

CMPE 206 – Computer Network Design

Lab 2

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Task1: Understand the Mechanism of Link-State Routing Protocol Open Shortest Path First (OSPF):

Quiz:

1A: Routers R5, R6, R7, R8, R9, R10, R11, and R12 are IRs. These routers have all interfaces in the same area.

1B: Routers R2, R3, and R4 are ABRs. These three routers have interfaces in two separate areas. So, they are ABRs.

1C: Routers R1, R2, R3, and R4 are BRs. These 4 routers are backbone routers because they all have at least one interface in the backbone area (Area 0).

1D: Router R1 is ASBR. This router connects the OSPF network to the internet (external network), and likely advertises a default route into the OSPF domain.

1E: No, it is not valid because it is not a correct OSPF design and will cause problems because Area 1 does not have an ABR connected to the backbone area, Area 0. All OSPF areas must have at least one ABR connected to the backbone area, if we connect R2 to R3, then R2 will be disconnected from the backbone area.

1F: No, it is non-contiguous. OSPF interfaces in the same subnet must be in the same area. Instead of all being connected, half of area of 1 is to the left most and another half is to the right most. This kind of network design is not allowed in OSPF and will cause problems.

2. **B** (Signal-area OSPF must use area 0), **F** (The OSPF process ID must match the area number).

For B: Although, it is common practice to use Area 0 for single-area OSPF, we can actually use any area.

For F: The OSPF process ID does not have to match the area number. In fact, in multi-area OSPF, there will be multiple areas operating in a single process. So, it is impossible to match the process ID to all area IDs. The other statements are all true.

3. **C** (R1(config-router)# network 10.0.12.0 0.0.1.255 area 0).

This is the only option that contains both IP addresses in its range. So, it is the only one that activates OSPF on both interfaces.

Option A: It is not correct because it only covers from 10.0.12.1 to 10.0.12.254 (i.e., 10.0.12.0/24) which is G0/1 only.

Option B: It is not correct because the wildcard mask itself is not valid.

Option D: It is not the correct option because it only covers from 10.0.8.1 to 10.0.11.254 (i.e., 10.0.8.0/22) which is neither G0/1 nor G0/2.

4. **B** (R1(config)# ip route 0.0.0.0 0.0.0.0 203.0.113.2

R1(config)# router ospf 1

R1(config-router)# default-information originate).

The correct option is B, which configures a default route and then advertises it into OSPF using the default-information originate command.

Option A simply configures two network commands which activates OSPF on the specified interfaces.

Option C activates OSPF on all interfaces with an IP address, since all IP addresses match 0.0.0.0/0.

Option D is not a real command.

5. **A.** The correct answer is A, router-id 1.1.1.1, entered in OSPF configuration mode. The command to manually configure the EIGRP router ID is `eigrp router-id`, but for OSPF it is just 'router-id'.

Option C configures an IP address on a loopback interface. If the router ID is not manually configured, this IP address might become the OSPF routerID, but it is different than manually configuring the router ID.

6. Down -> Init -> 2-way -> Exstart -> Exchange -> Loading -> Full.

7. **C** (Fast Ethernet, Gigabit Ethernet, and 10 Gigabit Ethernet interfaces have the same cost.). Option C is the correct answer. As the default cost is 100Mbps (which is Fast Ethernet interface bandwidth), and the cost less than 1 is converted to 1, the Fast Ethernet, Gigabit Ethernet, and 10 Gigabit Ethernet has the same cost which is 1.

Cost = Ref. Bandwidth / Interface Bandwidth

Cost (FaEth) = 100Mbps / 100Mbps = 1

Cost (GigaEth) = 100Mbps / 1000Mbps = 1

Cost (10 GigaEth) = 100Mbps / 10000Mbps = 1

8. **C** (R1(config-router)# auto-cost reference bandwidth 10000). Option C is correct because this command can be used to make a fast ethernet interface have an OSPF cost of 100.

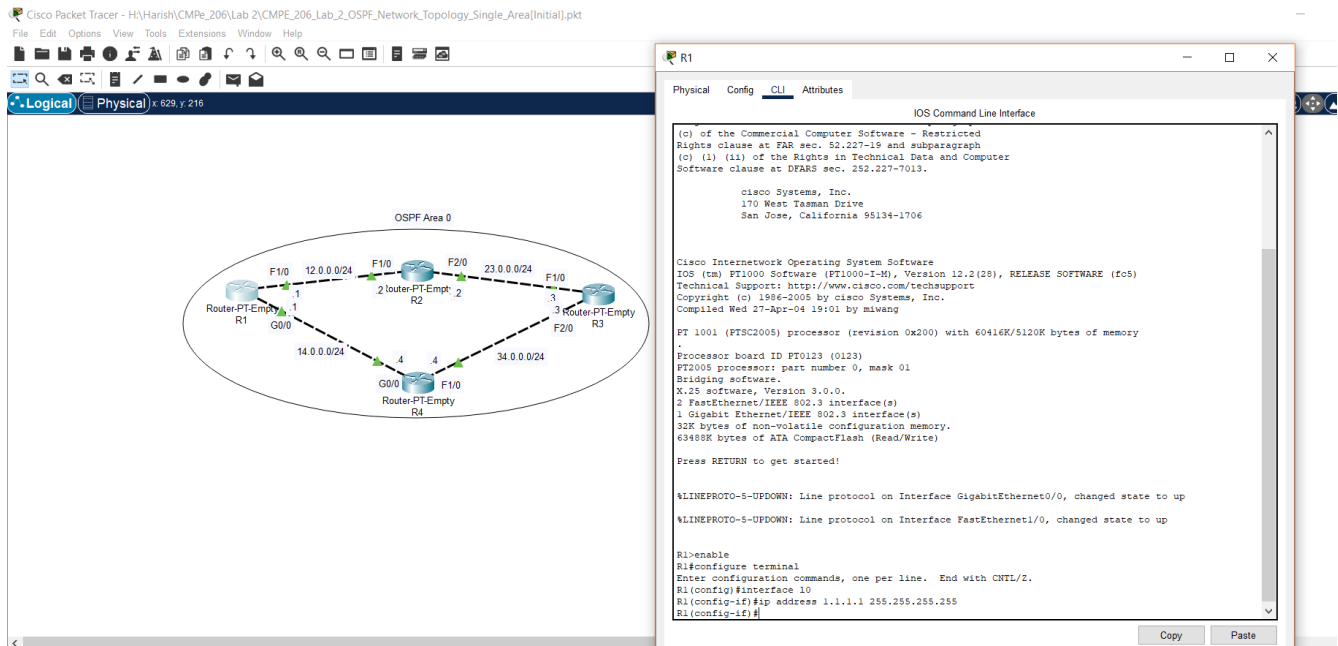
Cost (FaEth) = 10000Mbps / 100Mbps = 100.

9. **B.** The default OSPF hello and dead timers are 10sec and 40sec respectively.

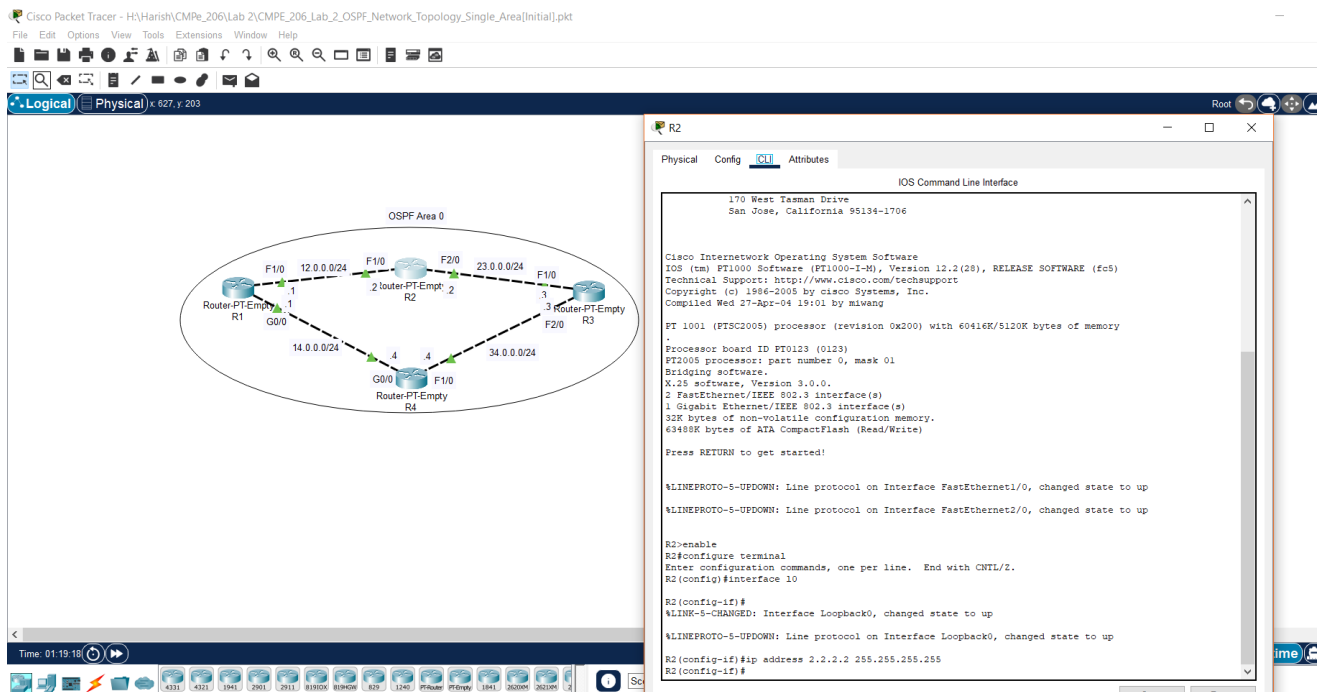
Task 2: Configure Router with Loopback Address:

Performed all the steps for configuring router with loopback address.

a. Screenshot for R1.



b. Screenshot for R2.



c. Screenshot for R3.

Cisco Packet Tracer - H:\Harish\CMPE_206\Lab 2\CMPE_206_Lab_2_OSPF_Network_Topology_Single_Area[Initial].pkt

File Edit Options View Tools Extensions Window Help

Logical Physical x 873, y 579

OSPF Area 0

Router-PT-Empty R1 F1/0 12.0.0.0/24 F1/0 1
Router-PT-Empty R2 F2/0 23.0.0.0/24 F1/0 2
Router-PT-Empty R3 F2/0 34.0.0.0/24 F1/0 3
Router-PT-Empty R4 G0/0 14.0.0.0/24 G0/0 4

Time: 01:20:20

R3

Physical Config CLI Attributes

IOS Command Line Interface

170 West Tasman Drive
San Jose, California 95134-1706

Cisco Internetwork Operating System Software
IOS (tm) PT1000 Software (PT1000-I-N), Version 12.2(28), RELEASE SOFTWARE (fc5)
Technical Support: <http://www.cisco.com/techsupport>
Copyright (c) 1986-2005 by Cisco Systems, Inc.
Compiled Wed 27-Apr-04 19:01 by mlwang

PT 1001 (PTSC2005) processor (revision 0x200) with 60416K/5120K bytes of memory
Processor board ID PT0123 (0123)
PT2005 processor: part number 0, mask 01
Bridging software.
X.25 software, Version 3.0.0.
2 FastEthernet/IEEE 802.3 interface(s)
1 Gigabit Ethernet/IEEE 802.3 interface(s)
32K bytes of non-volatile configuration memory.
63488K bytes of ATA CompactFlash (Read/Write)

Press RETURN to get started!

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/0, changed state to up

R3>enable
R3#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#interface 10
R3(config-if)#
%LINK-5-CHANGED: Interface Loopback0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R3(config-if)#ip address 3.3.3.3 255.255.255.255
R3(config-if)#

d. Screenshot for R4.

Cisco Packet Tracer - H:\Harish\CMPE_206\Lab 2\CMPE_206_Lab_2_OSPF_Network_Topology_Single_Area[Initial].pkt

File Edit Options View Tools Extensions Window Help

Logical Physical x 1555, y 450

OSPF Area 0

Router-PT-Empty R1 F1/0 12.0.0.0/24 F1/0 1
Router-PT-Empty R2 F2/0 23.0.0.0/24 F1/0 2
Router-PT-Empty R3 F2/0 34.0.0.0/24 F1/0 3
Router-PT-Empty R4 G0/0 14.0.0.0/24 G0/0 4

Time: 01:24:31

R4

Physical Config CLI Attributes

IOS Command Line Interface

170 West Tasman Drive
San Jose, California 95134-1706

Cisco Internetwork Operating System Software
IOS (tm) PT1000 Software (PT1000-I-N), Version 12.2(28), RELEASE SOFTWARE (fc5)
Technical Support: <http://www.cisco.com/techsupport>
Copyright (c) 1986-2005 by Cisco Systems, Inc.
Compiled Wed 27-Apr-04 19:01 by mlwang

PT 1001 (PTSC2005) processor (revision 0x200) with 60416K/5120K bytes of memory
Processor board ID PT0123 (0123)
PT2005 processor: part number 0, mask 01
Bridging software.
X.25 software, Version 3.0.0.
2 FastEthernet/IEEE 802.3 interface(s)
1 Gigabit Ethernet/IEEE 802.3 interface(s)
32K bytes of non-volatile configuration memory.
63488K bytes of ATA CompactFlash (Read/Write)

Press RETURN to get started!

