CCNA ENSA **Lab 1**

Team-No.: 05

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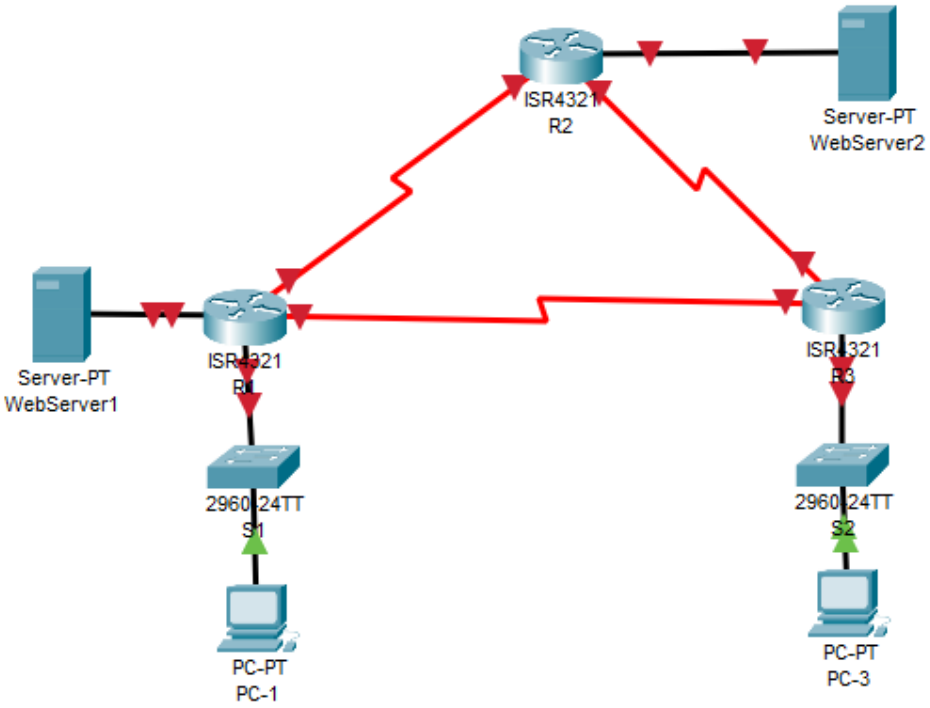
ENSA Module Group Exams **1-2 OSPF Concepts and Configuration**

Basic Single-Area OSPFv2

OSPFv2 Adjustments

OSPFv2 Security



Homework

Lab Instructions

Task 1	Basic Single-Area OSPFv2
Task 2	OSPFv2 Adjustments
Task 3	OSPFv2 Security

Deliverables and Due Dates

Homework / Lab Preparation

Part 1: Cisco IOS Basic Configuration Commands

a. Read the **Lab Instructions** of this Lab

b. Check the **IOS Command List**, provided for the Labs and review configuration commands.

Part 2: OSPFv2 Routing Configuration

a. Given are network addresses and network masks. Calculate the wildcard mask for the following networks:

Network address	Network Mask	Wildcard Mask
192.168.1.0	255.255.255.0	0.0.0.255
192.168.12.64	255.255.255.224	0.0.0.31
192.168.5.4	255.255.255.252	0.0.0.3

b. Configure a static IP default route with exit interface S0/1/0 on router R1.

```
R1(config)# ip route 0.0.0.0 0.0.0.0 s0/1/0
```

c. Start a OSPFv2 routing process with process number 11 on router R1 and configure some options.

