The University of Jordan, Comp. Eng. Dept.
Spring 2023: Networks lab: Experiment 7
OSPFv2 and OSPFv3 (Problem Sheet)

Student Name:	ID:	Section Number:

Problem 1: Configuring OSPFv2 (IPv4) routing protocol

In this activity (i.e., Exp_7_Problem_1_OSPFv2.pka), you are requested to configure the OSPF for IPv4 routing protocol with multiple areas and virtual links, which were discussed thoroughly in the handout. Then, you are requested to configure the static and default routing for Internet access and ensure full connectivity between all devices in the network. Figure 1 shows the topology that you want to configure. The PCs and routers' interfaces are configured for you. Accordingly, routers have information about the direct networks that they have on their own interfaces. Routers will not exchange this information between themselves. We need to implement the OSPF routing protocol, which will insist they share this information. Tables 1 and 2 show the addressing of the networks and interfaces, respectively.

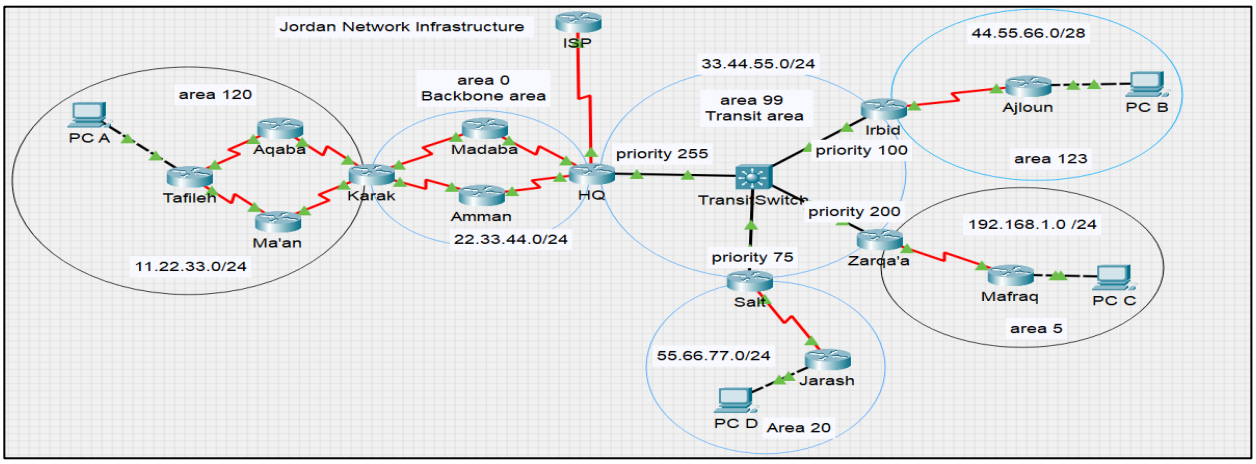

Figure 1. Network topology for problem 1.

Table 1: Network address for IPv4 configuration for problem 1

Routers	Network Address
Tafileh and PC A	11.22.33.0/28
Tafileh and Ma'an	11.22.33.16/28
Tafileh and Aqaba	11.22.33.32/28
Aqaba and Karak	11.22.33.64/28
Ma'an and Karak	11.22.33.48/28
Karak and Madaba	22.33.44.0/28
Karak and Amman	22.33.44.16/28
Madaba and HQ	22.33.44.48/28
Amman and HQ	22.33.44.32/28
HQ and Transient switch	33.44.55.0/24
Irbid and Transient switch	33.44.55.0/24
Irbid and Ajloun	44.55.66.0/28
Ajloun and PC B	44.55.66.16/28
Zarqa'a and Transient switch	33.44.55.0/24
Zarqa'a and Mafraq	192.168.1.0/30
Mafraq and PC C	192.168.1.4/30
Salt and Transient switch	33.44.55.0/24
Salt and Jarash	55.66.77.0/28
Jarash and PC D	55.66.77.16/28

Part 1: Configuring OSPF for IPv4 on all routers except ISP router using the following instructions:

1) Verify IP addressing and interfaces. Use the `show ip interface brief` command to verify that the IP addressing is correct and that the interfaces are active.
2) Configure all routers with OSPF routing except the ISP. In your configuration, make sure you do the following:
   - Enable the OSPF routing process on each router using a process ID number of 1.
   - Advertise directly connected networks with the correct wild mask and correct area number.
   - Configure LAN interfaces to not advertise OSPF updates as a passive interface on all routers.
   - To see the adjacency formed, type the following command: `log-adjacency-changes.`
   - Set a default route from the HQ router to the ISP using the exit interface.
   - Redistribute the default route from HQ router.
3) Set the OSPF priority on the interface Fast Ethernet 0/0 and the router ID as shown in the following table.

Router Name	OSPF priority	router ID
HQ router	255	33.44.55.254
Irbid router	100	44.55.66.1
Zarqa'a router	200	33.44.55.253
Salt router	75	55.66.77.1

4) The clear ip ospf process command is used to activate the RID on a router that is already running OSPF: `Router# clear ip ospf process`.
5) Configure **a summarized static route on the ISP** using the directly connected option. **Tip**: Each area has a summarized network address as shown in Figure 1.

Part 2: Verify Configurations

1) Verify full connectivity to all destinations between area 0 and other areas.
   - Every device between area 120, area 99, and area 0 should now be able to ping every other device inside this area. In addition, all devices should be able to ping the ISP.
     - ✓ Ping between the PC A and HQ router.
     - ✓ Ping between the PC A and Irbid router.
     - ✓ Ping between the PC A and Zaraqa'a router.
     - ✓ Ping between the PC A and Salt router.

   What is the result of ping?

   Answer:

   - Now try to ping between:
     - ✓ Ping between the PC A and PC B.
     - ✓ Ping between the PC A and PC C.
     - ✓ Ping between the PC A and PC D.

   What is the result of ping? Justify your answer?

   Answer:

2) View the routing tables using the appropriate command to view the routing table for HQ. Notice that HQ router has a full listing of all the networks. You also see the default route listed.
   - How does the OSPF appear in the routing table? **Take screen shot of HQ router'routing table.**

   Answer:

- Write the code and the AD for OSPF and for the default route listed in the routing table.

Answer:

3) View neighbors.
   - On the HQ, use the **`show ip ospf neighbor`** command to view the neighbor table and verify that OSPF has established an adjacency with the other routers. You should be able to see the Neighbor ID, priority value, state, and the interface of each adjacent router used to reach that OSPF neighbor. **Take screen shots of HQ router's neighbors table.**

Answer:

   - On the Irbid, use the **`show ip ospf neighbor`** command to view the neighbor table and verify that OSPF has established an adjacency with the other routers. You should be able to see the Neighbor ID, priority value, state, and the interface of each adjacent router used to reach that OSPF neighbor. **Take screen shots of Irbid router's neighbors' table.**

Answer:

4) View routing protocol information.
   - On the HQ router, use the `show ip protocols` command to view information about the routing protocol operation.
   - Answer the following questions?
     - ✓ What is the process ID of OSPF?_____
     - ✓ What is the router ID?_____
     - ✓ What is the number of areas?_____-
     - ✓ How do you know about the static route that is being distributed?_____
5) View the database. **Take screen shot of the HQ router' database.**

Answer:

6) On Salt Router, issue the `show ip route ospf | include 0.0.0.0` command to view statements specific to the default route. How is the static default route represented in the output? What is the administrative distance (AD) for the propagated route? Write here the statement.

Answer:

Part 3: Configuring virtual links:

1) We configure the virtual link between ABRs, and we use the `area [area #]virtual-link router-id` command.
2) To get start with the correct configuration of the virtual links:
   - Identify isolated areas that need to connect to area 0.

Answer:

   - Identify appropriate ABRs and make sure the above requirements are met.