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up

R4>enable
R4#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R4(config)#interface 10
R4(config-if)#
%LINK-5-CHANGED: Interface Loopback0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R4(config-if)#ip address 4.4.4.4 255.255.255.255
R4(config-if)#

Task3: Configure Router with OSPF and LSAs Message Sending:

Performed all the steps for configuring router with OSPF and LSAs message sending.

a. Screenshot for configuring R1 with OSPF and enabling LSAs message sending.

The screenshot displays the Cisco Packet Tracer interface. On the left, a network diagram shows OSPF Area 0 with four routers: R1, R2, R3, and R4. R1 is connected to R2 via F1/0 (12.0.0.0/24) and F1/0 (23.0.0.0/24). R2 is connected to R3 via F2/0 (23.0.0.0/24) and F1/0 (23.0.0.0/24). R3 is connected to R4 via F2/0 (34.0.0.0/24) and F1/0 (34.0.0.0/24). R4 is connected to R1 via G0/0 (14.0.0.0/24) and F1/0 (14.0.0.0/24). On the right, the CLI window for R1 shows the following configuration:

```
R1>configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#interface 10
R1(config-if)#ip address 1.1.1.1 255.255.255.255
R1(config-if)#
R1>
R1 con0 is now available

Press RETURN to get started.

R1>enable
R1#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#router ospf 1
R1(config-router)#network 12.0.0.0 0.0.0.255 area 0
R1(config-router)#network 14.0.0.0 0.0.0.255 area 0
R1(config-router)#network 1.1.1.1 0.0.0.0 area 0
R1(config-router)#
```

b. Screenshot for configuring R2 with OSPF and enabling LSAs message sending.

The screenshot displays the Cisco Packet Tracer interface. On the left, the same network diagram as in the previous screenshot is shown. On the right, the CLI window for R2 shows the following configuration:

```
R2>enable
R2#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#router ospf 2
R2(config-router)#network 12.0.0.0 0.0.0.255 area 0
R2(config-router)#network 23.0.0.0 0.0.0.255 area 0
R2(config-router)#network 2.2.2.2 0.0.0.0 area 0
R2(config-router)#
```

c. Screenshot for configuring R3 with OSPF and enabling LSAs message sending.

The screenshot displays the Cisco Packet Tracer interface. On the left, a network diagram shows four routers (R1, R2, R3, R4) connected in a ring topology within OSPF Area 0. R1 is connected to R2 (12.0.0.0/24), R2 to R3 (23.0.0.0/24), R3 to R4 (34.0.0.0/24), and R4 to R1 (14.0.0.0/24). On the right, the CLI window for R3 is open, showing the following configuration commands:

```
R3>enable
R3#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#router ospf 3
R3(config-router)#network 23.0.0.0 0.0.0.255 area 0
R3(config-router)#network 34.0.0.0
10:29:18: %OSPF-5-ADJCHG: Process 3, Nbr 2.2.2.2 on FastEthernet1/0 from LOADING to FULL, Loading Done
% Incomplete command.
R3(config-router)#network 34.0.0.0 0.0.0.255 area 0
R3(config-router)#network 3.3.3.3 0.0.0.0 area 0
R3(config-router)#
```

d. Screenshot for configuring R4 with OSPF and enabling LSAs message sending.

The screenshot displays the Cisco Packet Tracer interface. On the left, the same network diagram as in the previous screenshot is shown. On the right, the CLI window for R4 is open, showing the following configuration commands:

```
R4>enable
R4#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R4(config)#router ospf 4
R4(config-router)#network 34.0.0.0 0.0.0.255 area 0
R4(config-router)#network
10:31:43: %OSPF-5-ADJCHG: Process 4, Nbr 3.3.3.3 on FastEthernet1/0 from LOADING to FULL, Loading Done
% Incomplete command.
R4(config-router)#network 14.0.0.0 0.0.0.255 area 0
R4(config-router)#network 4.4.4.4 0.0.0.0 area 0
10:32:27: %OSPF-5-ADJCHG: Process 4, Nbr 1.1.1.1 on GigabitEthernet0/0 from LOADING to FULL, Loading Done
R4(config-router)#network 4.4.4.4 0.0.0.0 area 0
R4(config-router)#
```

e. Screenshot for examining the current OSPF neighbor and route information for R1.

The screenshot displays the Cisco Packet Tracer interface with a network topology in OSPF Area 0. The topology includes four routers: R1 (Router-PT-Empty), R2 (Router-PT-Empty), R3 (Router-PT-Empty), and R4 (Router-PT-Empty). R1 is connected to R2 via F1/0 (12.0.0.0/24) and F2/0 (23.0.0.0/24). R2 is connected to R3 via F1/0 (23.0.0.0/24) and F2/0 (34.0.0.0/24). R3 is connected to R4 via F1/0 (34.0.0.0/24) and F2/0 (14.0.0.0/24). R4 is connected to R1 via F1/0 (14.0.0.0/24) and F2/0 (12.0.0.0/24). The CLI window for R1 shows the following output:

```
R1>enable
R1#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#router ospf 1
R1(config-router)#do show ip ospf neighbor

Neighbor ID      Pri   State       Dead Time   Address        Interface
4.4.4.4          1     FULL/DR     00:00:34    14.0.0.4       GigabitEthernet0/0
2.2.2.2          1     FULL/DR     00:00:38    12.0.0.2       FastEthernet1/0

R1(config-router)#do show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
        D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
        i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
        * - candidate default, U - per-user static route, o - ODR
        P - periodic downloaded static route

Gateway of last resort is not set

1.0.0.0/32 is subnetted, 1 subnets
1.1.1.1 is directly connected, Loopback0
C    2.0.0.0/32 is subnetted, 1 subnets
2.2.2.2 [110/2] via 12.0.0.2, 00:15:39, FastEthernet1/0
C    3.0.0.0/32 is subnetted, 1 subnets
3.3.3.3 [110/3] via 12.0.0.2, 00:10:27, FastEthernet1/0
O    3.3.3.3 [110/3] via 14.0.0.4, 00:10:27, GigabitEthernet0/0
C    4.0.0.0/32 is subnetted, 1 subnets
4.4.4.4 [110/2] via 14.0.0.4, 00:10:27, GigabitEthernet0/0
O    12.0.0.0/24 is subnetted, 1 subnets
12.0.0.0 is directly connected, FastEthernet1/0
C    14.0.0.0/24 is subnetted, 1 subnets
14.0.0.0 is directly connected, GigabitEthernet0/0
C    23.0.0.0/24 is subnetted, 1 subnets
23.0.0.0 [110/2] via 12.0.0.2, 00:13:20, FastEthernet1/0
O    34.0.0.0/24 is subnetted, 1 subnets
34.0.0.0 [110/2] via 14.0.0.4, 00:10:27, GigabitEthernet0/0

R1(config-router)#
```

f. Screenshot for examining the current OSPF neighbor and route information for R2.

The screenshot displays the Cisco Packet Tracer interface with the same network topology in OSPF Area 0. The CLI window for R2 shows the following output:

```
R2>enable
R2#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#router ospf 2
R2(config-router)#do show ip ospf neighbor

Neighbor ID      Pri   State       Dead Time   Address        Interface
1.1.1.1          1     FULL/DR     00:00:34    12.0.0.1       FastEthernet1/0
3.3.3.3          1     FULL/DR     00:00:32    23.0.0.3       FastEthernet2/0

R2(config-router)#do show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
        D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
        i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
        * - candidate default, U - per-user static route, o - ODR
        P - periodic downloaded static route

Gateway of last resort is not set

1.0.0.0/32 is subnetted, 1 subnets
1.1.1.1 [110/2] via 12.0.0.1, 00:12:21, FastEthernet1/0
O    2.0.0.0/32 is subnetted, 1 subnets
2.2.2.2 is directly connected, Loopback0
C    3.0.0.0/32 is subnetted, 1 subnets
3.3.3.3 [110/2] via 23.0.0.3, 00:17:13, FastEthernet2/0
O    4.0.0.0/32 is subnetted, 1 subnets
4.4.4.4 [110/3] via 12.0.0.1, 00:14:55, FastEthernet1/0
O    4.4.4.4 [110/3] via 23.0.0.3, 00:14:55, FastEthernet2/0
C    12.0.0.0/24 is subnetted, 1 subnets
12.0.0.0 is directly connected, FastEthernet1/0
C    14.0.0.0/24 is subnetted, 1 subnets
14.0.0.0 [110/2] via 12.0.0.1, 00:14:55, FastEthernet1/0
C    23.0.0.0/24 is subnetted, 1 subnets
23.0.0.0 is directly connected, FastEthernet2/0
C    34.0.0.0/24 is subnetted, 1 subnets
34.0.0.0 [110/2] via 23.0.0.3, 00:15:43, FastEthernet2/0

R2(config-router)#
```


g. Screenshot for examining the current OSPF neighbor and route information for R3.

The screenshot displays the Cisco Packet Tracer interface. On the left, a network diagram for OSPF Area 0 shows four routers: R1 (Router-PT-Empty), R2 (router-PT-Empty), R3 (Router-PT-Empty), and R4 (Router-PT-Empty). R1 is connected to R2 via F1/0 (12.0.0.0/24) and G0/0 (14.0.0.0/24). R2 is connected to R3 via F2/0 (23.0.0.0/24) and F1/0 (23.0.0.0/24). R3 is connected to R4 via F2/0 (34.0.0.0/24) and F1/0 (34.0.0.0/24). R4 is connected to R1 via G0/0 (14.0.0.0/24) and F1/0 (14.0.0.0/24). On the right, the R3 CLI window shows the following commands and output:

```
R3>enable
R3#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#router ospf 3
R3(config-router)#do show ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
2.2.2.2	1	FULL/DR	00:00:33	23.0.0.2	FastEthernet1/0
4.4.4.4	1	FULL/BDR	00:00:36	34.0.0.4	FastEthernet2/0

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
I - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

```
1.0.0.0/32 is subnetted, 1 subnets
O 1.1.1.1 [110/3] via 23.0.0.2, 00:17:15, FastEthernet1/0
[110/3] via 34.0.0.4, 00:17:15, FastEthernet2/0
2.0.0.0/32 is subnetted, 1 subnets
O 2.2.2.2 [110/2] via 23.0.0.2, 00:20:07, FastEthernet1/0
3.0.0.0/32 is subnetted, 1 subnets
C 3.3.3.3 is directly connected, Loopback0
4.0.0.0/32 is subnetted, 1 subnets
O 4.4.4.4 [110/2] via 34.0.0.4, 00:17:15, FastEthernet2/0
12.0.0.0/24 is subnetted, 1 subnets
O 12.0.0.0 [110/2] via 23.0.0.2, 00:20:07, FastEthernet1/0
14.0.0.0/24 is subnetted, 1 subnets
O 14.0.0.0 [110/2] via 34.0.0.4, 00:17:15, FastEthernet2/0
23.0.0.0/24 is subnetted, 1 subnets
O 23.0.0.0 [110/2] via 23.0.0.2, 00:20:07, FastEthernet1/0
34.0.0.0/24 is subnetted, 1 subnets
C 34.0.0.0 is directly connected, FastEthernet2/0
```

h. Screenshot for examining the current OSPF neighbor and route information for R4.

The screenshot displays the Cisco Packet Tracer interface. On the left, a network diagram for OSPF Area 0 shows four routers: R1 (Router-PT-Empty), R2 (router-PT-Empty), R3 (Router-PT-Empty), and R4 (Router-PT-Empty). R1 is connected to R2 via F1/0 (12.0.0.0/24) and G0/0 (14.0.0.0/24). R2 is connected to R3 via F2/0 (23.0.0.0/24) and F1/0 (23.0.0.0/24). R3 is connected to R4 via F2/0 (34.0.0.0/24) and F1/0 (34.0.0.0/24). R4 is connected to R1 via G0/0 (14.0.0.0/24) and F1/0 (14.0.0.0/24). On the right, the R4 CLI window shows the following commands and output:

```
R4>enable
R4#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R4(config)#router ospf 4
R4(config-router)#do show ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
1.1.1.1	1	FULL/DR	00:00:33	14.0.0.1	GigabitEthernet0/0
3.3.3.3	1	FULL/DR	00:00:39	34.0.0.3	FastEthernet1/0