- Router ID is 1.2.3.4
- Advertise networks 192.168.12.64 / 27 and 10.0.10.16 / 30 in OSPF Area 0
- Reference bitrate is 1 Gbit/s
- Prevent OSPF messages for LAN interface g0/0/1
- Default route is advertised by OSPF

```
R1(config)# router ospf 11
R1(. . . )# router-id 1.2.3.4
R1(. . . )# network 192.168.12.64  0.0.0.31 area 0
R1(. . . )# network 10.0.10.16 0.0.0.3 area 0
R1(. . . )# auto-cost reference-bandwidth 1000
R1(. . . )# passive-interface g0/0/1
R1(. . . )# default-information originate
```

d. Display the IPv4 routing table of router R1

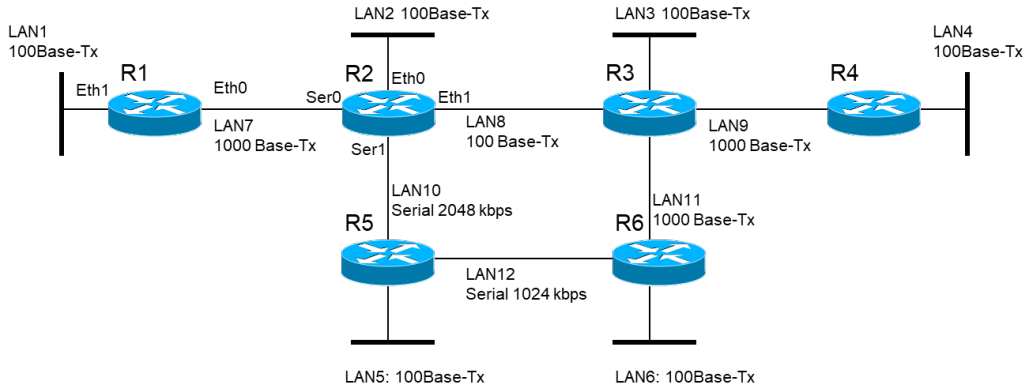
```
R1# show ip route
```

e. OSPF link costs and paths

The OSPF link cost c is calculated: $link\ cost\ = \frac{reference\ bandwidth}{link\ bandwidth}$, an integer value with a minimum of 1 and default reference bandwidth of 100 Mbps.

The OSPF metric of a route from a router to a destination network is the sum of all links on the path to the destination network including the destination network. $m = \sum_i c_i$

Given is the following topology.



Calculate the OSPF Link Costs of the following Links:

LAN	OSPF Link Cost
LAN6	1
LAN7	0.1
LAN8	1
LAN10	48
LAN11	0.1
LAN12	97

Calculate the OSPF metric of the route from router R1 to LAN6:

f. OSPF Authentication

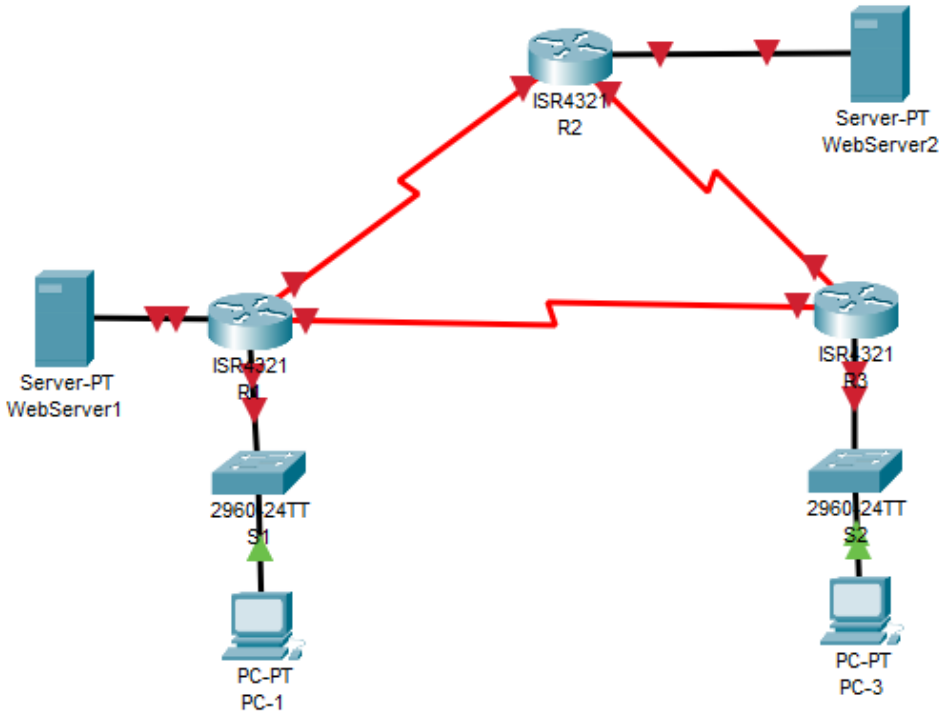
Create OSPF authentication in global mode. Use MD5 hashing and message authentication code **class456**. The serial interface S0/1/1 is connected to the neighbor router.

```
R1(config)# interface serial s0/1/1
R1(config-router)# # ip ospf message-digest-key 1 md5 class456

R1(config)# interface serial s0/1/1
R1(config-if)#  ip ospf authentication message-digest
```