Answer:

   - After determining these areas, you need **configure the virtual links between the ABRs of isolated areas and the HQ** under the OSPF process using the above command.
   - You must specify the router ID of ABRs. Use the following command `show ip ospf interface f0/0.` You need to configure the OSPF router ID and NOT the IP address of the ABR. If everything is OK, the isolated area will be directly connected to area 0 through our virtual link. Keep this in mind, that we configure the router ID for HQ manually.

- **Important note:** In case that your activity does not correct the virtual links on the HQ router, do the following steps to reset the OSPF process: go the HQ router, in the privileged mode type `show run` command, copy the commands that related to the OSPF, then go to configuration mode, and type the `no router ospf 1`, then paste your commands.

Part 4: Verification of the configuration:

- Verify the configuration of virtual links on HQ, by using this command `show ip ospf virtual-links.` **Take screen shot of HQ's output.**

Answer:

- Verify the configuration of virtual links on Irbid router by using this command `show ip ospf virtual-links.` **Take screen shot of Irbid's router output.**

Answer:

- Verify the OSPF neighbors on the HQ router. **Take a screen shot of the output.** Explain how the virtual links appears.

Answer:

- On Zaraq'a router verify whether OSPF routes are learnt by using this command `show ip route ospf.` **Take a screen shot of the output.**

Answer:

- If you look at the LSDB on the HQ router you will see that the virtual link shows up as a type 1 router LSA. You can also see DNA which means do not age. by using this command `show ip ospf database.` **Take a screen shot of the output.**

Answer:

Part 4: Verification of the configuration:

- Ping ISP from PC A.
- Ping PC B from PC A.
- Ping PC C from PC A.
- Ping PC D from PC A.

Table 2: Addressing table for IPv4 configuration for problem 1

Device	Interface	Area	IPv4 Address	Subnet mask	Default Gateway	Connected with
PC A	Fa0/0	120	11.22.33.14/28	255.255.255.240	11.22.33.1	FastEthernet0/0 of Tafileh Router
Tafileh Router	FastEthernet0/0	120	11.22.33.1	255.255.255.240	--	PC X
	Serial0/0/0	120	11.22.33.38	255.255.255.240	--	Serial0/0/0 of Aqaba Router
	Serial0/0/1	120	11.22.33.18	255.255.255.240	--	Serial0/0/1of Ma'an Router
Aqaba Router	Serial0/0/0	120	11.22.33.39	255.255.255.240	--	Serial0/0/0 of Tafileh Router
	Serial0/0/1	120	11.22.33.65	255.255.255.240	--	Serial0/0/1 of Karak Router
Ma'an Router	Serial0/0/0	120	11.22.33.49	255.255.255.240	--	Serial0/0/0 of Karak Router
	Serial0/0/1	120	11.22.33.19	255.255.255.240	--	Serial0/0/0 of Tafileh Router
Karak Router	Serial0/0/0	120	11.22.33.62	255.255.255.240	--	Serial0/0/0 of Ma'an Router
	Serial0/0/1	120	11.22.33.78	255.255.255.240	--	Serial0/0/1 of Aqaba Router
	Serial0/1/0	0	22.33.44.1	255.255.255.240	--	Serial0/1/0 of Madaba Router
	Serial0/1/1	0	22.33.44.18	255.255.255.240	--	Serial0/1/1 of Amman Router
Madaba Router	Serial0/0/0	0	22.33.44.49	255.255.255.240	--	HQ Router
	Serial0/1/0	0	22.33.44.2	255.255.255.240	--	Serial0/1/0 of Karak Router
Amman Router	Serial0/0/1	0	22.33.44.33	255.255.255.240	--	HQ Router
	Serial0/1/1	0	22.33.44.19	255.255.255.240	--	Serial0/1/1 of Karak Router
HQ Router	FastEthernet0/0	99	33.44.55.254	255.255.255.0	--	FastEthernet0/1 of Transient Switch
	Serial0/0/0	0	22.33.44.62	255.255.255.240	--	Madaba Router
	Serial0/0/1	0	22.33.44.46	255.255.255.240	--	Amman Router
	Serial0/1/0	--	200.200.100.2	255.255.255.252	--	ISP Router
Irbid Router	FastEthernet0/0	99	33.44.55.252	255.255.255.0	--	FastEthernet0/2 Transient Switch
	Serial0/0/0	123	44.55.66.1	255.255.255.240	--	Serial0/0/0 of Ajloun Router
Ajloun Router	FastEthernet0/0	123	44.55.66.17	255.255.255.240	--	PC Y
	Serial0/0/0	123	44.55.66.14	255.255.255.240	--	Serial0/0/0 of Irbid Router
PC B	Fa0/0	123	44.55.66.30	255.255.255.240	44.55.66.17	FastEthernet0/0 of Ajloun Router
Zarqa'a Router	FastEthernet0/0	99	33.44.55.253	255.255.255.0	--	FastEthernet0/3 Transient Switch
	Serial0/0/0	5	192.168.1.1	255.255.255.252	--	Serial0/3/0 of Mafraq Router
Mafraq Router	FastEthernet0/0	5	192.168.1.6	255.255.255.252		PC C
	Serial0/3/0	5	192.168.1.2	255.255.255.252	--	Serial0/0/0 of Zarqa'a Router
PC C	Fa0/0	5	192.168.1.5	255.255.255.252	192.168.1.6	FastEthernet0/0 of Mafraq Router
Salt Router	FastEthernet0/0	99	33.44.55.250	255.255.255.0	--	FastEthernet0/4 Transient Switch
	Serial0/0/0	20	55.66.77.1	255.255.255.240	--	Serial0/0/0 of Jarash Router
Jarash Router	FastEthernet0/0	20	55.66.77.17	255.255.255.240	--	PC D
	Serial0/0/0	20	55.66.77.14	255.255.255.240	--	Serial0/0/0 of Salt Router
PC D	Fa0/0	20	55.66.77.30	255.255.255.240	55.66.77.17	FastEthernet0/0 of Jarash Router
ISP Router	Serial0/0/0	--	200.200.100.1	255.255.255.252	--	Serial0/1/0 of HQ Router