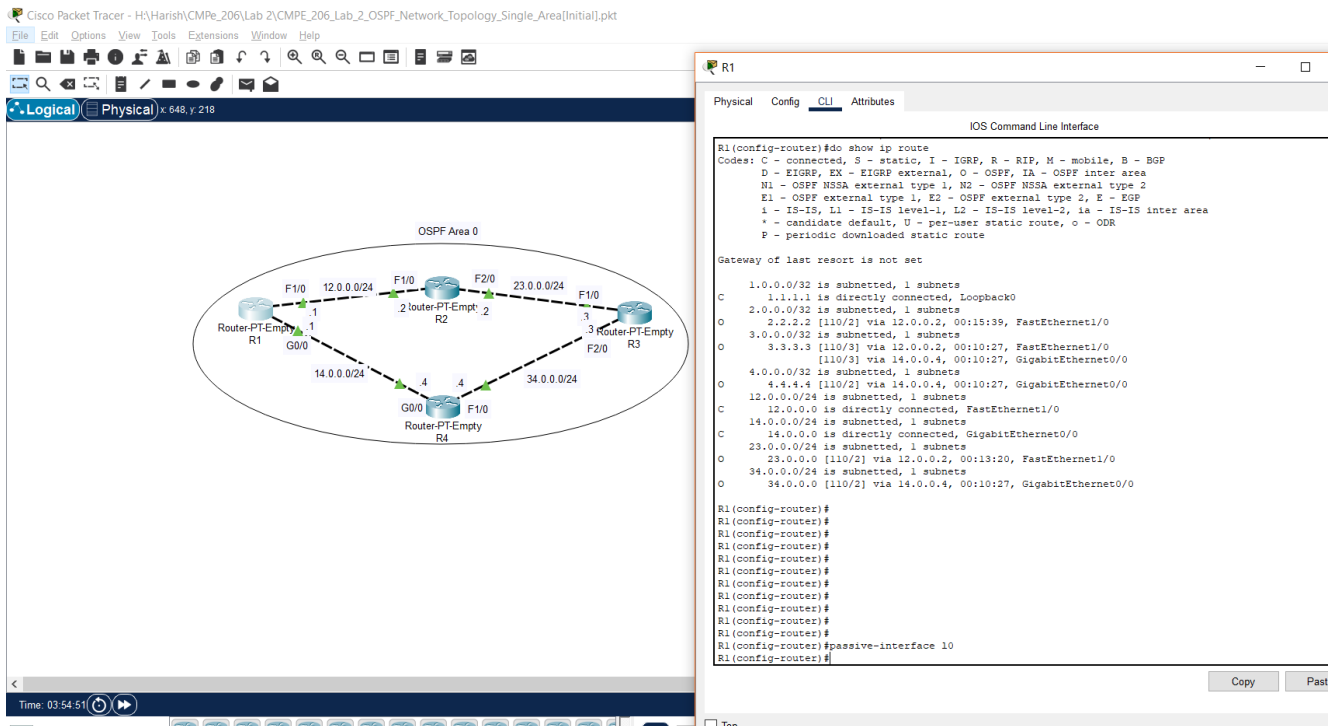
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
I - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

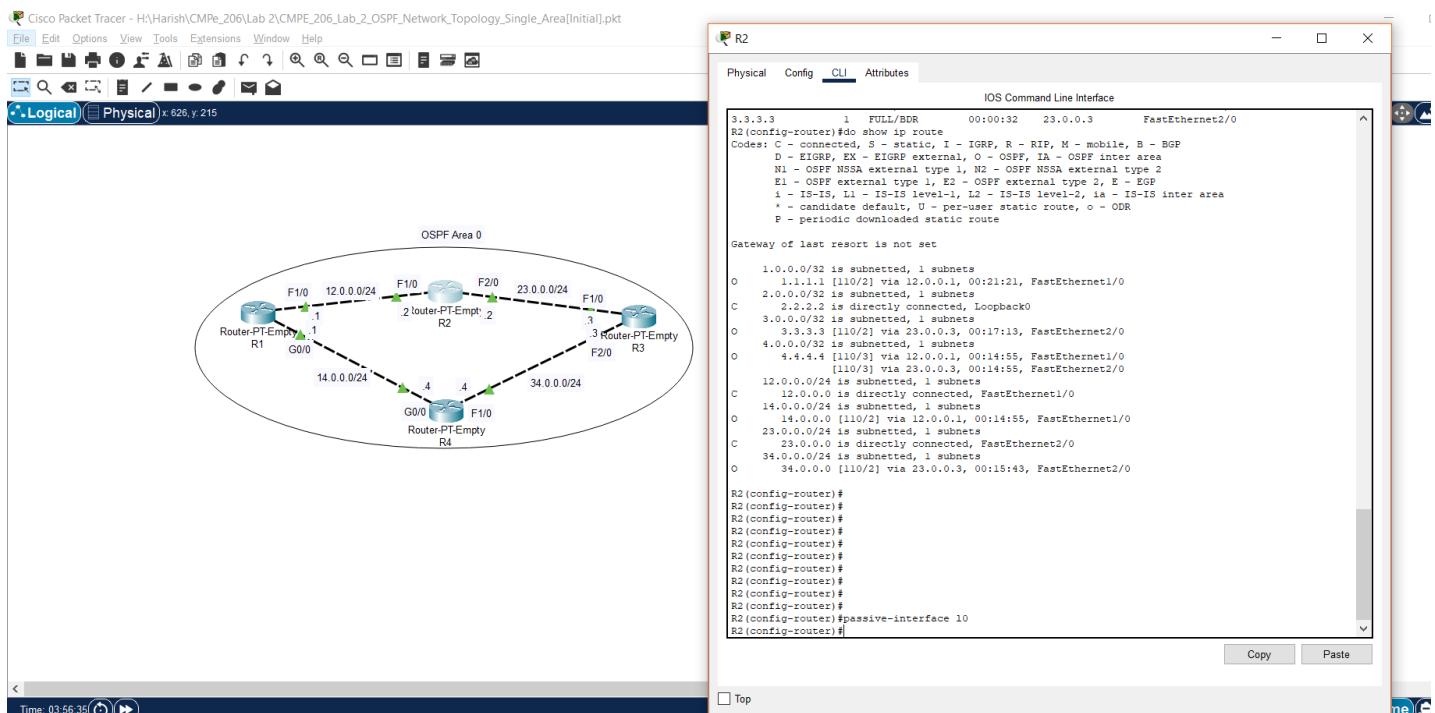
```
1.0.0.0/32 is subnetted, 1 subnets
O 1.1.1.1 [110/2] via 14.0.0.1, 00:19:07, GigabitEthernet0/0
2.0.0.0/32 is subnetted, 1 subnets
O 2.2.2.2 [110/3] via 34.0.0.3, 00:19:07, FastEthernet1/0
[110/3] via 14.0.0.1, 00:19:07, GigabitEthernet0/0
3.0.0.0/32 is subnetted, 1 subnets
O 3.3.3.3 [110/2] via 34.0.0.3, 00:19:52, FastEthernet1/0
4.0.0.0/32 is subnetted, 1 subnets
C 4.4.4.4 is directly connected, Loopback0
12.0.0.0/24 is subnetted, 1 subnets
O 12.0.0.0 [110/2] via 14.0.0.1, 00:19:07, GigabitEthernet0/0
14.0.0.0/24 is subnetted, 1 subnets
C 14.0.0.0 is directly connected, GigabitEthernet0/0
23.0.0.0/24 is subnetted, 1 subnets
O 23.0.0.0 [110/2] via 34.0.0.3, 00:19:52, FastEthernet1/0
34.0.0.0/24 is subnetted, 1 subnets
C 34.0.0.0 is directly connected, FastEthernet1/0
```

Performed all the steps for configuring router with OSPF LSAs message suppression.

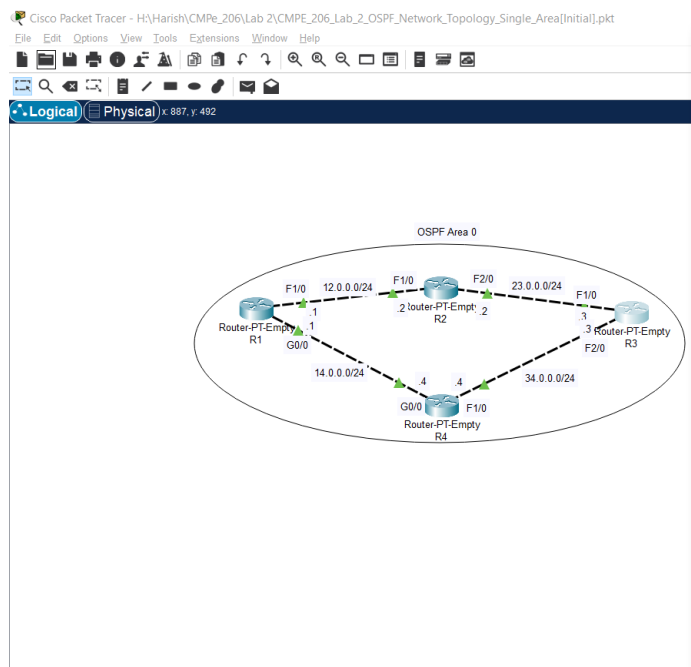
a. Screenshot for R1.



b. Screenshot for R2.



c. Screenshot for R3.



R3
⌵
✕

Physical
Config
CLI
Attributes

IOS Command Line Interface

```

4.4.4.4      1    FULL/BDR          00:00:36   34.0.0.4       FastEthernet2/0
R3(config-router)#do show ip route
Codes: C - connected, S - static, I - IGMP, R - RIP, M - mobile, B - BGP
        D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
        I - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
        * - candidate default, U - per-user static route, o - ODR
        P - periodic downloaded static route

Gateway of last resort is not set

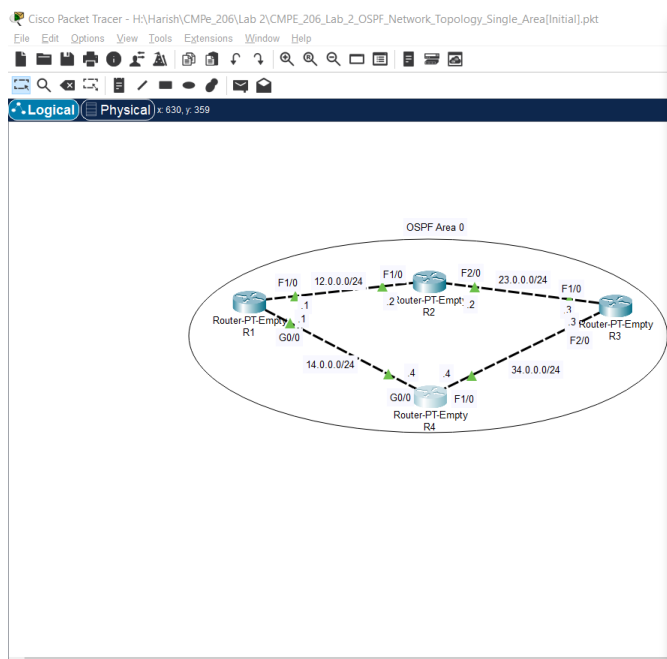
1.0.0.0/32 is subnetted, 1 subnets
O    1.1.1.1 [110/3] via 23.0.0.2, 00:17:15, FastEthernet1/0
O    2.0.0.0/32 is subnetted, 1 subnets
O    2.2.2.2 [110/2] via 23.0.0.2, 00:20:07, FastEthernet1/0
C    3.0.0.0/32 is subnetted, 1 subnets
C    3.3.3.3 is directly connected, Loopback0
O    4.0.0.0/32 is subnetted, 1 subnets
O    4.4.4.4 [110/2] via 34.0.0.4, 00:17:15, FastEthernet2/0
12.0.0.0/24 is subnetted, 1 subnets
O    12.0.0.0 [110/2] via 23.0.0.2, 00:20:07, FastEthernet1/0
14.0.0.0/24 is subnetted, 1 subnets
O    14.0.0.0 [110/2] via 34.0.0.4, 00:17:15, FastEthernet2/0
23.0.0.0/24 is subnetted, 1 subnets
C    23.0.0.0 is directly connected, FastEthernet1/0
34.0.0.0/24 is subnetted, 1 subnets
C    34.0.0.0 is directly connected, FastEthernet2/0

R3(config-router)#
R3(config-router)#
R3(config-router)#
R3(config-router)#
R3(config-router)#
R3(config-router)#
R3(config-router)#
R3(config-router)#
R3(config-router)#
R3(config-router)#
R3(config-router)#passive-interface lo
R3(config-router)#

```

Copy
Paste

d. Screenshot for R4.