Task 1 – Basic Single-Area OSPFv2 Routing

Topology



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	G0/0/0	192.168.10.1	255.255.255.0	N/A
	G0/0/1	192.168.11.1	255.255.255.0	N/A
	S0/1/0 (DCE)	10.1.1.1	255.255.255.252	N/A
	S0/1/1	10.1.3.1	255.255.255.252	N/A
R2	G0/0/0	209.165.200.225	255.255.255.224	N/A
	S0/1/0	10.1.1.2	255.255.255.252	N/A
	S0/1/1 (DCE)	10.1.2.1	255.255.255.252	N/A
R3	G0/0/0	192.168.30.1	255.255.255.0	N/A
	S0/1/0	10.1.2.2	255.255.255.252	N/A
	S0/1/1 (DCE)	10.1.3.2	255.255.255.252	N/A
PC-1	NIC	192.168.10.11	255.255.255.0	192.168.10.1
PC-3	NIC	192.168.30.33	255.255.255.0	192.168.30.1
WebServer1	NIC	192.168.11.2	255.255.255.0	192.168.11.1
WebServer2	NIC	209.165.200.226	255.255.255.224	209.165.200.225

Note: Depending on the slot in which you implemented the NIM-2T module, serial interface names may be different.

Background / Scenario

Open Shortest Path First (OSPF) is a link-state routing protocol for IP networks. OSPFv2 is defined for IPv4 networks, and OSPFv3 is defined for IPv6 networks. OSPF detects changes in the topology, such as link failures, and converges on a new loop-free routing structure very quickly. It computes each route using Dijkstra's algorithm, a shortest path first algorithm.

Part 1: Build the Switched Network and Verify Connectivity

Step 1: Build topology in Packet Tracer.

COVID-19 Version: Build topology in **Packet Tracer**. Use and re-label the following devices:

a. Build the network with ISR4321 router, 2960 switches, PCs and Servers in Packet Tracer. Rename the devices.

b. Cable the network according to the topology with straight-through TP cables  .

c. Implement NIM-2T modules at each router, and connect these interfaces by serial cables. 

d. We will use the CLI window of the network devices directly for configurations.

Step 2: Configure the PC hosts and Web Servers

Assign IP addresses and default gateways to the PCs and Webservers according to the Addressing Table.

Step 3: Basic settings for each router.

a. Disable DNS lookup.

b. Configure the device name.

c. Assign **class** as the encrypted privileged EXEC mode password.

d. Assign **cisco** as console password, set console logging to synchronous mode, enable login.

e. Assign **cisco** as vty password, and enable login.

f. Encrypt plain text passwords.

g. Save the running configuration to the startup configuration file.

Step 4: Ethernet and Serial Interface at each routers R1, R2, and R3

a. All Ethernet interfaces: Configure the IPv4 addresses listed in the Addressing Table and switch-on the interfaces.

b. All Serial interfaces: Configure the IPv4 addresses listed in the Addressing Table,
- Set the clock rate for all DCE serial interfaces to **128 kHz,**
- (DCE or DTE V.35 interface mode can be checked by **show controllers serial <x/y/z>**)
- and switch-on interfaces.

Note: Depending on how you implemented the serial cable, DCE location may be flipped.

c. Save the running configuration to the startup configuration file.