Problem 2: Configuring OSPV3 (IPv6) routing protocol

In this activity, you will configure an IPv6 network with the OSPFv3 routing protocol using the instructions and information given in Figure 2 and Table 3. In a few words, in this activity (Exp 7_Problem_2_OSPFv3.pka), you will build an IPv6 routing table by OSPFv3. This is a configuration activity for a normal OSPF process. The IPv6 addresses provided in Table 3. Figure 2 shows the topology that you want to configure.

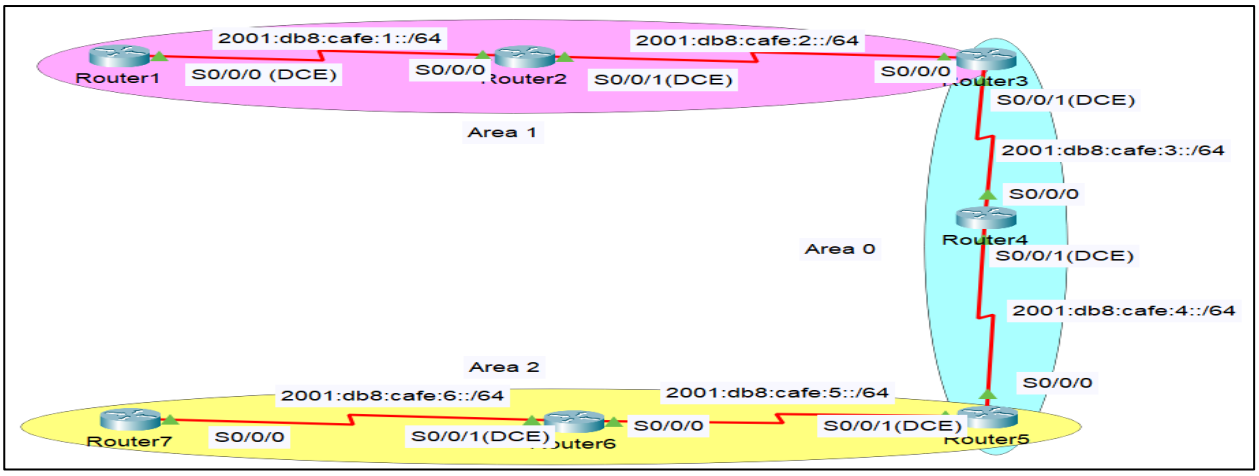

Figure 2. Network topology for problem 2.