The screenshot shows the R4 router configuration window with the following content:

```

IOS Command Line Interface

1.1.1.1      1    FULL/DR      00:00:33      14.0.0.1      GigabitEthernet0/0
3.3.3.3      1    FULL/DR      00:00:39      34.0.0.3      FastEthernet1/0
R4(config-router)#do show ip route

Codes: C - connected, S - static, I - IGMP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       I - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

1.0.0.0/32 is subnetted, 1 subnets
O   1.1.1.1 [110/2] via 14.0.0.1, 00:19:07, GigabitEthernet0/0
O   2.0.0.0/32 is subnetted, 1 subnets
O   2.2.2.2 [110/3] via 34.0.0.3, 00:19:07, FastEthernet1/0
O   1.0.0.0/32 is subnetted, 1 subnets
O   1.0.0.0 [110/3] via 14.0.0.1, 00:19:07, GigabitEthernet0/0
O   3.0.0.0/32 is subnetted, 1 subnets
O   3.3.3.3 [110/2] via 34.0.0.3, 00:19:52, FastEthernet1/0
O   4.0.0.0/32 is subnetted, 1 subnets
C   4.4.4.4 is directly connected, Loopback0
O   12.0.0.0/24 is subnetted, 1 subnets
O   12.0.0.0 [110/2] via 14.0.0.1, 00:19:07, GigabitEthernet0/0
O   14.0.0.0/24 is subnetted, 1 subnets
O   14.0.0.0 is directly connected, GigabitEthernet0/0
O   23.0.0.0/24 is subnetted, 1 subnets
O   23.0.0.0 [110/2] via 34.0.0.3, 00:19:52, FastEthernet1/0
O   34.0.0.0/24 is subnetted, 1 subnets
C   34.0.0.0 is directly connected, FastEthernet1/0

R4(config-router)#
R4(config-router)#
R4(config-router)#
R4(config-router)#
R4(config-router)#
R4(config-router)#
R4(config-router)#
R4(config-router)#
R4(config-router)#
R4(config-router)#passive-interface 10
R4(config-router)#

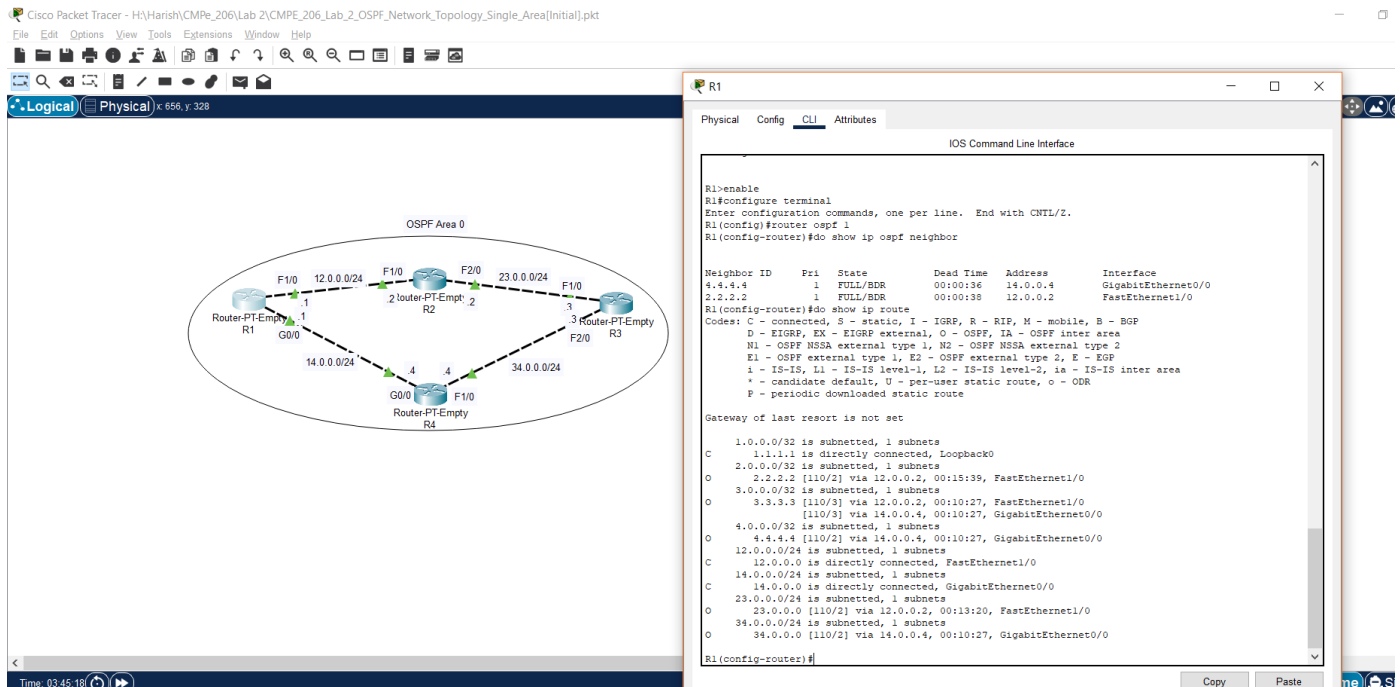
```

Task 5: Configure Router with OSPF Reference Bandwidth:

Performed all the steps for configuring router with OSPF reference bandwidth.

1. There is an issue with the current reference bandwidth. Say we are sending a message from R1 to R3, then according to the routing info of R1, there are two possible ways to reach R3 even though one of them is a Gigabit Ethernet Interface. Since, the reference bandwidth is default set to 100Mbps, the cost of higher interface will be 1.

The below screenshot shows the same where R1 to R3 has two possibilities.



So, the routes that we can take to forward messages from R1 to R3 are:

3.3.3.3 [110/3] via 12.0.0.2, 00:10:27, FastEthernet1/0

[110/3] via 14.0.0.4, 00:10:27, GigabitEthernet0/0

We can say that there should be only GigabitEthernet0/0.

1b. R1 has two different interfaces with one being FastEthernet1/0 and other being GigabitEthernet0/0, yet they both have same cost. The reason is that the cost is calculated based on the reference bandwidth (Default = 100Mbps) that is already been set.

Cost of FastEthernet1/0 = Ref. Bandwidth / Interface Bandwidth = 100Mbps / 100Mbps = 1

Cost of GigabitEthernet0/0 = Ref. Bandwidth / Interface Bandwidth = 100Mbps / 1000Mbps = 1 (Since cost values less than 1 will be converted to 1)

Therefore, both costs are same.

1c. To fix the issue, the default reference bandwidth needs to be changed to the highest interface bandwidth.

2. a. Screenshot for fixing the wrong bandwidth issue in the network for R1.

The screenshot shows a Cisco Packet Tracer network diagram for OSPF Area 0. Four routers (R1, R2, R3, R4) are connected in a diamond topology. R1 is at the top left, R2 at the top right, R3 at the bottom right, and R4 at the bottom left. The links are labeled with their respective IP addresses and bandwidths: R1-F1/0 to R2-F1/0 (12.0.0.0/24, 100Mbps), R2-F2/0 to R3-F1/0 (23.0.0.0/24, 100Mbps), R3-F2/0 to R4-F1/0 (34.0.0.0/24, 100Mbps), and R4-G0/0 to R1-G0/0 (14.0.0.0/24, 100Mbps). The routers are labeled as 'Router-PT-Empty'. The R1 CLI window is open, showing the following configuration:

```
R1 (config-router)#
R1 (config-router)#
R1 (config-router)#
R1 (config-router)#passive-interface 10
R1 (config-router)#
```

The CLI output shows 'R1 con0 is now available' and 'Press RETURN to get started.' The R1 CLI window also shows the following configuration:

```
R1>enable
R1#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R1 (config)#router ospf 1
R1 (config-router)#auto-cost reference-bandwidth 10000
* OSPF: Reference bandwidth is changed.
Please ensure reference bandwidth is consistent across all routers.
R1 (config-router)#
```

b. Screenshot for fixing the wrong bandwidth issue in the network for R2.

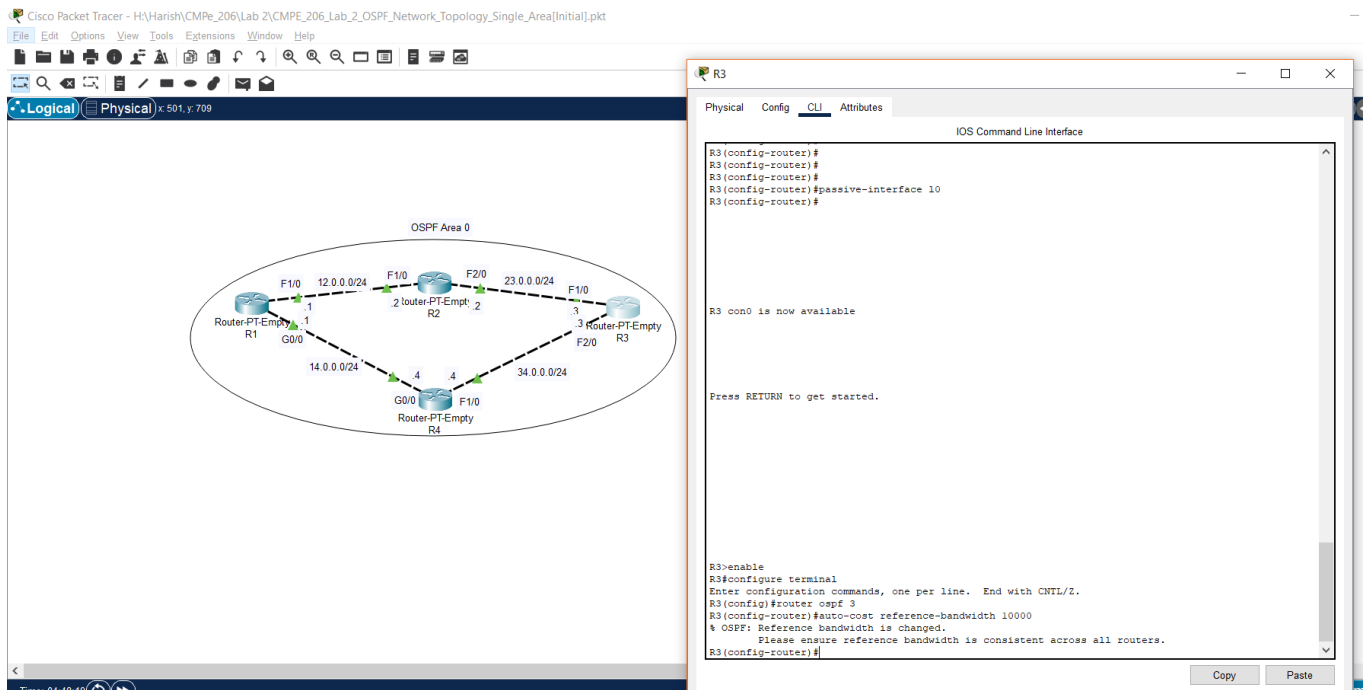
The screenshot shows the same Cisco Packet Tracer network diagram for OSPF Area 0. The R2 CLI window is open, showing the following configuration:

```
R2 (config-router)#
R2 (config-router)#
R2 (config-router)#
R2 (config-router)#passive-interface 10
R2 (config-router)#
```

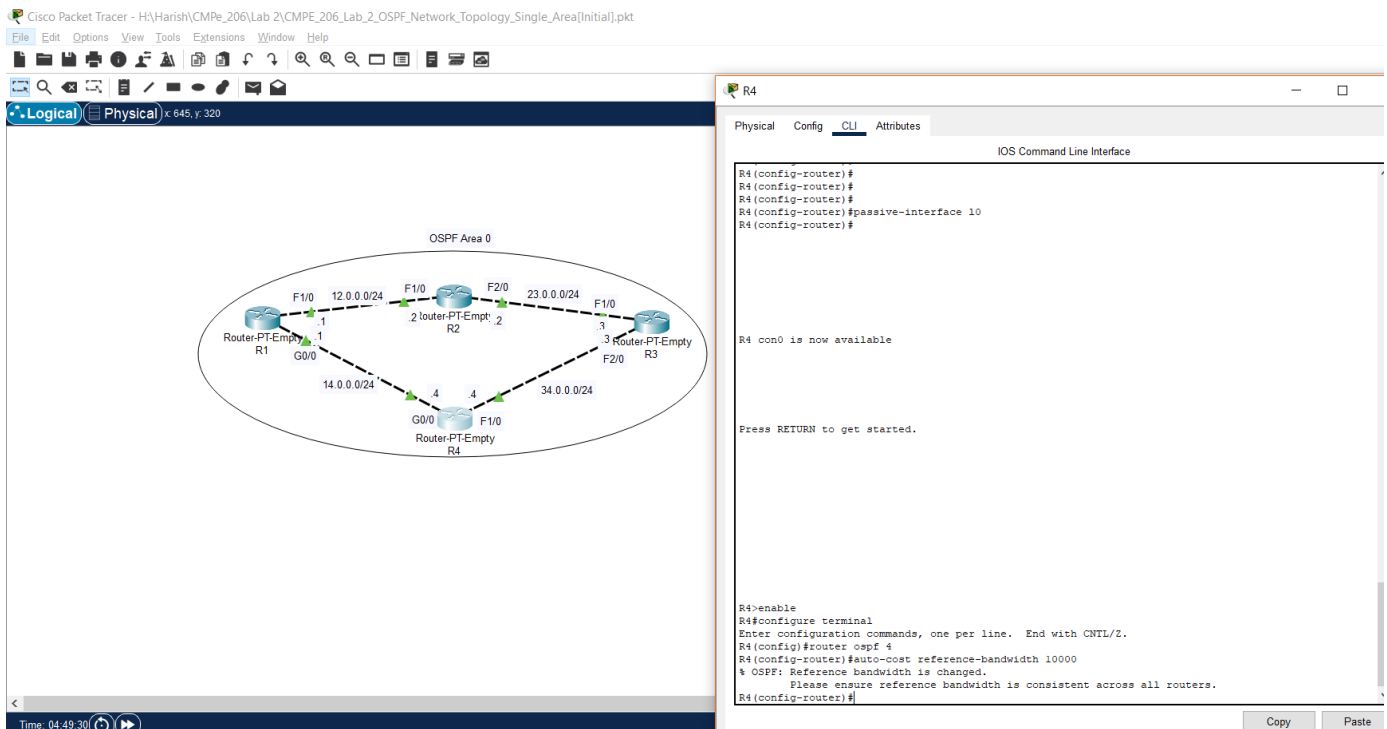
The CLI output shows 'R2 con0 is now available' and 'Press RETURN to get started.' The R2 CLI window also shows the following configuration:

```
R2>enable
R2#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R2 (config)#router ospf 2
R2 (config-router)#auto-cost reference-bandwidth 10000
* OSPF: Reference bandwidth is changed.
Please ensure reference bandwidth is consistent across all routers.
R2 (config-router)#
```

c. Screenshot for fixing the wrong bandwidth issue in the network for R3.



d. Screenshot for fixing the wrong bandwidth issue in the network for R4.



e. Screenshot of R1 for checking if it only uses the best route to forward message to R3.

The screenshot displays the Cisco Packet Tracer interface. On the left, a network diagram for OSPF Area 0 shows four routers: R1 (Router-PT-Empty), R2 (Router-PT-Empty), R3 (Router-PT-Empty), and R4 (Router-PT-Empty). R1 is connected to R2 via F1/0 (12.0.0.0/24) and G0/0 (14.0.0.0/24). R2 is connected to R3 via F2/0 (23.0.0.0/24) and F1/0 (23.0.0.0/24). R3 is connected to R4 via F2/0 (34.0.0.0/24) and F1/0 (34.0.0.0/24). R4 is connected to R1 via G0/0 (14.0.0.0/24) and F1/0 (14.0.0.0/24). On the right, the CLI window for R1 shows the following configuration:

```
R1#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#router ospf 1
R1(config-router)#auto-cost reference-bandwidth 10000
% OSPF: Reference bandwidth is changed.
Please ensure reference bandwidth is consistent across all routers.
R1(config-router)#
R1(config-router)#
R1(config-router)#
R1(config-router)#
R1(config-router)#do show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

1.0.0.0/32 is subnetted, 1 subnets
C 1.1.1.1 is directly connected, Loopback0
C 2.0.0.0/32 is subnetted, 1 subnets
O 2.2.2.2 [110/101] via 12.0.0.2, 00:03:19, FastEthernet1/0
C 3.0.0.0/32 is subnetted, 1 subnets
O 3.3.3.3 [110/111] via 14.0.0.4, 00:02:05, GigabitEthernet0/0
C 4.0.0.0/32 is subnetted, 1 subnets
O 4.4.4.4 [110/11] via 14.0.0.4, 00:07:01, GigabitEthernet0/0
C 12.0.0.0/24 is subnetted, 1 subnets
C 12.0.0.0 is directly connected, FastEthernet1/0
C 14.0.0.0/24 is subnetted, 1 subnets
C 14.0.0.0 is directly connected, GigabitEthernet0/0
C 23.0.0.0/24 is subnetted, 1 subnets
O 23.0.0.0 [110/200] via 12.0.0.2, 00:02:05, FastEthernet1/0
C 34.0.0.0/24 is subnetted, 1 subnets
O 34.0.0.0 [110/110] via 14.0.0.4, 00:02:05, GigabitEthernet0/0
R1(config-router)#
```

Task 6: Configure Router with OSPF Route Cost on interfaces:

Performed all the steps for configuring router with OSPF route cost on interfaces.

a. Screenshot to adjust OSPF interface cost for R1.

The screenshot displays the Cisco Packet Tracer interface. On the left, the same network diagram for OSPF Area 0 is shown. On the right, the CLI window for R1 shows the following configuration:

```
R1(config-router)#
R1(config-router)#
R1(config-router)#
R1(config-router)#do show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

1.0.0.0/32 is subnetted, 1 subnets
C 1.1.1.1 is directly connected, Loopback0
C 2.0.0.0/32 is subnetted, 1 subnets
O 2.2.2.2 [110/101] via 12.0.0.2, 00:03:19, FastEthernet1/0
C 3.0.0.0/32 is subnetted, 1 subnets
O 3.3.3.3 [110/111] via 14.0.0.4, 00:02:05, GigabitEthernet0/0
C 4.0.0.0/32 is subnetted, 1 subnets
O 4.4.4.4 [110/11] via 14.0.0.4, 00:07:01, GigabitEthernet0/0
C 12.0.0.0/24 is subnetted, 1 subnets
C 12.0.0.0 is directly connected, FastEthernet1/0
C 14.0.0.0/24 is subnetted, 1 subnets
C 14.0.0.0 is directly connected, GigabitEthernet0/0
C 23.0.0.0/24 is subnetted, 1 subnets
O 23.0.0.0 [110/200] via 12.0.0.2, 00:02:05, FastEthernet1/0
C 34.0.0.0/24 is subnetted, 1 subnets
O 34.0.0.0 [110/110] via 14.0.0.4, 00:02:05, GigabitEthernet0/0

R1(config-router)#
R1(config-router)#
R1(config-router)#
R1(config-router)#
R1(config-router)#
R1(config-router)#
R1(config-router)#interface g0/0
R1(config-if)#ip ospf cost 10000
R1(config-if)#
```

b. Screenshot to adjust OSPF interface cost for R4.

The screenshot shows a Cisco Packet Tracer interface with a network diagram of OSPF Area 0. The topology includes four routers: R1 (Router-PT-Empty), R2 (router-PT-Empty), R3 (Router-PT-Empty), and R4 (Router-PT-Empty). R1 is connected to R2 via F1/0 (12.0.0.0/24) and G0/0 (14.0.0.0/24). R2 is connected to R3 via F2/0 (23.0.0.0/24) and F1/0 (23.0.0.0/24). R3 is connected to R4 via F2/0 (34.0.0.0/24) and F1/0 (34.0.0.0/24). R4 is connected to R1 via G0/0 (14.0.0.0/24) and F1/0 (34.0.0.0/24). The right pane shows the CLI configuration for R4:

```
R4>enable
R4#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R4(config)#router ospf 4
R4(config-router)#auto-cost reference-bandwidth 10000
% OSPF: Reference bandwidth is changed.
Please ensure reference bandwidth is consistent across all routers.
R4(config-router)#

R4 con0 is now available.

Press RETURN to get started.

R4>enable
R4#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R4(config)#router ospf 4
R4(config-router)#interface g0/0
R4(config-router-if)#ip ospf cost 10000
R4(config-router-if)#
```

c. Screenshot for R1 to check if it uses the best route to forward message to R3.

The screenshot shows a Cisco Packet Tracer interface with the same network diagram as in part b. The right pane shows the CLI configuration for R1:

```
R1(config-router)#
R1(config-router)#interface g0/0
R1(config-router-if)#ip ospf cost 10000
R1(config-router-if)#exit
R1(config)#
R1(config)#
R1(config)#
R1(config)#
R1(config)#
R1(config)#
R1(config)#
R1(config)#router ospf 1
R1(config-router)#do show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

1.0.0.0/32 is subnetted, 1 subnets
C 1.1.1.1 is directly connected, Loopback0
2.0.0.0/32 is subnetted, 1 subnets
O 2.2.2.2 [110/101] via 12.0.0.2, 00:19:38, FastEthernet1/0
3.0.0.0/32 is subnetted, 1 subnets
O 3.3.3.3 [110/201] via 12.0.0.2, 00:03:25, FastEthernet1/0
4.0.0.0/32 is subnetted, 1 subnets
O 4.4.4.4 [110/301] via 12.0.0.2, 00:03:25, FastEthernet1/0
12.0.0.0/24 is subnetted, 1 subnets
C 12.0.0.0 is directly connected, FastEthernet1/0
14.0.0.0/24 is subnetted, 1 subnets
C 14.0.0.0 is directly connected, GigabitEthernet0/0
23.0.0.0/24 is subnetted, 1 subnets
O 23.0.0.0 [110/200] via 12.0.0.2, 00:18:24, FastEthernet1/0
34.0.0.0/24 is subnetted, 1 subnets
O 34.0.0.0 [110/300] via 12.0.0.2, 00:03:25, FastEthernet1/0

R1(config-router)#
```

Here, there is this line 3.3.3.3 [110/201] via 12.0.0.2, 00:03:25, FastEthernet1/0. So, it shows the message to R3 now goes through R2.

Task 7: Configure Router in OSPF Multi-Area Environment:

Performed all the steps for configuring router in OSPF multi-area environment.

a. Screenshot for configuring R1 in OSPF Multi-Area environment.

The screenshot displays the Cisco Packet Tracer interface. On the left, a network diagram shows three OSPF areas: Area 1 (blue), Area 0 (green), and Area 2 (yellow). Routers are connected as follows: R1 (F1/0 to F1/0, 10.12.0.0/24) connects to R2 (F1/0 to F1/0, 10.12.0.0/24). R2 (F2/0 to F2/0, 10.23.0.0/24) connects to R3 (F2/0 to F2/0, 10.23.0.0/24). R3 (F3/0 to F3/0, 10.35.0.0/24) connects to R5 (F3/0 to F3/0, 10.35.0.0/24). R1 (G0/0 to G0/0, 10.14.0.0/24) connects to R4 (G0/0 to G0/0, 10.14.0.0/24). R4 (G0/0 to G0/0, 10.14.0.0/24) connects to R5 (G0/0 to G0/0, 10.14.0.0/24). On the right, the CLI for Router R1 is shown. The configuration commands entered are:

```
R1>enable
R1#configure terminal
R1(config)#router ospf 1
R1(config-router)#network 10.12.0.0 0.0.0.255 area 1
R1(config-router)#network 10.14.0.0 0.0.0.255 area 1
R1(config-router)#network 1.1.1.1 0.0.0.0 area 1
R1(config-router)#
```

The CLI output shows the router is now available and ready for configuration.

b. Screenshot for configuring R2 in OSPF Multi-Area environment.

The screenshot displays the Cisco Packet Tracer interface. On the left, the same network diagram as in the previous screenshot is shown. On the right, the CLI for Router R2 is shown. The configuration commands entered are:

```
R2>enable
R2#configure terminal
R2(config)#router ospf 1
R2(config-router)#network 10.12.0.0 0.0.0.255 area 1
R2(config-router)#network 10.23.0.0 0.0.0.255 area 0
R2(config-router)#network 2.2.2.2 0.0.0.0 area 0
R2(config-router)#
```

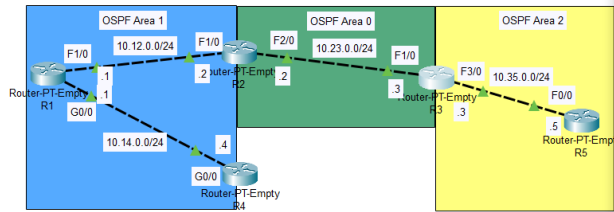
The CLI output shows the router is now available and ready for configuration.

c. Screenshot for configuring R3 in OSPF Multi-Area environment.

Cisco Packet Tracer - H:\Harish\CMPE_206\Lab 2\CMPE_206_Lab_2_OSPF_Network_Topology_Multi_Area[Initial].pkt

File Edit Options View Tools Extensions Window Help

Logical Physical x 1250, y 246



R3

Physical Config CLI Attributes

IOS Command Line Interface

```
Cisco Internetwork Operating System Software
IOS (tm) PT1000 Software (PT1000-I-M), Version 12.2(28), RELEASE SOFTWARE (fc5)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2005 by Cisco Systems, Inc.
Compiled Wed 27-Apr-04 19:01 by miwang

PT 1001 (PTSC2005) processor (revision 0x200) with 60416K/5120K bytes of memory
.
Processor board ID PT0123 (0123)
PT2005 processor: part number 0, mask 01
Bridging software.
X.25 software, Version 3.0.0.
3 FastEthernet/IEEE 802.3 interface(s)
1 Gigabit Ethernet/IEEE 802.3 interface(s)
32K bytes of non-volatile configuration memory.
63498K bytes of ATA CompactFlash (Read/Write)

Press RETURN to get started!

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet3/0, changed state to up
07:00:45: %OSPF-5-ADJCHG: Process 1, Nbr 5.5.5.5 on FastEthernet3/0 from LOADING to FULL, Loading Done
07:00:45: %OSPF-5-ADJCHG: Process 1, Nbr 2.2.2.2 on FastEthernet1/0 from LOADING to FULL, Loading Done

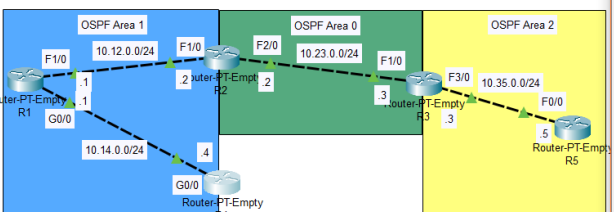
R3>enable
R3#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#router ospf 1
R3(config-router)#network 10.23.0.0 0.0.0.255 area 0
R3(config-router)#network 10.35.0.0 0.0.0.255 area 2
R3(config-router)#network 3.3.3.3 0.0.0.0 area 0
R3(config-router)#
```

d. Screenshot for configuring R4 in OSPF Multi-Area environment.

Cisco Packet Tracer - H:\Harish\CMPE_206\Lab 2\CMPE_206_Lab_2_OSPF_Network_Topology_Multi_Area[Initial].pkt

File Edit Options View Tools Extensions Window Help

Logical Physical x 1227, y 292



R4

Physical Config CLI Attributes

IOS Command Line Interface

```
Cisco Internetwork Operating System Software
IOS (tm) PT1000 Software (PT1000-I-M), Version 12.2(28), RELEASE SOFTWARE (fc5)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2005 by Cisco Systems, Inc.
Compiled Wed 27-Apr-04 19:01 by miwang

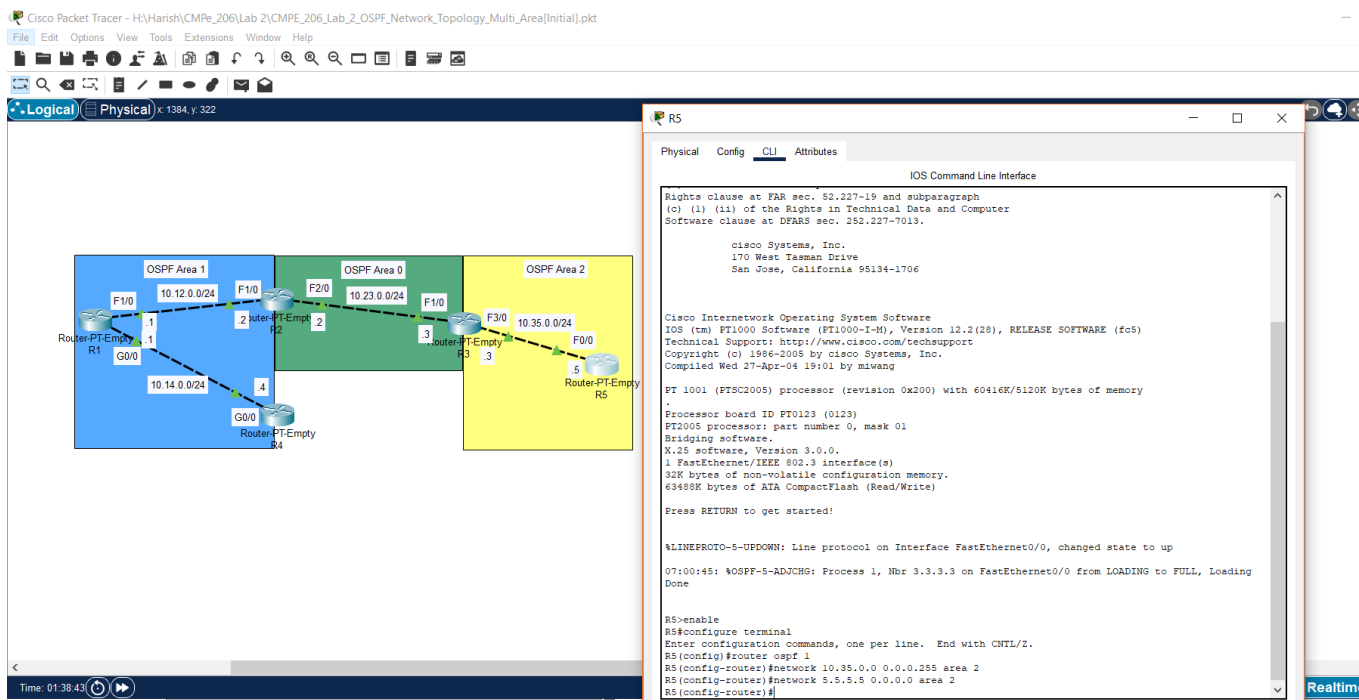
PT 1001 (PTSC2005) processor (revision 0x200) with 60416K/5120K bytes of memory
.
Processor board ID PT0123 (0123)
PT2005 processor: part number 0, mask 01
Bridging software.
X.25 software, Version 3.0.0.
2 FastEthernet/IEEE 802.3 interface(s)
1 Gigabit Ethernet/IEEE 802.3 interface(s)
32K bytes of non-volatile configuration memory.
63498K bytes of ATA CompactFlash (Read/Write)

Press RETURN to get started!

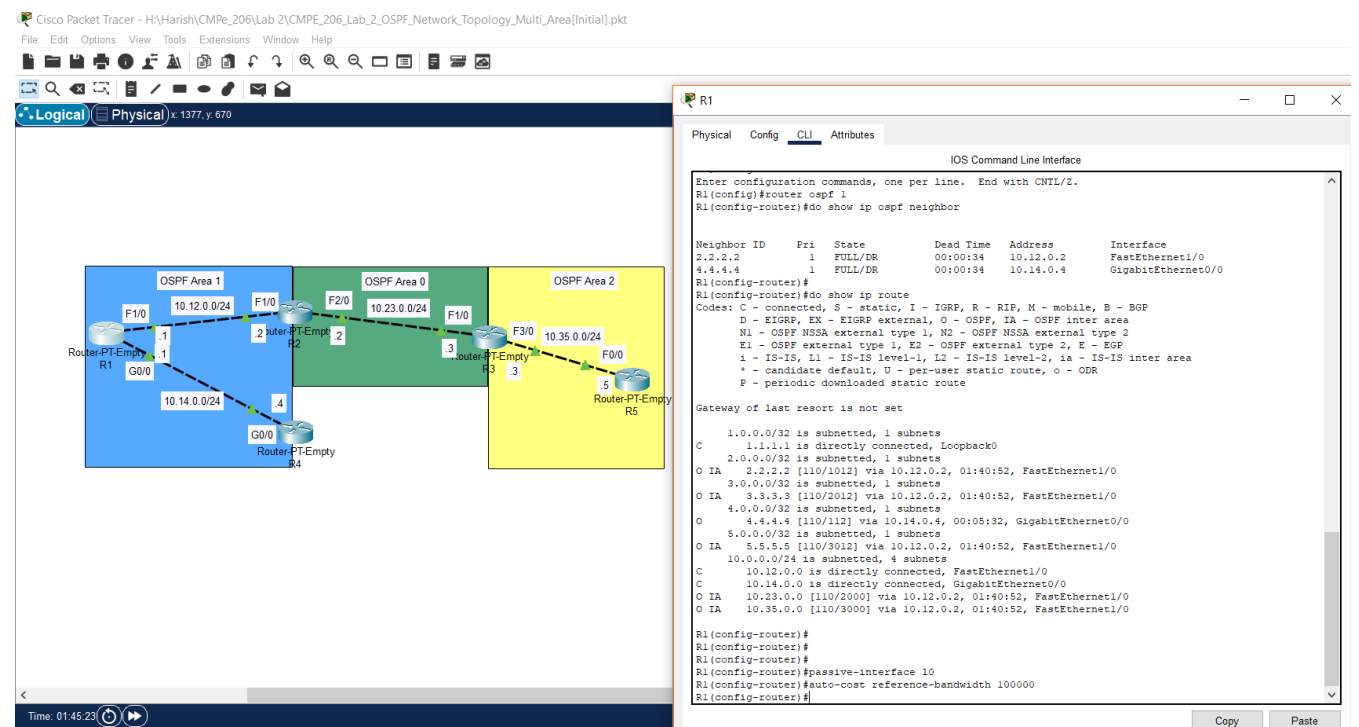
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0, changed state to up
07:00:40: %OSPF-5-ADJCHG: Process 1, Nbr 1.1.1.1 on GigabitEthernet0/0 from LOADING to FULL, Loading Done

R4>enable
R4#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R4(config)#router ospf 1
R4(config-router)#network 10.14.0.0 0.0.0.255 area 1
R4(config-router)#network 4.4.4.4 0.0.0.0 area 0
R4(config-router)#
08:35:42: %OSPF-6-AREACHG: 4.4.4.4/0 changed from area 1 to area 0
R4(config-router)#network 4.4.4.4 0.0.0.0 area 1
R4(config-router)#
08:36:15: %OSPF-6-AREACHG: 4.4.4.4/0 changed from area 0 to area 1
R4(config-router)#
```

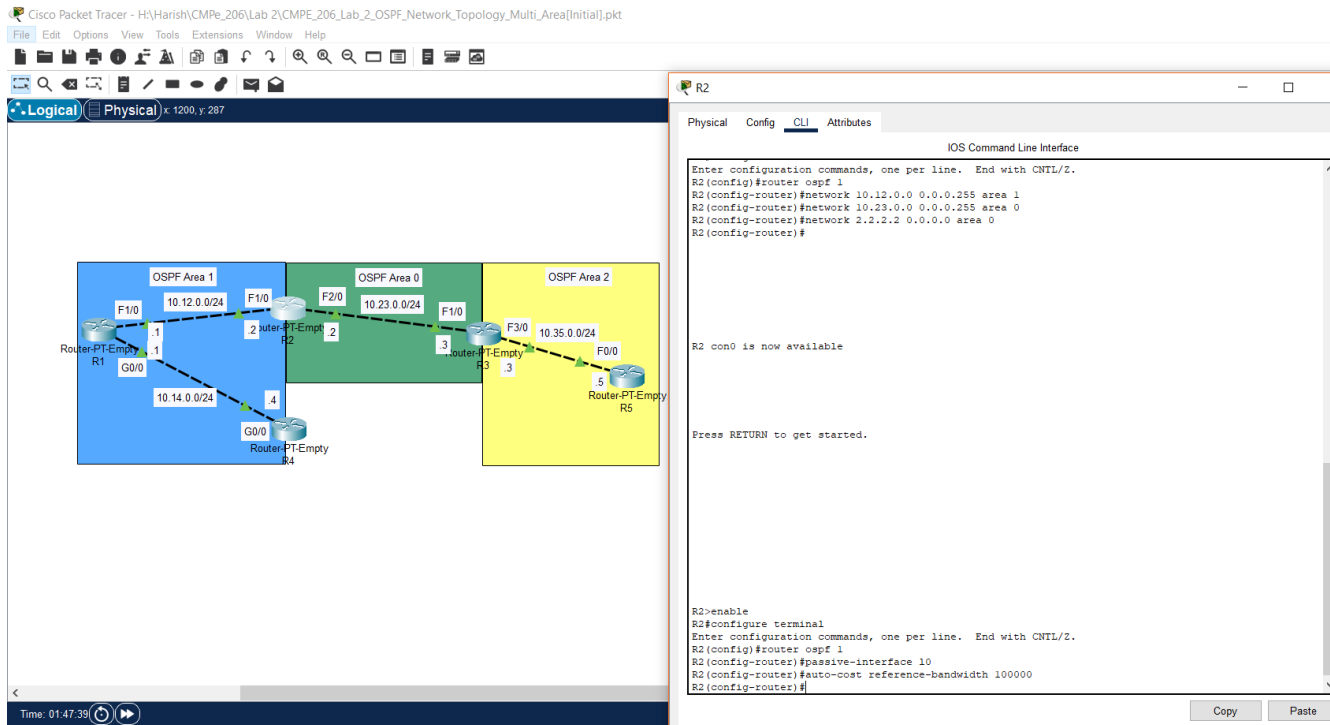
e. Screenshot for configuring R5 in OSPF Multi-Area environment.



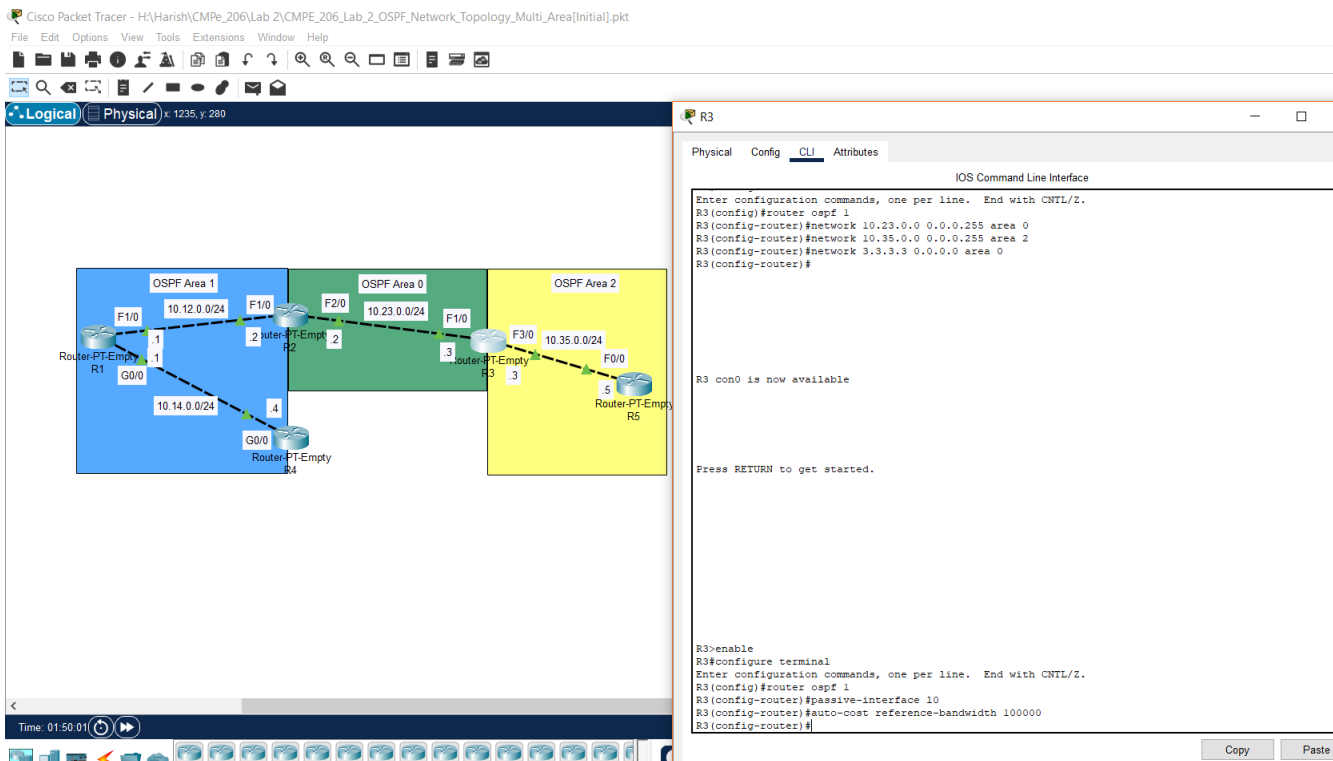
f. Screenshot of R1 for turning loopback interface from active to passive and configuring the proper bandwidth number.



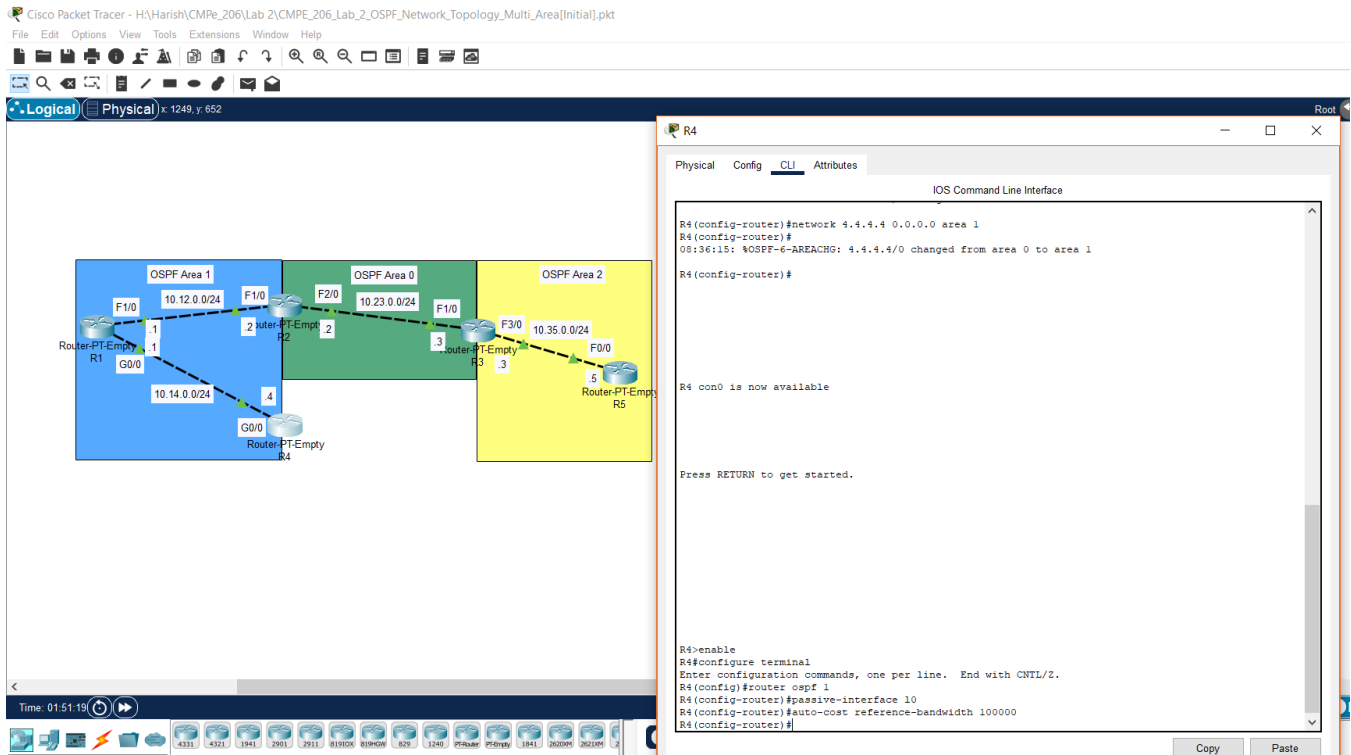
g. Screenshot of R2 for turning loopback interface from active to passive and configuring the proper bandwidth number.



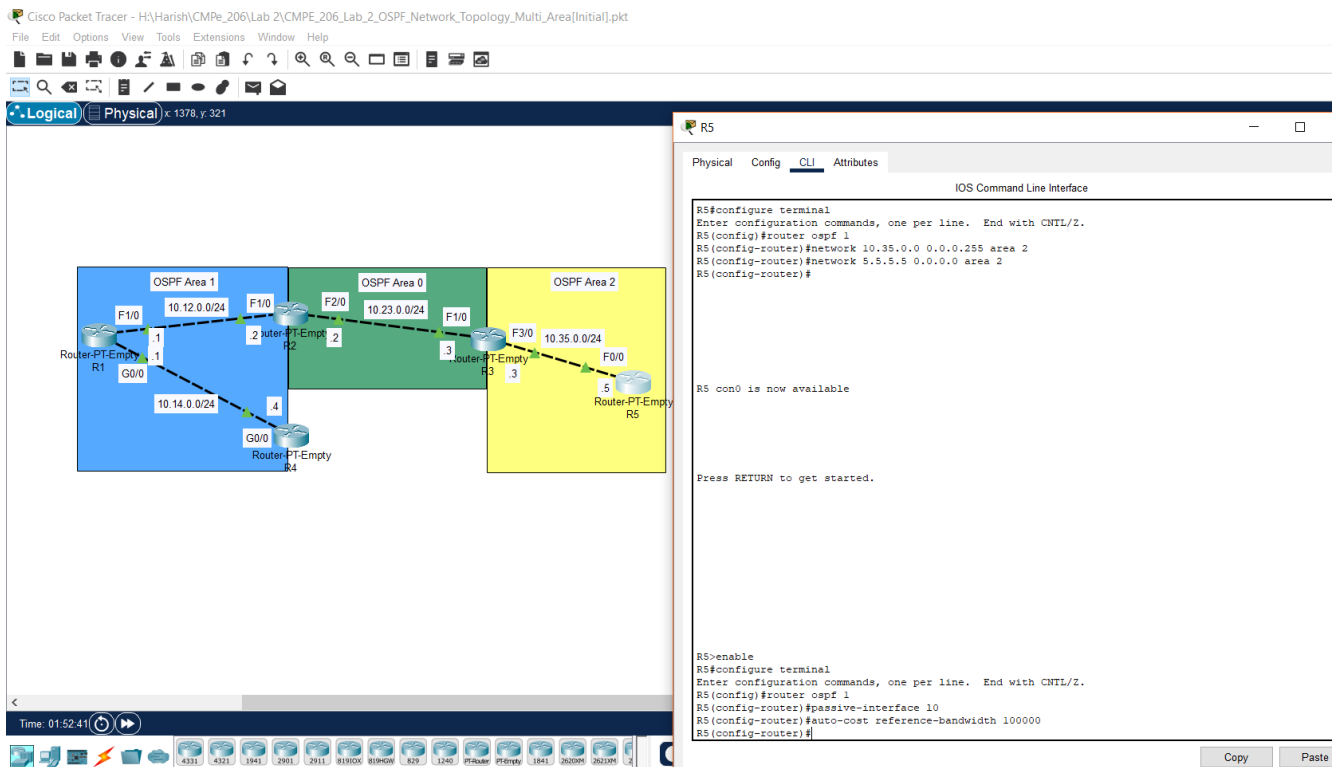
h. Screenshot of R3 for turning loopback interface from active to passive and configuring the proper bandwidth number.



i. Screenshot of R4 for turning loopback interface from active to passive and configuring the proper bandwidth number.



j. Screenshot of R5 for turning loopback interface from active to passive and configuring the proper bandwidth number.



k. Screenshot of R1 to examine its current OSPF neighbor and route information.

Cisco Packet Tracer - H:\Harish\CMPE_206\Lab 2\CMPE_206_Lab_2_OSPF_Network_Topology_Multi_Area[Initial].pkt

File Edit Options View Tools Extensions Window Help

Logical Physical x 1194, y 277

R1

Physical Config CLI Attributes

IOS Command Line Interface

```
R1(config-router)#
R1(config-router)#
R1(config-router)#passive-interface 10
R1(config-router)#auto-cost reference-bandwidth 100000
R1(config-router)#
R1(config-router)#
R1(config-router)#do show ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
2.2.2.2	1	FULL/DR	00:00:37	10.12.0.2	FastEthernet1/0
4.4.4.4	1	FULL/DR	00:00:37	10.14.0.4	GigabitEthernet0/0

```
R1(config-router)#do show ip route
```

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
I - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

```
1.0.0.0/32 is subnetted, 1 subnets
C 1.1.1.1 is directly connected, Loopback0
2.0.0.0/32 is subnetted, 1 subnets
O IA 2.2.2.2 [110/1012] via 10.12.0.2, 01:53:34, FastEthernet1/0
3.0.0.0/32 is subnetted, 1 subnets
O IA 3.3.3.3 [110/2012] via 10.12.0.2, 01:53:34, FastEthernet1/0
4.0.0.0/32 is subnetted, 1 subnets
O 4.4.4.4 [110/112] via 10.14.0.4, 00:18:14, GigabitEthernet0/0
5.0.0.0/32 is subnetted, 1 subnets
O IA 5.5.5.5 [110/3012] via 10.12.0.2, 01:53:34, FastEthernet1/0
10.0.0.0/24 is subnetted, 4 subnets
C 10.12.0.0 is directly connected, FastEthernet1/0
C 10.14.0.0 is directly connected, GigabitEthernet0/0
O IA 10.23.0.0 [110/2000] via 10.12.0.2, 01:53:34, FastEthernet1/0
O IA 10.35.0.0 [110/3000] via 10.12.0.2, 01:53:34, FastEthernet1/0
```

R1(config-router)#

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l. Screenshot of R2 to examine its current OSPF neighbor and route information.

Cisco Packet Tracer - H:\Harish\CMPE_206\Lab 2\CMPE_206_Lab_2_OSPF_Network_Topology_Multi_Area[Initial].pkt

File Edit Options View Tools Extensions Window Help

Logical Physical x 1414, y 616

R2

Physical Config CLI Attributes

IOS Command Line Interface

```
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#router ospf 1
R2(config-router)#passive-interface 10
R2(config-router)#auto-cost reference-bandwidth 100000
R2(config-router)#
R2(config-router)#
R2(config-router)#do show ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
1.1.1.1	1	FULL/DR	00:00:37	10.12.0.1	FastEthernet1/0
3.3.3.3	1	FULL/DR	00:00:37	10.23.0.3	FastEthernet2/0

```
R2(config-router)#do show ip route
```

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
I - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

```
1.0.0.0/32 is subnetted, 1 subnets
O 1.1.1.1 [110/1012] via 10.12.0.1, 01:56:04, FastEthernet1/0
2.0.0.0/32 is subnetted, 1 subnets
C 2.2.2.2 is directly connected, Loopback0
3.0.0.0/32 is subnetted, 1 subnets
O 3.3.3.3 [110/1012] via 10.23.0.3, 01:55:59, FastEthernet2/0
4.0.0.0/32 is subnetted, 1 subnets
O 4.4.4.4 [110/1112] via 10.12.0.1, 00:20:34, FastEthernet1/0
5.0.0.0/32 is subnetted, 1 subnets
O IA 5.5.5.5 [110/2012] via 10.23.0.3, 01:55:59, FastEthernet2/0
10.0.0.0/24 is subnetted, 4 subnets
C 10.12.0.0 is directly connected, FastEthernet1/0
O 10.14.0.0 [110/1100] via 10.12.0.1, 01:56:04, FastEthernet1/0
C 10.23.0.0 is directly connected, FastEthernet2/0
O IA 10.35.0.0 [110/2000] via 10.23.0.3, 01:55:59, FastEthernet2/0
```

R2(config-router)#

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m. Screenshot of R3 to examine its current OSPF neighbor and route information.

Cisco Packet Tracer - H:\Harish\CMPE_206\Lab 2\CMPE_206_Lab_2_OSPF_Network_Topology_Multi_Area[Initial].pkt

File Edit Options View Tools Extensions Window Help

Logical Physical x 1230, y 277

Time: 01:58:33

R3

Physical Config CLI Attributes

IOS Command Line Interface

Enter configuration commands, one per line. End with CNTL/Z.

```
R3(config)#router ospf 1
R3(config-router)#passive-interface 10
R3(config-router)#auto-cost reference-bandwidth 1000000
R3(config-router)#
R3(config-router)#
R3(config-router)#do show ip ospf neighbor
R3(config-router)#do show ip route
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
2.2.2.2	1	FULL/DR	00:00:37	10.23.0.2	FastEthernet1/0
5.5.5.5	1	FULL/DR	00:00:37	10.35.0.5	FastEthernet3/0

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

```
1.0.0.0/32 is subnetted, 1 subnets
O IA 1.1.1.1 [110/2012] via 10.23.0.2, 01:57:15, FastEthernet1/0
O 2.0.0.0/32 is subnetted, 1 subnets
O 2.2.2.2 [110/1012] via 10.23.0.2, 01:57:15, FastEthernet1/0
C 3.0.0.0/32 is subnetted, 1 subnets
C 3.3.3.3 is directly connected, Loopback0
O IA 4.0.0.0/32 is subnetted, 1 subnets
O IA 4.4.4.4 [110/2112] via 10.23.0.2, 00:21:45, FastEthernet1/0
O 5.0.0.0/32 is subnetted, 1 subnets
O 5.5.5.5 [110/1012] via 10.35.0.5, 01:57:20, FastEthernet3/0
O 10.0.0.0/24 is subnetted, 4 subnets
O IA 10.12.0.0 [110/2000] via 10.23.0.2, 01:57:15, FastEthernet1/0
O IA 10.14.0.0 [110/2100] via 10.23.0.2, 01:57:15, FastEthernet1/0
C 10.23.0.0 is directly connected, FastEthernet1/0
C 10.35.0.0 is directly connected, FastEthernet3/0
```

R3(config-router)#

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n. Screenshot of R4 to examine its current OSPF neighbor and route information.

Cisco Packet Tracer - H:\Harish\CMPE_206\Lab 2\CMPE_206_Lab_2_OSPF_Network_Topology_Multi_Area[Initial].pkt

File Edit Options View Tools Extensions Window Help

Logical Physical x 1212, y 433

Time: 01:58:26

R4

Physical Config CLI Attributes

IOS Command Line Interface

Enter configuration commands, one per line. End with CNTL/Z.

```
R4(config)#router ospf 1
R4(config-router)#passive-interface 10
R4(config-router)#auto-cost reference-bandwidth 1000000
R4(config-router)#
R4(config-router)#
R4(config-router)#do show ip ospf neighbor
R4(config-router)#do show ip route
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
1.1.1.1	1	FULL/DR	00:00:39	10.14.0.1	GigabitEthernet0/0

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

```
1.0.0.0/32 is subnetted, 1 subnets
O 1.1.1.1 [110/112] via 10.14.0.1, 01:58:25, GigabitEthernet0/0
O 4.0.0.0/32 is subnetted, 1 subnets
C 4.4.4.4 is directly connected, Loopback0
O 10.0.0.0/24 is subnetted, 2 subnets
O 10.12.0.0 [110/1100] via 10.14.0.1, 01:58:10, GigabitEthernet0/0
C 10.14.0.0 is directly connected, GigabitEthernet0/0
```

R4(config-router)#

R4(config-router)#

Copy Paste

o. Screenshot of R5 to examine its current OSPF neighbor and route information.

The screenshot shows a network topology in Cisco Packet Tracer. The network is divided into three OSPF areas: Area 1 (blue), Area 0 (green), and Area 2 (yellow). Routers are connected as follows: R1 (Area 1) to R2 (Area 0) via F1/0 (10.12.0.0/24) and F1/0 (10.14.0.0/24); R2 (Area 0) to R3 (Area 0) via F2/0 (10.23.0.0/24); R3 (Area 0) to R5 (Area 2) via F3/0 (10.35.0.0/24) and F0/0 (10.35.0.0/24). R4 is a dummy router connected to R1 and R2. The CLI window for R5 shows the following output:

```
R5#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R5(config)#router ospf 1
R5(config-router)#passive-interface 10
R5(config-router)#auto-cost reference-bandwidth 100000
R5(config-router)#
R5(config-router)#
R5(config-router)#do show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
3.3.3.3         1    FULL/BDR        00:00:33    10.35.0.3       FastEthernet0/0

R5(config-router)#do show ip route

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
        D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
        I - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
        * - candidate default, U - per-user static route, o - ODR
        P - periodic downloaded static route

Gateway of last resort is not set

1.0.0.0/32 is subnetted, 1 subnets
O IA   1.1.1.1 [110/3012] via 10.35.0.3, 01:59:06, FastEthernet0/0
O IA   2.0.0.0/32 is subnetted, 1 subnets
O IA   2.2.2.2 [110/2012] via 10.35.0.3, 01:59:06, FastEthernet0/0
O IA   3.0.0.0/32 is subnetted, 1 subnets
O IA   3.3.3.3 [110/1012] via 10.35.0.3, 01:59:06, FastEthernet0/0
O IA   4.0.0.0/32 is subnetted, 1 subnets
O IA   4.4.4.4 [110/3112] via 10.35.0.3, 00:23:36, FastEthernet0/0
O IA   5.0.0.0/32 is subnetted, 1 subnets
C       5.5.5.5 is directly connected, Loopback0
O IA   10.0.0.0/24 is subnetted, 4 subnets
O IA   10.12.0.0 [110/3000] via 10.35.0.3, 01:59:06, FastEthernet0/0
O IA   10.14.0.0 [110/3100] via 10.35.0.3, 01:59:06, FastEthernet0/0
O IA   10.23.0.0 [110/2000] via 10.35.0.3, 01:59:06, FastEthernet0/0
C       10.35.0.0 is directly connected, FastEthernet0/0

R5(config-router)#
```

Task 8: Configure Area Border Router with Router Summarization:

Performed all the steps for configuring area border router with router summarization.

a. Screenshot of performing route summarization on R2 to optimize the LSDB of R1 and R4.

The screenshot shows the same network topology as before. The CLI window for R2 shows the following configuration and output:

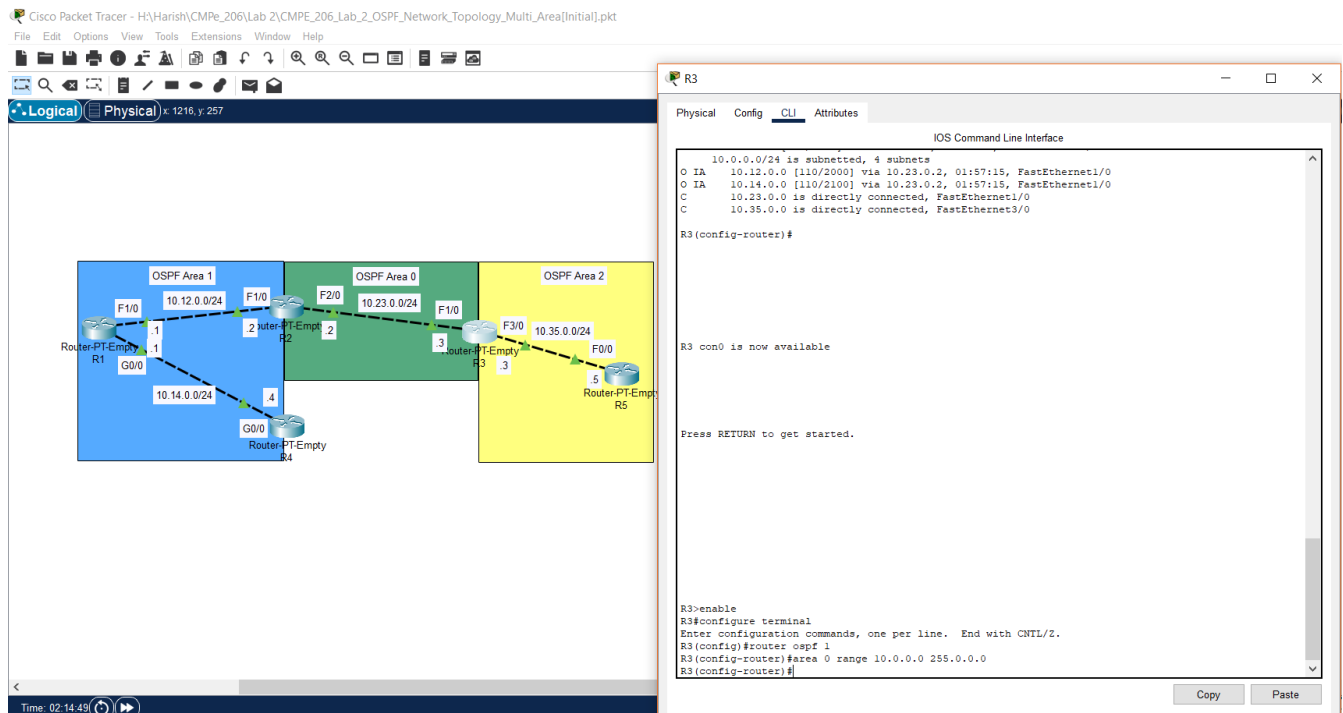
```
R2#enable
R2#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#router ospf 1
R2(config-router)#area 0 range 10.0.0.0 255.0.0.0
R2(config-router)#

R2 con0 is now available.

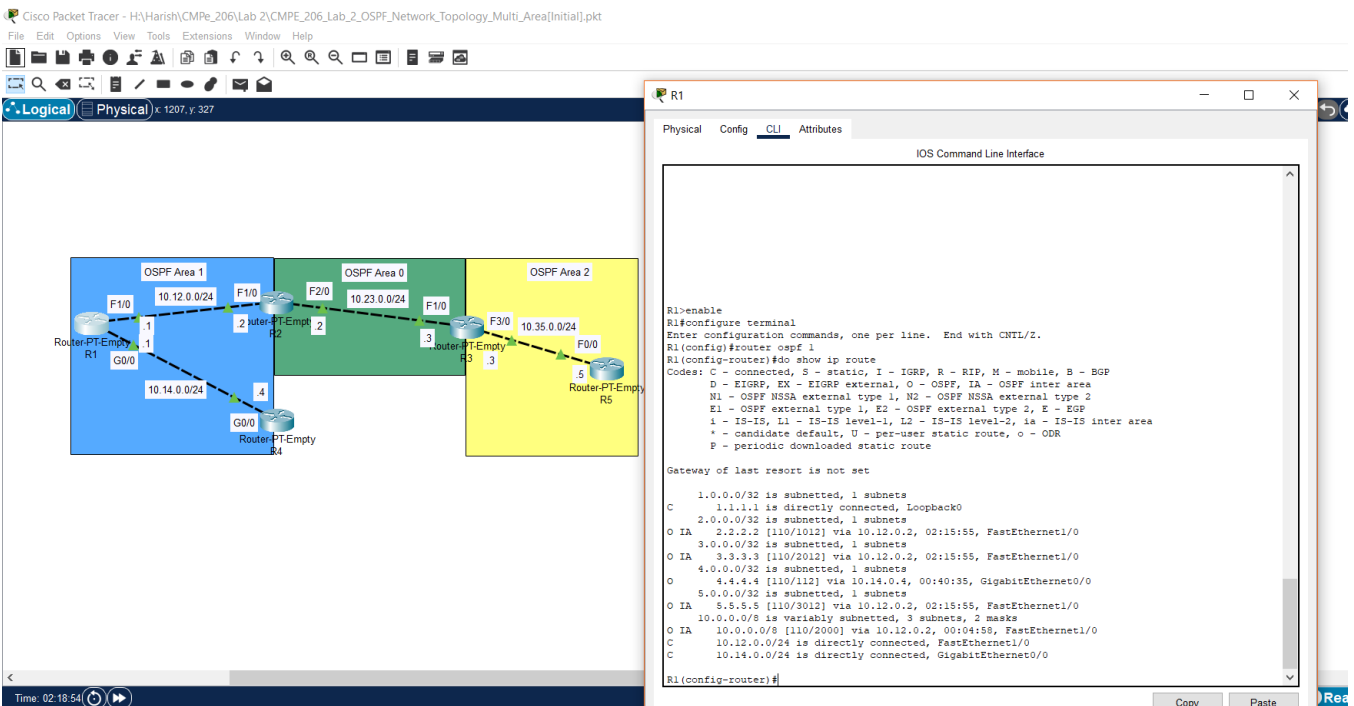
Press RETURN to get started.

R2>enable
R2#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#router ospf 1
R2(config-router)#area 0 range 10.0.0.0 255.0.0.0
R2(config-router)#
```


b. Screenshot of performing route summarization on R3 to optimize the LSDB of R5.



c. Screenshot for examining the routing table on R1 to see if the routing information has been summarized.



d. Screenshot for examining the routing table on R3 to see if the routing information has been summarized.

The screenshot shows a Cisco Packet Tracer interface with a network topology and a CLI window for router R3. The topology consists of three OSPF areas: Area 1 (blue), Area 0 (green), and Area 2 (yellow). Routers R1, R2, R3, R4, and R5 are connected in a mesh topology. R3 is connected to R2, R4, and R5. The CLI window for R3 shows the following output:

```
R3>enable
R3#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#router ospf 1
R3(config-router)#area 0 range 10.0.0.0 255.0.0.0
R3(config-router)#
R3(config-router)#
R3(config-router)#do show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

1.0.0.0/32 is subnetted, 1 subnets
O IA 1.1.1.1 [110/2012] via 10.23.0.2, 02:19:44, FastEthernet1/0
O 2.0.0.0/32 is subnetted, 1 subnets
O 2.2.2.2 [110/1012] via 10.23.0.2, 02:19:44, FastEthernet1/0
O 3.0.0.0/32 is subnetted, 1 subnets
C 3.3.3.3 is directly connected, Loopback0
O 4.0.0.0/32 is subnetted, 1 subnets
O IA 4.4.4.4 [110/2112] via 10.23.0.2, 00:44:14, FastEthernet1/0
O 5.0.0.0/32 is subnetted, 1 subnets
O 5.5.5.5 [110/1012] via 10.35.0.5, 02:19:49, FastEthernet3/0
O 10.0.0.0/8 is a summary, 00:00:00, Null0
O 10.12.0.0/24 [110/2000] via 10.23.0.2, 02:19:44, FastEthernet1/0
O IA 10.14.0.0/24 [110/2100] via 10.23.0.2, 02:19:44, FastEthernet1/0
C 10.23.0.0/24 is directly connected, FastEthernet1/0
C 10.35.0.0/24 is directly connected, FastEthernet3/0

R3(config-router)#
```

e. Screenshot for examining the routing table on R5 to see if the routing information has been summarized.

The screenshot shows a Cisco Packet Tracer interface with a network topology and a CLI window for router R5. The topology is the same as in the previous screenshot. The CLI window for R5 shows the following output:

```
R5>enable
R5#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R5(config)#router ospf 1
R5(config-router)#do show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

1.0.0.0/32 is subnetted, 1 subnets
O IA 1.1.1.1 [110/3012] via 10.35.0.3, 02:21:04, FastEthernet0/0
O 2.0.0.0/32 is subnetted, 1 subnets
O IA 2.2.2.2 [110/2012] via 10.35.0.3, 02:21:04, FastEthernet0/0
O 3.0.0.0/32 is subnetted, 1 subnets
O IA 3.3.3.3 [110/1012] via 10.35.0.3, 02:21:04, FastEthernet0/0
O 4.0.0.0/32 is subnetted, 1 subnets
O IA 4.4.4.4 [110/3112] via 10.35.0.3, 00:45:34, FastEthernet0/0
O 5.0.0.0/32 is subnetted, 1 subnets
C 5.5.5.5 is directly connected, Loopback0
O 10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O IA 10.0.0.0/8 [110/2000] via 10.35.0.3, 00:07:17, FastEthernet0/0
C 10.35.0.0/24 is directly connected, FastEthernet0/0

R5(config-router)#
R5(config-router)#
```

From the above screenshots, it can be seen that the routes have been summarized and the RAM of IRs in a large network can be released for other information storage activities.

9. Conclusion:

From this lab, I:

1. Understood the Mechanism of Link-State Routing Protocol Open Shortest Path First (OSPF).
2. Learned how to Configure Router with Loopback Address.
3. Learned how to Configure Router with OSPF and LSAs Message Sending.
4. Learned how to Configure Router with OSPF LSAs Message Suppression.
5. Learned how to Configure Router with OSPF Reference Bandwidth.
6. Learned how to Configure Router with OSPF Route Cost on Interfaces.
7. Learned how to Configure Router in OSPF Multi-Area Environment.
8. Learned how to Configure Area Border Router with Route Summarization.