Step 5: Test router connectivity.

Neighbored routers should be able to ping one another.

a. Ping from R1 to R2. Connectivity (y/n)? yes

b. Ping from R1 to R3. Connectivity (y/n)? yes

c. Ping from R2 to R3. Connectivity (y/n)? yes

Note: Troubleshoot, if connectivity is not successful.

Part 2: Basic OSPFv2 Routing

Step 1: Configure OSPF on all routers R1-R3.

a. Router R1: Use the **router ospf** command in global configuration mode to enable OSPF on LAN router R1 with process ID 1. **Note:** The OSPF process id is kept locally and has no meaning to other routers on the network. We select the OSPF area ID of 0.

- Router R1 shall get the router ID 1.1.1.1
- Advertise all connected networks in OSPF area 0
- Networks must be advertised with wildcard mask, which is the inverted network mask. Mask 255.255.255.0 is wildcard 0.0.0.255, mask 255.255.255.252 is wildcard 0.0.0.3.

How many networks are to be advertised on R1? 4

b. Configure OSPF on R2, Router-ID is 2.2.2.2, in the same OSPF area.

Do not advertise the network to Webserver2 !!!!

How many networks are to be advertised on R2? 3

c. Configure OSPF on R3, Router-ID is 3.3.3.3, in the same OSPF area.

How many networks are to be advertised on R3? 3

Step 2: Verify OSPF settings and neighbor adjacencies

a. Router R1: Check the OSPF neighbors list, (**show ip ospf neighbor**). [110/6486] via 10.1.3.2, 00:04:40, Serial0/1/1

Which neighbor(s) is (are) present at R1?

```
3.3.3.3         0   FULL/  -        00:00:33    10.1.3.2        Serial0/1/1
2.2.2.2         0   FULL/  -        00:00:37    10.1.1.2        Serial0/1/0
```

b. Router R1: Issue the **show ip protocols** command to verify OSPF settings

How many networks are routed? 4

Which distance is given to neighbors? 110

c. Router R3: Issue the **show ip protocols** command to verify OSPF settings

How many networks are routed? 3

Which distance is given to neighbors? 110

Step 3: Verify OSPF routing information

a. Router R1: Verify that all networks are displayed in the routing tables (**show ip route**).

Note: Troubleshoot, if a network is not displayed in the routing table of R1.

Record the metrics of the following remote networks on R1:

Which [AD/metric] is given to the network 10.1.2.0/30? via 10.1.1.2,Serial0/1/0
via 10.1.3.2, Serial0/1/1

Which [AD/metric] is given to the network 192.168.30.0/24? directly connected, Serial0/1/1

Step 4: Verify OSPF interface settings.

a. Router R1: Issue the **show ip interface** command to display a summary of OSPF-enabled interfaces.

How many interfaces are in OSPF area 0? #show ip ospf interface

4

Record OSPF timer intervals at interface S0/1/0?

```
Serial0/1/0 is up, line protocol is up
  Internet address is 10.1.1.1/30, Area 0
  Process ID 1, Router ID 1.1.1.1, Network Type POINT-TO-POINT, Cost: 64
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:09
```

Record OSPF timer intervals at interface G0/0/0?

```
GigabitEthernet0/0/0 is up, line protocol is up
  Internet address is 192.168.10.1/24, Area 0
  Process ID 1, Router ID 1.1.1.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 1.1.1.1, Interface address 192.168.10.1
  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 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 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
```

Does router R1 send OSPF messages from G0/0/0 into the LAN?

Is this a useful and secure action of router R1?

1000Mbps/100Mbps=1

Step 5: Verify PC-C connectivity.

All PCs should be able to ping all routers and LANs, but not the R2 G0/0/0 interface to the Webserver2.

a. Ping from PC-1 to R1. Connectivity (y/n)? yes

b. Ping from PC-1 to R2. Connectivity (y/n)? yes

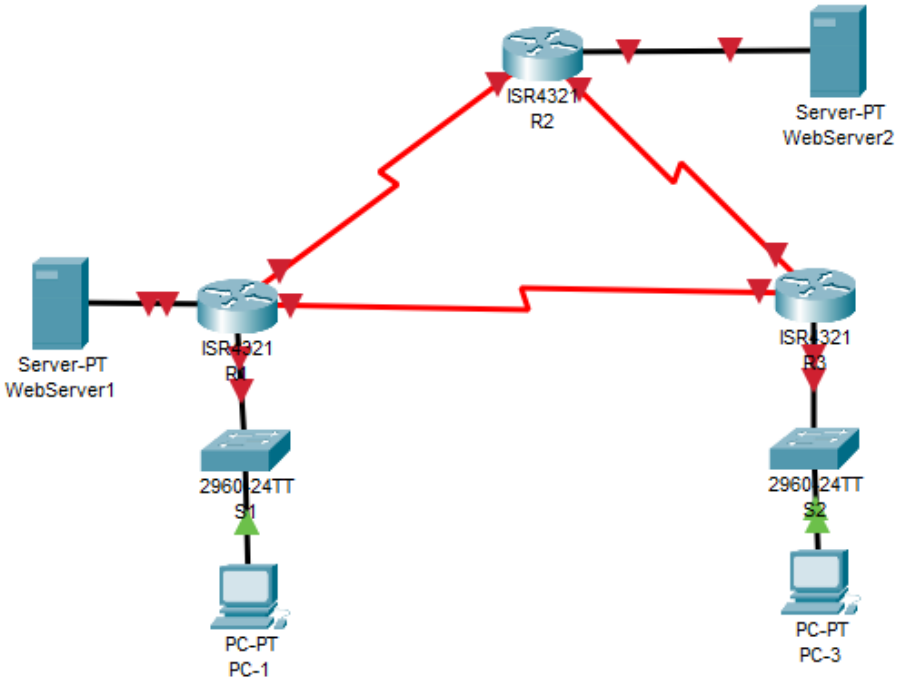
c. Ping from PC-3 to R2. Connectivity (y/n)? yes

d. Ping from PC-3 to PC-1. Connectivity (y/n)? yes

Note: Troubleshoot, if connectivity is not successful.

Task 2- OSPFv2 Adjustments

Topology



We continue with the Topology and Addressing Table.

Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	G0/0/0	192.168.10.1	255.255.255.0	N/A
	G0/0/1	192.168.11.1	255.255.255.0	N/A
	S0/1/0 (DCE)	10.1.1.1	255.255.255.252	N/A
	S0/1/1	10.1.3.1	255.255.255.252	N/A
R2	G0/0/0	209.165.200.225	255.255.255.224	N/A
	S0/1/0	10.1.1.2	255.255.255.252	N/A
	S0/1/1 (DCE)	10.1.2.1	255.255.255.252	N/A
R3	G0/0/0	192.168.30.1	255.255.255.0	N/A
	S0/1/0	10.1.2.2	255.255.255.252	N/A
	S0/1/1 (DCE)	10.1.3.2	255.255.255.252	N/A
PC-1	NIC	192.168.10.11	255.255.255.0	192.168.10.1
PC-3	NIC	192.168.30.33	255.255.255.0	192.168.30.1
WebServer1	NIC	192.168.11.2	255.255.255.0	192.168.11.1
WebServer2	NIC	209.165.200.226	255.255.255.224	209.165.200.225

Part 1: Configure and Verify a Default Route

A default route identifies the gateway to which the router sends all IP packets for which it does not have a learned or static route. A default static route is a static route with 0.0.0.0 as the destination IP address and /0 subnet mask. This is commonly referred to as a "quad zero" route.

Step 1: Create and distribute default route

a. In a default route, either the next-hop IP address or exit interface can be specified. Configure a default route at the R2 router with using the exit interface of G0/0/0.

Record the required command: ip route 0.0.0.0 0.0.0.0 g0/0/0

b. View the routing table to verify the new static route entry.

How is this new route marked in the routing table of R2? Gateway of last resort is 0.0.0.0 to network 0.0.0.0

c. Distribute the default route in OSPF.