Table 2: Addressing table for IPv6 configuration for problem 2

Device	Interface	IPv6 address	Link-local
Router 1	S0/0/0 (DCE)	2001:db8:cafe:1::1/64	FE80::1
	Loopback0	2001:100:1::1/64	FE80::1
Router 2	S0/0/0	2001:db8:cafe:1::2/64	FE80::2
	S0/0/1 (DCE)	2001:db8:cafe:2::1/64	FE80::2
	Loopback0	2001:100:2::2/64	FE80::2
Router 3	S0/0/0	2001:db8:cafe:2::2/64	FE80::3
	S0/0/1 (DCE)	2001:db8:cafe:3::1/64	FE80::3
	Loopback0	2001:100:3::3/64	FE80::3
Router 4	S0/0/0	2001:db8:cafe:3::2/64	FE80::4
	S0/0/1 (DCE)	2001:db8:cafe:4::1/64	FE80::4
	Loopback0	2001:100:4::4/64	FE80::4
Router 5	S0/0/0	2001:db8:cafe:4::2/64	FE80::5
	S0/0/1 (DCE)	2001:db8:cafe:5::1/64	FE80::5
	Loopback0	2001:100:5::5/64	FE80::5
Router 6	S0/0/0	2001:db8:cafe:5::2/64	FE80::6
	S0/0/1 (DCE)	2001:db8:cafe:6::1/64	FE80::6
	Loopback0	2001:100:6::6/64	FE80::6
Router 7	S0/0/0	2001:db8:cafe:6::2/64	FE80::7
	Loopback0	2001:100:7::7/64	FE80::7

Part 1: Configuring a network with IPv6 and OSPV3:

1. **On all routers, configure the following:**
   - Enable IPv6 routing.
   - Make sure that the Loopback0 prefix of each router is registered in the routing table with a prefix length of /64.

- Configure the loopback interface for each router with the assigned IPv6 link-local address, and global unicast IPv6 address, as shown in Table 2.
- Other routers' interfaces were configured for you with the assigned IPv6 link-local address, and global unicast IPv6 address, and the clock rate for serial DCE interfaces were set to 64000. Moreover, the interfaces were enabled.

Part 2: Configuration and Verification

1. **Enabling OSPFv3 on each router:**
   - Enable OSPFv3 for each router interface with process ID equal to 1.
   - Set the router ID of each router will be X.X.X.X, where X is the Router number (i.e., for router 1 the router ID is 1.1.1.1, and so on). Since it is considered that some routers do not have IPv4 addresses, **the router ID is basically configured statically in OSPFv3.**
   - Type the following command: `log-adjacency-changes`
2. **Enabling OSPFv3 on each router' interfaces:**
   - Enable OSPFv3 based on the area layout shown in Figure 2 for each router interface with process ID equal to 1.
3. **Verify Neighbors:**
   - Verify that OSPFv3 neighbors have been established by using the `show ipv6 ospf neighbor` command on Router 3. **Take a screen shot of the output.**

Answer:
4. **Verify OSPFv3 routes**
   - Use the appropriate command to show the routing table of Router 5. OSPF now appears with connected (C) and local (L) routes in the routing table. All networks have an entry. Verify whether OSPFv3 routes can be learned by using the `show ipv6 route ospf` command on Router 5. **Take a screen shot of the output.**

Answer:
5. **Verify full connectivity to all destinations.**
   - Every device should now be able to ping every other device inside the network. Try to ping this IPv6 address 2001:db8:cafe:1::1 from Router 7. **Take a screen shot of the output.**

Answer: