Prevent unwanted messages from interrupting your commands as you type.

1.3.7 Configure an appropriate EXEC timeout on the console and vty lines.

1.3.8 Configure the appropriate interfaces, including the loopback interfaces, with:

- The correct IP address.
- An appropriate description.
- A clock rate if required
- Activate the interface.

1.3.9 **Verify the bandwidth settings all of your routers serial interfaces. They should all be set to 128 until you are told to change them. Change any that vary to 128 and re-verify.**

1.3.10 **DO NOT configure any routing yet.**

1.4 Assign your PC its IP address and test the PC configuration by pinging the default gateway.

1.5 Verify your basic connectivity**. Do not proceed until all PC's can ping their gateways, and all routers can ping their neighboring routers.**

Note: You will have to wait until your partner is done configuring his/her router.

What command do you use to check your routers IP address and interface status?

_____

- Verify that the directly connected networks are in the routing table for each router.

DO NOT PROCEED UNTIL ALL DIRECTLY CONNECTED NETWORKS ARE IN THE ROUTING TABLE

Basic OSPF Configuration Instructions

Use the `router ospf` command in global configuration mode to enable OSPF on the each router. Enter a process ID of 1 for the process-ID parameter.

```
Rx(config)#router ospf 1
Rx(config-router)#
```

Note: You can use different process-ids on each router, however to make life easier it is best if you used the same number.

The OSPF network command uses a combination of network-address and wildcard-mask similar to that which can be used by EIGRP. Unlike EIGRP, the wildcard mask in OSPF is always required. Use an area ID of 1 for the OSPF area-id parameter. 1 will be used for the OSPF area ID in all of the network statements in this topology. For example:

```
Rx(config-router)#network 172.16.1.16 0.0.0.15 area 1
Rx(config-router)#
```

Note: Unlike the process-id, the **area-id must be the same for all OSPF routers in the same routing domain**.

You may notice that when the network for the serial links are added to the OSPF configuration, the router sends a notification message to the console stating that a neighbor relationship with another OSPF router has been established. Something like this…

```
00:17:46: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.10.5 on Serial0/0/0 from LOADING
to FULL, Loading Done
```

Part 2: Configure OSPF on the routers

2.1 Using the instructions above configure OSPF on all three routers. Ensure that you advertise all the appropriate networks.

2.2 When all three routers are configured do the following:

- 2.2.1 Traceroute from PC A to PC B
- 2.2.2 Traceroute from PC A to PC C

2.3 Type `show ip ospf neighbor` to confirm that your router has established adjacencies with the other routers.

- 2.3.1 Copy and paste the neighbor adjacencies to notepad. Call this **LAB 11 – OSPF Neighbors.txt**

Check point #1

Show the following from all 3 routers:

- OSPF routing configurations (from show run cmd) ready for viewing in a single text file.
- OSPF Neighbors adjacencies from all 3 routers ready for viewing in a single text file.

Note: Be prepared to show any or all of this information live on the routers as well.

OSPF Router ID

The OSPF router ID is used to uniquely identify the router in the OSPF routing domain. A router ID is an IP address. Cisco routers derive the Router ID in one of three ways and with the following precedence:

a. **IP address configured with the OSPF router-id command.**
b. **Highest IP address of any of the router's loopback addresses.**
c. **Highest active IP address on any of the router's physical interfaces.**

Part 3: Configure OSPF Router IDs

3.1 Using the **topology** determine the current router IDs. Since no router IDs or loopback interfaces have been configured on the three routers, the router ID for each router is determined by the highest IP address of any active interface.

3.1.1 What is the router ID for SHANGHAI? _____

3.1.2 What is the router ID for HONG KONG? _____

3.1.3 What is the router ID for BEIJING? _____

3.2 Use **`show ip protocols`** to verify the Shanghai's router ID: _____

3.3 Use **`show ip ospf`** to verify the HONG KONG's router ID: _____

3.4 Use **`show ip ospf interface`** to verify the BEIJING's router ID: _____

3.5 Use loopback addresses to change the router IDs of the routers in the topology. Configure the following loopback interface on your router. Use loopback 0 for all routers.

SHANGHAI – 1.1.1.1/32
HONG KONG – 2.2.2.2 /32
BEIJING- 3.3.3.3/32

3.6 Reload the routers to force the new Router IDs to be used. When a new Router ID is configured, it will not be used until the OSPF process is restarted. Make sure that the current configuration is saved to NVRAM, and then use the reload command to restart each of the routers.

***You can also try using: `clear ip ospf process`**

3.7 Verify the router ID for each router.

3.7.1 When the router is reloaded, what is the router ID for SHANGHAI? _____

3.7.2 When the router is reloaded, what is the router ID for HONG KONG? _____

3.7.3 When the router is reloaded, what is the router ID for BEIJING? _____

3.8 Use the router-id command to change the router ID on your router. The syntax to set the router-id using the router-id command is:

```
Router(config)#router ospf 1
Router(config-router)#router-id [ip address]
```

Using the following addresses for the router id on your router:
SHANGHAI – 200.1.1.1
HONG KONG – 200.2.2.2
BEIJING- 200.3.3.3

3.9 Reload the routers to force the new Router IDs to be used. Verify the router ID for each router by use the `show ip ospf neighbor` command on all routers.

3.9.1 When the router is reloaded, what is the router ID for SHANGHAI? _____

3.9.2 When the router is reloaded, what is the router ID for HONG KONG? _____

3.9.3 When the router is reloaded, what is the router ID for BEIJING? _____

3.8 Copy and paste the output from **`show ip protocol`** notepad. Call this **Lab 11- Router ID.txt**

Check Point #2

- ❑ Live from your routers, show that your router have the latest router ids.

Part 4: Verify OSPF Operation

4.1 From the Beijing Router, use the `show ip protocols` command to view information about the routing protocol operation. Answer the following questions:

4.1.1 What is the routing protocol? _____

4.1.2 What is the router ID? _____

4.1.3 What networks is your router routing for?

_____

4.1.4 What sources is your router receiving routing information from? _____

4.2 Examine the routing table(s) and answer the following questions

4.2.1 What is OSPF admin distance? _____

4.2.2 What code does OSPF use in the routing table? _____

4.3 While you are viewing the routing table record the OSPF cost (for each router) to reach PC C.

4.3.1 What is the cost reach PC C from SHANGHAI? _____ _____

4.3.2 What is the cost reach PC C from HONG KONG? _____

4.3.3 What is the cost reach PC C from BEIJING? _____

The command used to view the cost on individual links is: `show ip ospf interface f0/0`

Notice: That unlike RIPv2 and EIGRP, OSPF does not automatically summarize at major network boundaries.

Part 5: Configure OSPF Cost

The bandwidth cmd is used to modify the bandwidth value used by the IOS in calculating the OSPF cost metric.

5.1 Use the bandwidth command to change the bandwidth of the serial interfaces of the routers. The bandwidth values are on the topology and need to be adjusted on **both ends** of the serial link.

5.2 Once all bandwidth values have been configured, use the `show ip ospf interface` command to verify the cost of the serial links.

5.3 Now what is the cost (for each router) to reach PC C.

5.3.1 What is the cost reach PC C from SHANGHAI? _____

5.3.2 What is the cost reach PC C from HONG KONG? _____

5.3.3 What is the cost reach PC C from BEIJING? _____

FYI ONLY - An alternative method to using the bandwidth command is to use the `ip ospf cost` command, which allows you to directly configure the cost.

```
R1(config)#interface serial0/0/0
R1(config-if)#ip ospf cost 1562
R1(config-if)#interface serial0/0/1
R1(config-if)#ip ospf cost 1562
```

Check Point #3

- Display the new bandwidth setting on the serial links.

Part 6: Redistribute an OSPF Default Route

6.1 Configure another loopback address on the BEIJING router to simulate a link to an ISP. Assign it ip address 172.30.1.1 255.255.255.252.

6.2 Create a default route using the loopback interface as the egress interface.

6.3 Using OSPF, share this route with the other routers. What is the command to do so?

_____

6.4 Verify that you have the default route on the other routers. What is the command to do so?

_____

6.5 What is the administrative distance for this route? _____

6.6 Copy and paste the 3 running configurations and routing tables to notepad. Call this **Lab 11- Final configs.txt**

Check Point #4

- Have the routing tables on display for the 3 routers.

Scenario B

In the second scenario, you will learn to configure OSPF on a multi-access network. You will also learn to use the OSPF election process to determine the designated router (DR), backup designated router (BDR), and DRother states

Background Information

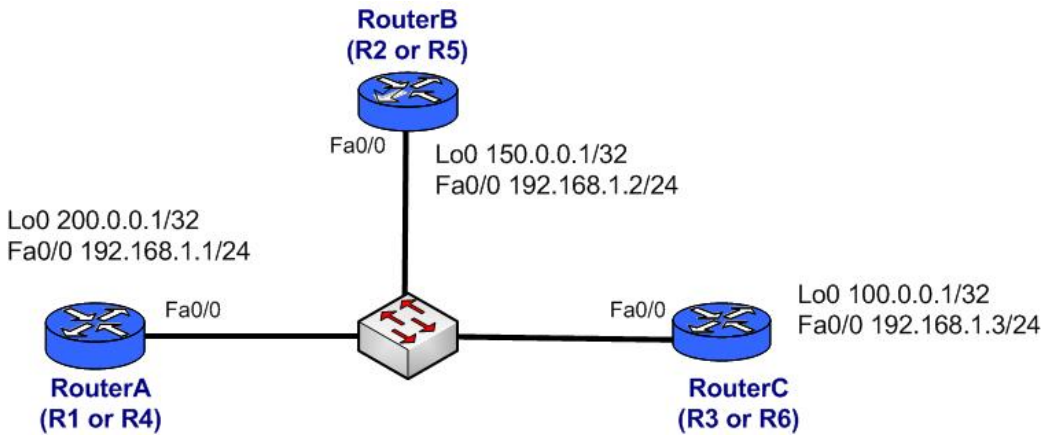
On multi-access networks, OSPF elects a Designated Router (DR) to be the collection and distribution point for LSAs sent and received. A Backup Designated Router (BDR) is also elected in case the Designated Router fails. All other routers become DROthers (this indicates a router that is neither the DR nor the BDR).

How do the DR and BDR get elected? The following criteria are applied:

1. DR: Router with the highest OSPF interface priority.
2. BDR: Router with the second highest OSPF interface priority.
3. If OSPF interface priorities are equal, the highest router ID is used to break the tie.

The DR and BDR election process takes place as soon as the first router has its interface enabled on the multiaccess network. This can happen as the routers are powered-on or when the OSPF network command for that interface is configured. If a new router enters the network after the DR and BDR have already been elected, it will not become the DR or BDR even if it has a higher OSPF interface priority or router ID than the current DR or BDR. (This may be the case on your routers.)

Normally you would configure the OSPF process on the router with the highest router ID first to ensure that this router becomes the DR.



Device	Interface	IP Address	Subnet Mask
RouterA (R1 or R4)	**Fa0/0**	192.168.1.1	255.255.255.0
	Loopback0	200.0.0.1	255.255.255.255
RouterB (R2 or R5)	**Fa0/0**	192.168.1.2	255.255.255.0
	Loopback0	150.0.0.1	255.255.255.255
RouterC (R3 or R6)	**Fa0/0**	192.168.1.3	255.255.255.0
	Loopback0	100.0.0.1	255.255.255.255

Part 1: Prepare the Network.

1.1 Cable a network that is similar to the one in the Topology Diagram.

1.2 Clear any existing configurations on the routers.

1.3 To save time we will only configure the following on each router:

- 1.3.1 Configure the router hostname.
- 1.3.2 The interfaces that are in use.

1.4. Configure OSPF.

- 1.4.1 This time, we'll use 22 as the area number.
- 1.4.2 No need to advertise the Loopback interfaces. They are being used as Router IDs only.

1.5 Ensure that each router can ping the other routers. Note: That you will only have directly connected networks in your routing table.

1.6 Save the running configuration to the NVRAM of the router.

1.7 Reboot all routers at the same time.

Part 2: Initial Information

2.1 Using the `show ip ospf interface fastethernet f0/0` command or to answer the following questions:

- 2.1.1 What is the router-id for RouterA? _____
- 2.1.2 What is the router-id for RouterB? _____
- 2.1.3 What is the router-id for RouterC? _____

2.2 Using the `show ip ospf neighbor` command or to answer the following questions:

- 2.2.1 What is RouterA role in this multi-access network? _____
- 2.2.2 What is RouterB role in this multi-access network? _____
- 2.2.3 What is RouterC role in this multi-access network? _____

Note: The roles of the routers will vary depending on which router boots first.

Part 3: Using the OSPF Priority to Determine the DR and BDR

You can use the `ip ospf priority interface` command to change the OSPF priority of the routers.

```
Router(config)#interface fastEthernet0/0
Router(config-if)#ip ospf priority 255
```

2.1 Set the router's priority to the following values:

- 2.1.1 Set RouterA's priority to 0 (A priority of 0 causes the router to ineligible to participate in an OSPF election and becomes a DROther)
- 2.1.2 Set RouterB's priority to 100
- 2.1.3 Set RouterC's priority to 150

2.2 Once everyone has configured their router's priority, shut down and re-enable the FastEthernet0/0 interfaces to force an OSPF election. Make sure that RouterC comes up first so that it 'wins' the election. It may take up to 40 seconds for the routers to send a hello packet.

2.3 Use the show `ip ospf neighbor` command on the routers to view the OSPF neighbor information for the routers. What are the roles for the 3 routers?

2.3.1 RouterA is a _____

2.3.2 RouterB is a _____

2.3.3 RouterC is a _____

Notice that even though the RouterA has a higher router ID than the other routers. RouterA has been set to a state of DRother because the OSPF priority has been set to 0.

Check-point #5

- ❑ Show the lab instructor the DR, BDR and the DROther routers.

Check POINT #6

- ❑ Have the lab instructor confirm that the routers are cleared.