Record the required command: #router ospf 1
#default-information originate

d. Check the routing table on R3.

How is the default route represented in the routing table of router R3? Gateway of last resort is 10.1.2.1 to network 0.0.0.0

Step 2: Verify OSPF settings and neighbor adjacencies

a. Router R2: Issue the **show ip protocols** command to verify OSPF settings

How many networks are routed? 3

Which distance is given to neighbors? 110

Which OSPF roles / OSPF router type has R2? 1

Step 3: Verify end-to-end connectivity.

a. Ping from PC-3 to the Webserver2. Connectivity (y/n)? yes

Note: Troubleshoot, if connectivity is not successful.

Part 2: Configure OSPF Passive Interfaces

The **passive-interface** command prevents routing updates from being sent through the specified router interface. This is commonly done to reduce traffic on the LANs as they do not need to receive dynamic routing protocol communication.

a. Issue the **show ip ospf interface G0/0/0** command on R1. Notice the timer indicating when the next Hello packet is expected. Hello packets are sent every 10 seconds and are used between OSPF routers to verify that their neighbors are up.

In how many seconds will the next Hello message been sent? 5seconds

b. Switch-off OSPF forwarding at interface G0/0/0. Issue the **passive-interface** command in the router process to change the G0/0/0 interface on R1 to passive.

c. Confirm OSPF interface status by **show ip ospf interface G0/0/0** command.

Is interface G0/0/0 passive now? yes

Part 3: Change OSPF Metric Cost Reference

Step 1: Change the reference bandwidth on the routers.

Important note: The default reference-bandwidth for OSPF is 100Mb/s (Fast Ethernet speed). However, most modern infrastructure devices have links that are faster than 100Mb/s. Because the OSPF cost

metric must be an integer, all links with transmission speeds of 100Mb/s or higher have a cost of 1. This results in Fast Ethernet, Gigabit Ethernet and 10G Ethernet interfaces all having the same cost.

Therefore, the reference-bandwidth must be changed to a higher value to accommodate networks with links faster that 100Mb/s.

a. Router R1: Use **show ip route ospf** command to determine the route to network 192.168.30.0/24.

Which OSPF [AD/metric] is given to that network: via 10.1.3.2 ,Serial0/1/1

b. Router R1: Use **show interface** command to view the default bandwidth setting for G0/0/0.

Which bandwidth (BW) parameter is used on the G0/0/0 interface? BW 1000000 Kbit =1000Mb

c. Router R1: Issue the **show ip ospf interface <interface>** command to check the link costs for interface G0/0/0 and interface S0/1/1.

Which OSPF link cost is given to the G0/0/0 interface? 1

Which OSPF link cost is given to the S0/1/1 interface? 64

d. The metric adds all costs of all links from router R1 to PC-C including the destination network.

Calculate the OSPF metric of the OSPF path from router R1 to PC-C LAN network with the default OSPF reference bandwidth of 100 Mbps. 64+1=65

Does your calculation match the OSPF route metric found in Step1 a)? yes

e. All Routers: Issue the **auto-cost reference-bandwidth 1000** command on R1, R2 and R3 to change the default reference bandwidth setting in the OSPF router process.

With this setting, 1 Gb/s interfaces will have a cost of 1, and 100Mb/s interfaces will have a cost of 10.

f. Router R1: Re-issue the **show ip ospf interface** command to view the new cost of interface G0/0/0, and interface S0/1/1.

Which OSPF cost is given to the G0/0/0 interface? 10

Which OSPF cost is given to the S0/1/1 interface? 6476

g. Router R1: Re-issue the **show ip route ospf** command.

Which [AD/metric] is given to the network 192.168.30.0/24 now? [110/6486] via 10.1.3.2, 00:04:40, Serial0/1/1

Step 2: Change the route cost.

OSPF uses the bandwidth setting to calculate the cost for a link by default. However, you can override this calculation by manually setting the cost of a link using the **ip ospf cost** command.

Note: Manipulating link costs using the **ip ospf cost** command is the easiest and preferred method for changing OSPF route costs. In addition to changing the cost based on bandwidth, a network administrator may have other reasons for changing the cost of a route, such as preference for a particular service provider or the actual monetary cost of a link or route.

a. Check the path from PC-1 to PC-3 by traceroute. Record the hops.

```
1   0 ms    0 ms    1 ms    192.168.10.1
2   0 ms    1 ms    0 ms    10.1.3.2
3   *      10 ms    0 ms    192.168.30.33
```

b. Router R1: Apply the **ip ospf cost 31250** command to the S0/1/1 interface.
Router R3: Apply the **ip ospf cost 31250** command to the S0/1/1 interface.

Verify your answer by the **show ip route ospf** command.

Router R1: Which entrance for [AD/metric] is given now to the network 192.168.30.0/24? 110/12962

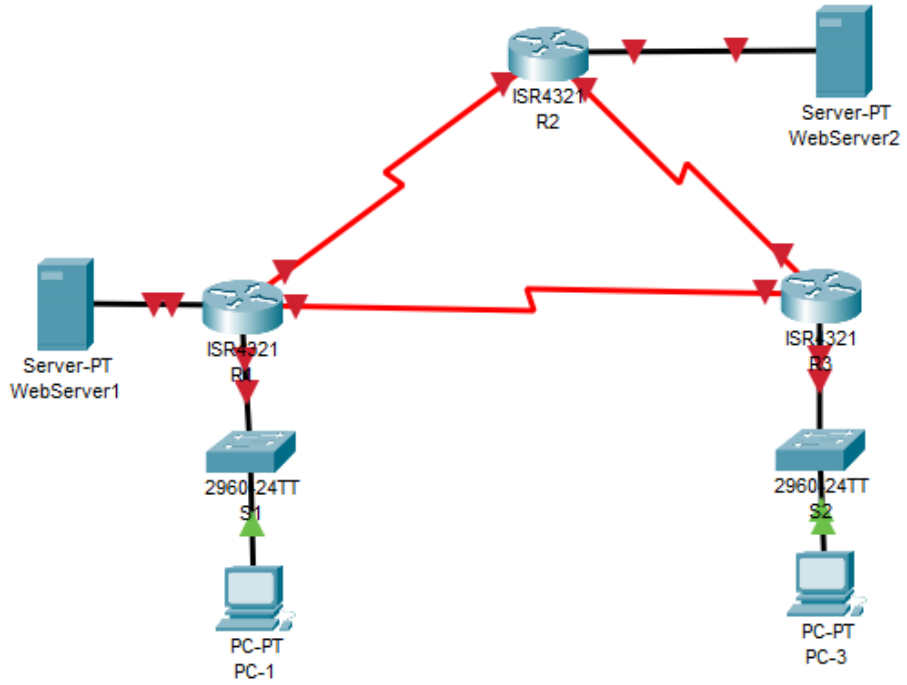
Which path is now the best OSPF path? [110/12962] via 10.1.1.2, 00:02:14, Serial0/1/0

c. Again, check the path from PC-1 to PC-3 by traceroute. Record the hops.

```
1   0 ms    1 ms    0 ms    192.168.10.1
2   1 ms    2 ms    1 ms    10.1.1.2
3   2 ms    6 ms    2 ms    10.1.2.2
4   2 ms    7 ms    2 ms    192.168.30.33
```

Task 3- OSPFv2 Security

Topology



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	G0/0/1	192.168.11.1	255.255.255.0	N/A
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	S0/1/1	10.1.3.1	255.255.255.252	N/A
R2	G0/0/0	209.165.200.225	255.255.255.224	N/A
	S0/1/0	10.1.1.2	255.255.255.252	N/A
	S0/1/1 (DCE)	10.1.2.1	255.255.255.252	N/A
R3	G0/0/0	192.168.30.1	255.255.255.0	N/A
	S0/1/0	10.1.2.2	255.255.255.252	N/A
	S0/1/1 (DCE)	10.1.3.2	255.255.255.252	N/A
PC-1	NIC	192.168.10.11	255.255.255.0	192.168.10.1
PC-3	NIC	192.168.30.33	255.255.255.0	192.168.30.1
WebServer1	NIC	192.168.11.2	255.255.255.0	192.168.11.1
WebServer2	NIC	209.165.200.226	255.255.255.224	209.165.200.225

Part 1: MD5 authentication for OSPF neighbors

Step 1: Check basic OSPF configuration first

a. Test connectivity by a ping from PC-1 to Webserver2. Successful? yes

b. Test connectivity by a ping from PC-3 to Webserver2. Successful? yes

c. Why is it a good idea to verify that OSPF is functioning correctly before configuring OSPF authentication? to prevent a rogue router from injecting false routing information and therefore causing a Denial-of-Service attack

Step 2: Global configuration of OSPF hashed-MD5 authentication

a. Router R1: Configure global OSPF MD5 authentication in router process.

b. Router R1: Configure OSPF MD5 authentication key **Cisco123** at serial interfaces.

c. Router R2: Configure global OSPF MD5 authentication in router process.

d. Router R2: Configure OSPF MD5 authentication key **Cisco123** at serial interfaces.

Step 3: Only interface configuration of OSPF hashed-MD5 authentication

a. Router R3: Configure OSPF MD5 authentication and OSPF MD5 authentication key **Cisco123** at each serial interface

Step 4: Verify OSPF adjacencies have been re-established.

a. Issue the **show ip ospf neighbor** command again to verify that adjacencies have been re-established after MD5 authentication was implemented.

R1 neighbor(s):
```
3.3.3.3         0   FULL/  -        00:00:32    10.1.3.2        Serial0/1/1
2.2.2.2         0   FULL/  -        00:00:32    10.1.1.2        Serial0/1/0
```

R2 neighbor(s):
```
1.1.1.1         0   FULL/  -        00:00:36    10.1.1.1        Serial0/1/0
3.3.3.3         0   FULL/  -        00:00:36    10.1.2.2        Serial0/1/1
```

R3 neighbor(s):
```
1.1.1.1         0   FULL/  -        00:00:37    10.1.3.1        Serial0/1/1
2.2.2.2         0   FULL/  -        00:00:37    10.1.2.1        Serial0/1/0
```

Note: If neighbor adjacencies are missing, evaluate and correct authentication od Step 2 or Step3.

Step 5: Check OSPF interafces and costs

a. Router R1: Issue the **show ip ospf interface** command to display ospf information of interfaces.

Interface G0/0/0 OSPF Costs: 1

Interface G0/0/1 OSPF Costs: 1

Interface S0/1/0 OSPF Costs: 64

Interface S0/1/1 OSPF Costs: 31250

Did the OSPF interface costs change by OSPF authentication? yes

Step 6: Check OSPF connectivity again

a. Test connectivity by a ping from PC-1 to Webserver2. Connectivity (y/n)? yes

Note: Troubleshoot, if connectivity is not successful.

Deliverables

Lab Teams

This lab may be solved in teams of max. 3 students. All teams have to provide their deliverables in time.

Teams are grouped into 2 groups, which have different due dates and presentation dates.

Module Group Exams

Each team member must solve the requested **Module Group Exams** before delivery date.

Deliverables

Each teams delivers the following documents and files:

- One **PDF-File (.pdf)** with the completed **Homework and Instructions**.
  All tasks and questions must be answered.
- One **PacketTracer-File** (.pkt) in PacketTracer Version 8 with your **final configuration**.
- One **Text-File in** ASCII-Format (.txt, simple Text Editor) with the **running configurations of Router R1.**

Due Dates

Group 1	Teams 1-10	Due Date
	Module Group Exams 1-2	16.5.- EOB
	Deliverable Upload	16.5. - EOB
	CCNA ZOOM Presentation	19.5. - 16:45 ff.

Group 2	Teams 11-20	Due Date
	Module Group Exams 1-2	23.5. - EOB
	Deliverable Upload	23.5. - EOB
	CCNA ZOOM Presentation	26.5. - 16:45 ff.