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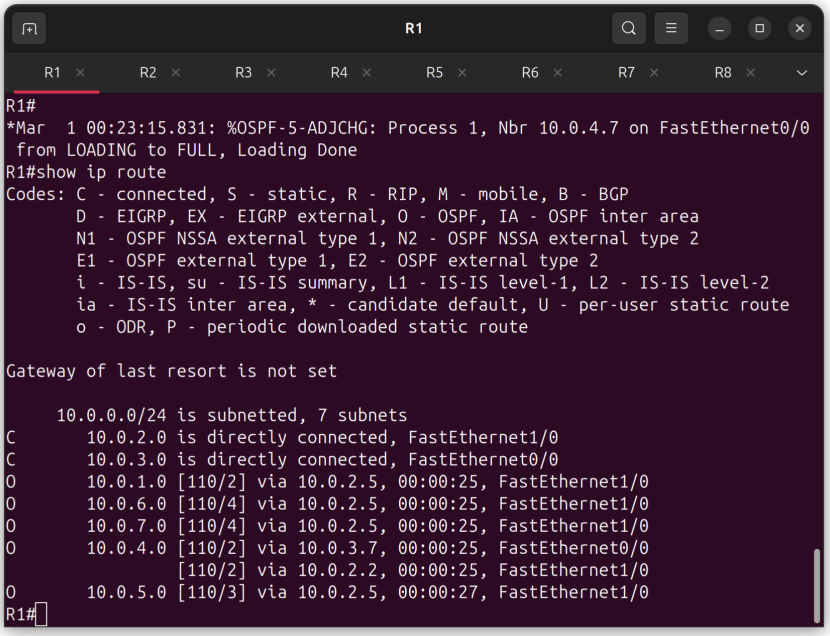
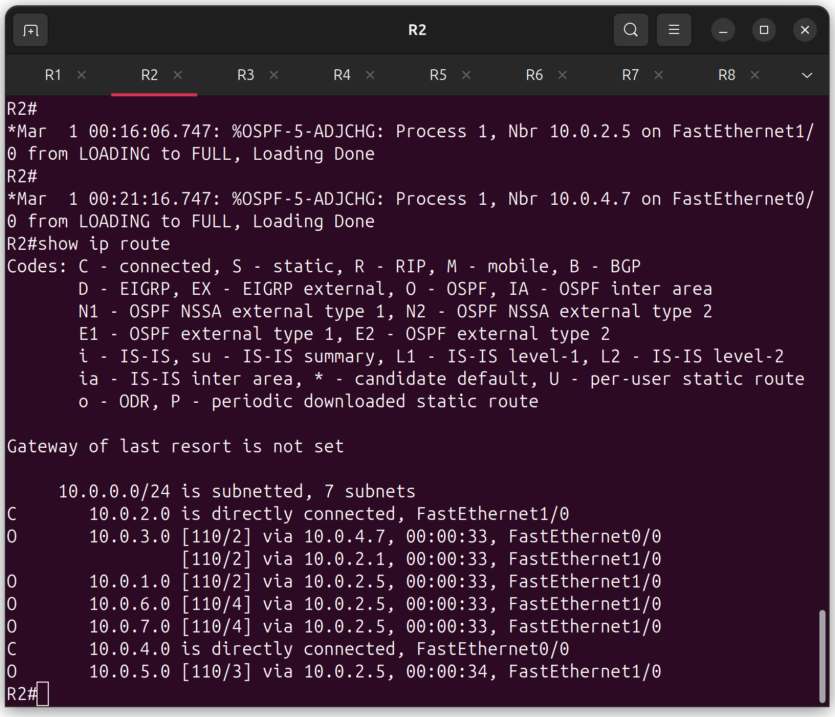
Interconnexion des réseaux - Lab 4

PART 1. Configuring Open Shortest Path First (OSPF) :





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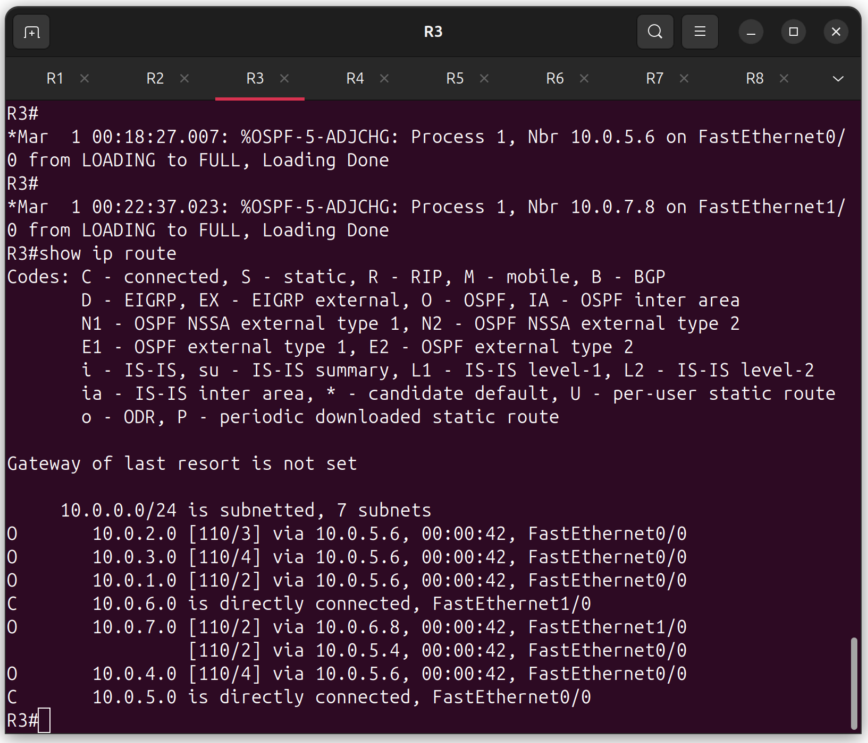

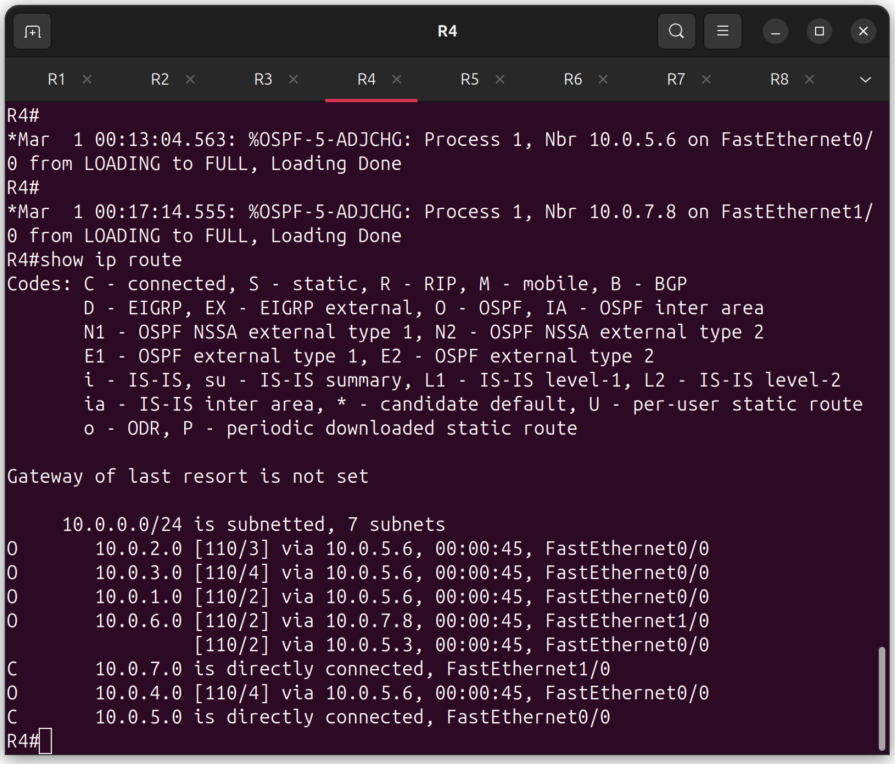

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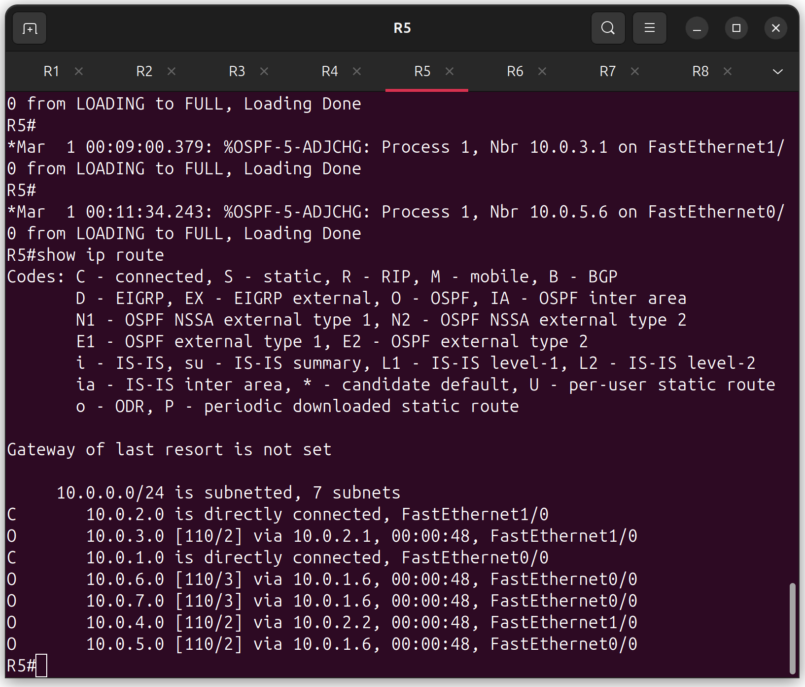

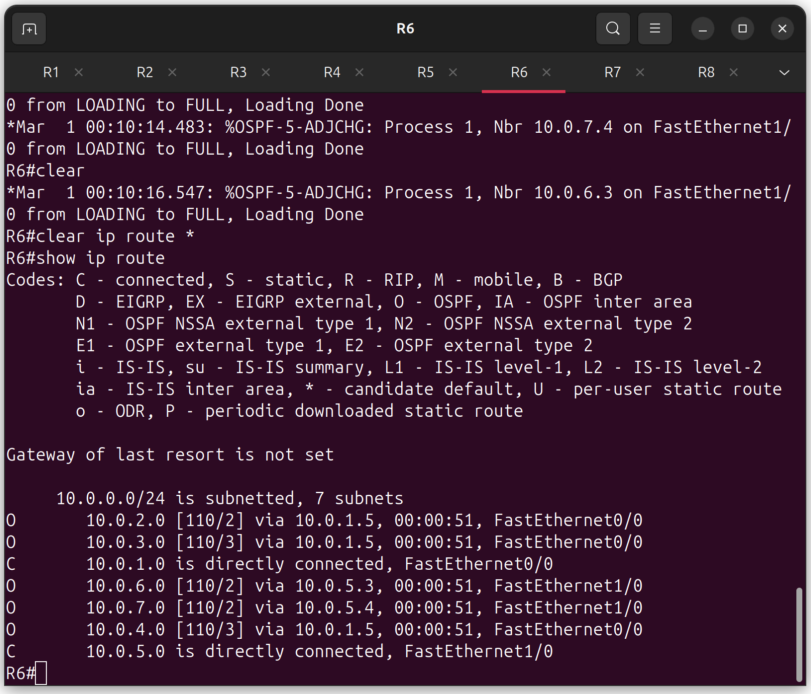

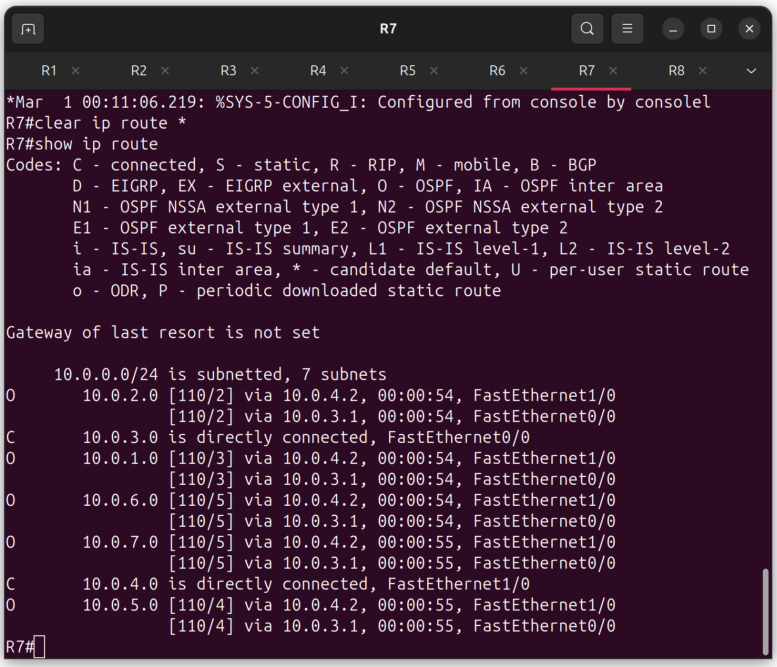

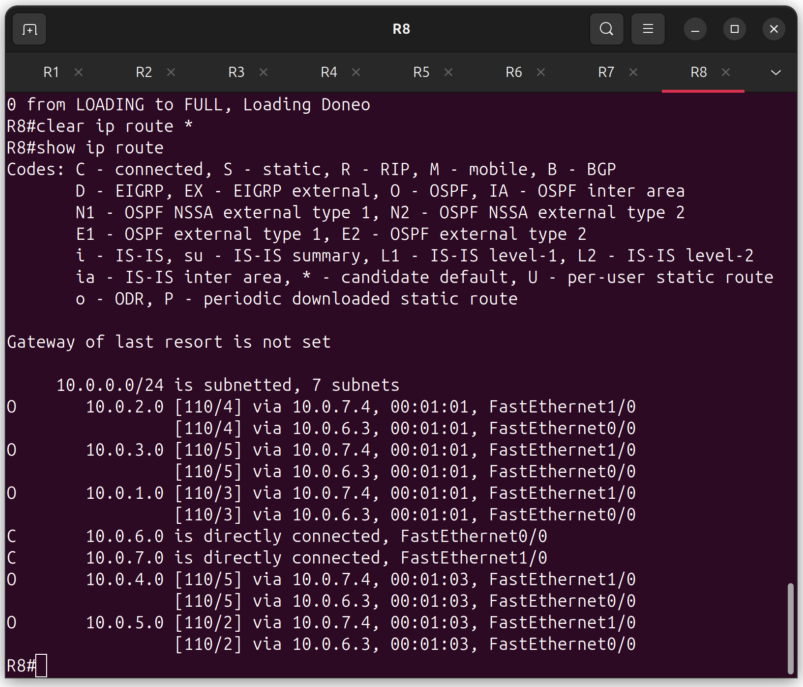

- After you have configured the routers, and started GNS3, check the routing table at each router with the show ip route command. Routers 1 - 8 should have 7 entries (Why?) in the routing table: two entries for directly connected networks and five other entries for remote networks that were added by OSPF.

  All routers (Router 1 to Router 8) have 7 entries in their routing table after OSPF convergence because the total number of unique networks in the topology is 7, and OSPF has successfully learned all of them.

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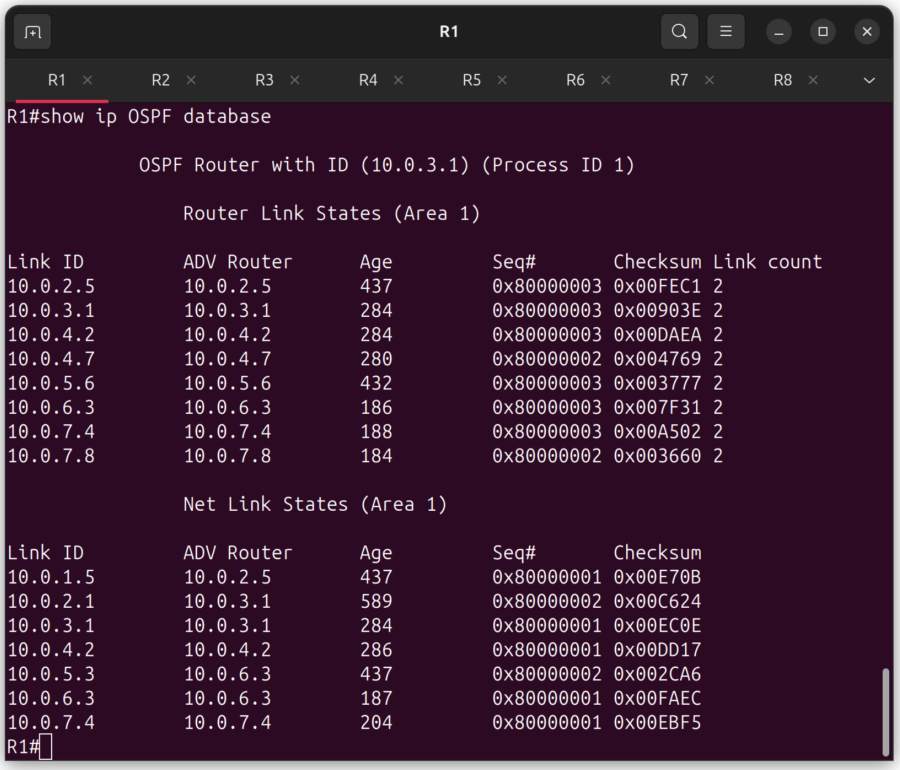

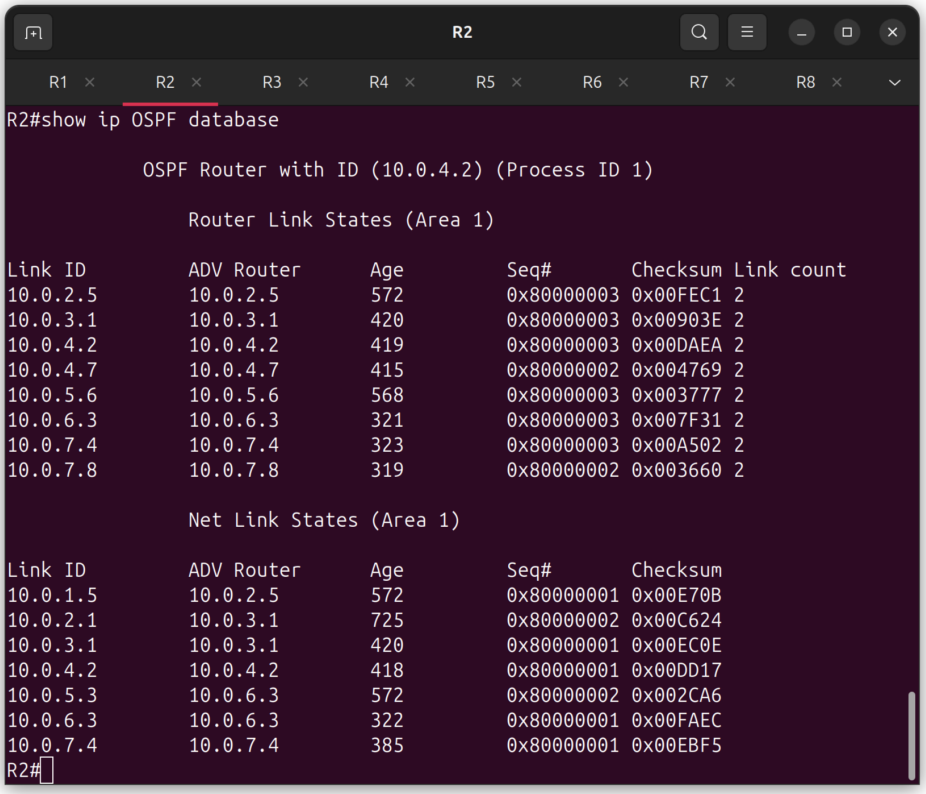

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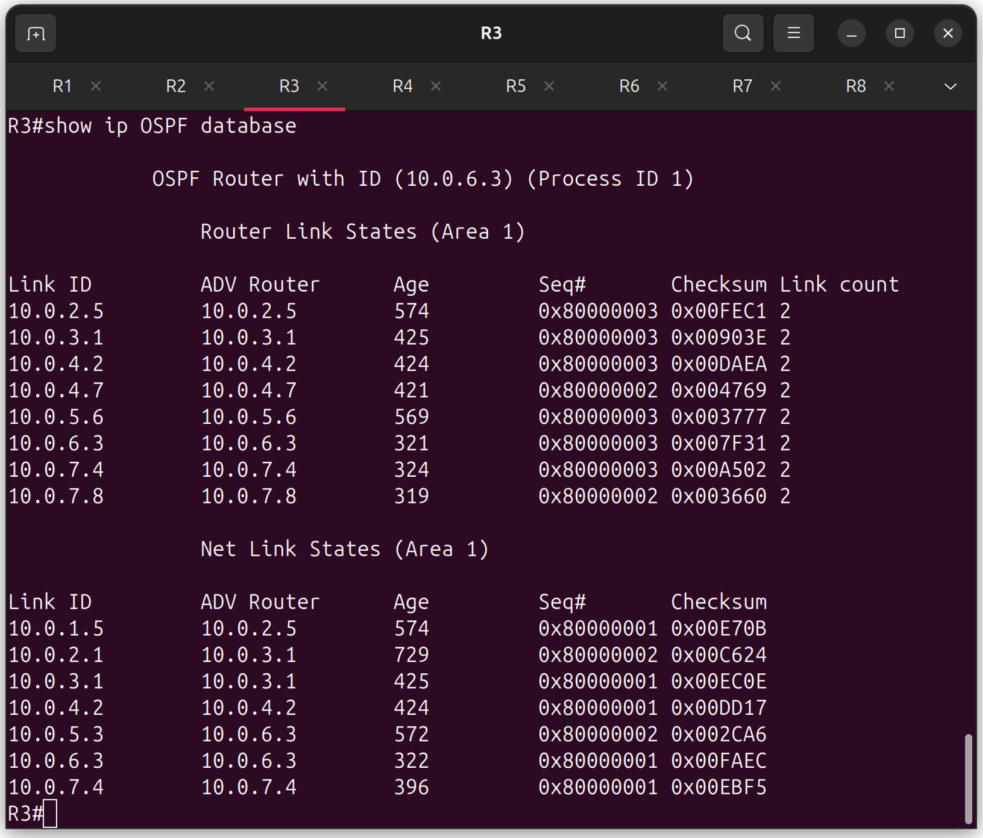

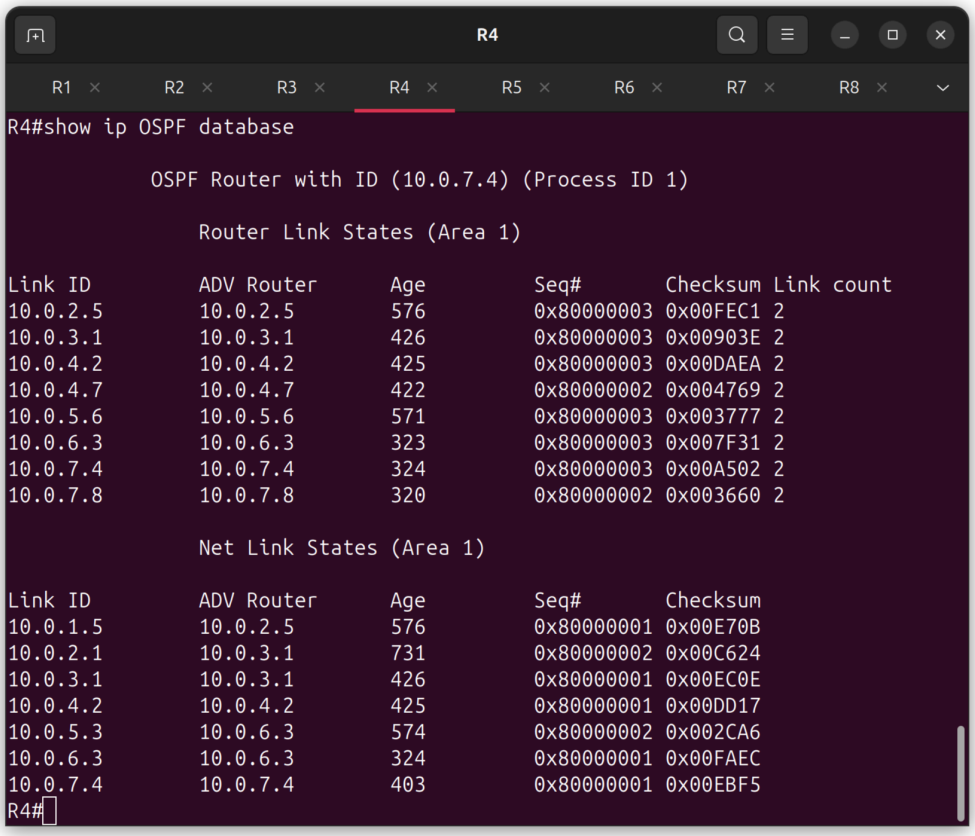

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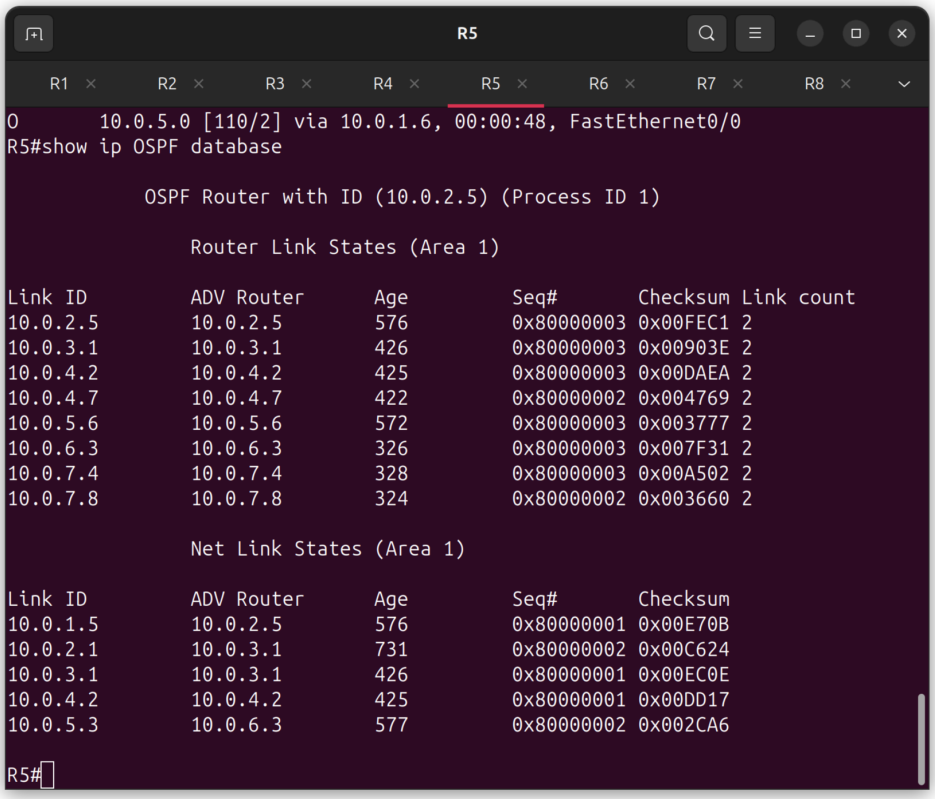

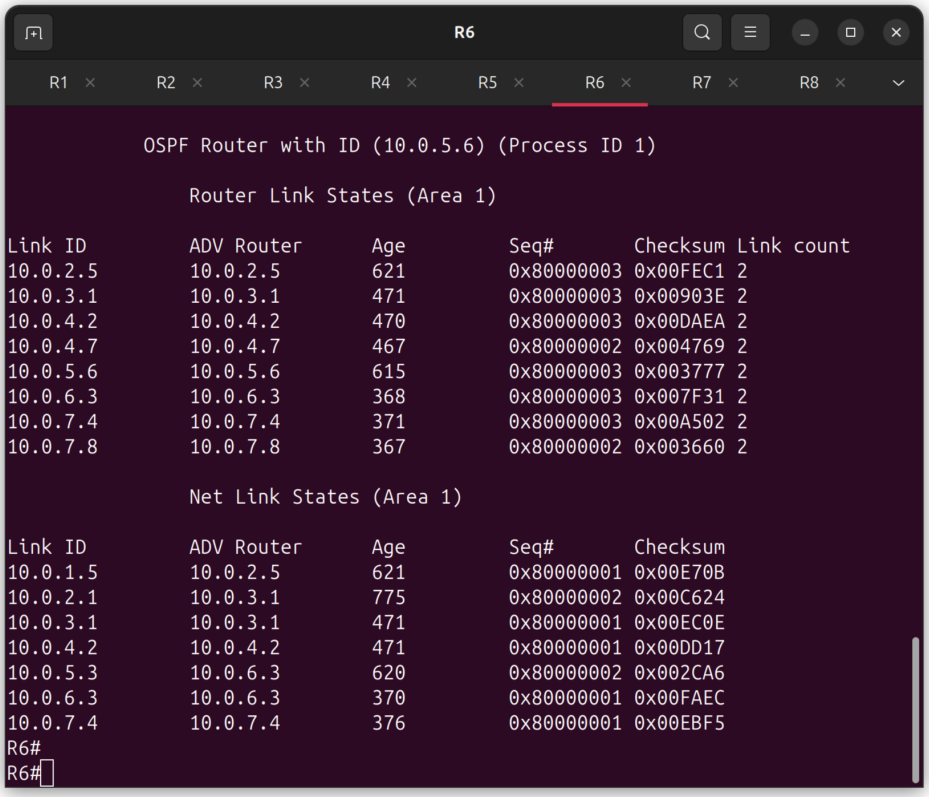

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R7

R1 R2 R3 R4 R5 R6 R7 R8

```
R7#show ip OSPF database

            OSPF Router with ID (10.0.4.7) (Process ID 1)

                Router Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.0.2.5        10.0.2.5        587         0x80000003 0x00FEC1 2
10.0.3.1        10.0.3.1        436         0x80000003 0x00903E 2
10.0.4.2        10.0.4.2        435         0x80000003 0x00DAEA 2
10.0.4.7        10.0.4.7        430         0x80000002 0x004769 2
10.0.5.6        10.0.5.6        583         0x80000003 0x003777 2
10.0.6.3        10.0.6.3        337         0x80000003 0x007F31 2
10.0.7.4        10.0.7.4        339         0x80000003 0x00A502 2
10.0.7.8        10.0.7.8        335         0x80000002 0x003660 2

                Net Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum
10.0.1.5        10.0.2.5        587         0x80000001 0x00E70B
10.0.2.1        10.0.3.1        740         0x80000002 0x00C624
10.0.3.1        10.0.3.1        435         0x80000001 0x00EC0E
10.0.4.2        10.0.4.2        434         0x80000001 0x00DD17
10.0.5.3        10.0.6.3        588         0x80000002 0x002CA6
10.0.6.3        10.0.6.3        338         0x80000001 0x00FAEC
10.0.7.4        10.0.7.4        434         0x80000001 0x00EBF5
R7#
```

R8

R1 R2 R3 R4 R5 R6 R7 R8

```
R8#show ip OSPF database

            OSPF Router with ID (10.0.7.8) (Process ID 1)

                Router Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.0.2.5        10.0.2.5        592         0x80000003 0x00FEC1 2
10.0.3.1        10.0.3.1        442         0x80000003 0x00903E 2
10.0.4.2        10.0.4.2        441         0x80000003 0x00DAEA 2
10.0.4.7        10.0.4.7        438         0x80000002 0x004769 2
10.0.5.6        10.0.5.6        586         0x80000003 0x003777 2
10.0.6.3        10.0.6.3        339         0x80000003 0x007F31 2
10.0.7.4        10.0.7.4        341         0x80000003 0x00A502 2
10.0.7.8        10.0.7.8        335         0x80000002 0x003660 2

                Net Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum
10.0.1.5        10.0.2.5        592         0x80000001 0x00E70B
10.0.2.1        10.0.3.1        746         0x80000002 0x00C624
10.0.3.1        10.0.3.1        442         0x80000001 0x00EC0E
10.0.4.2        10.0.4.2        443         0x80000001 0x00DD17
10.0.5.3        10.0.6.3        591         0x80000002 0x002CA6
10.0.6.3        10.0.6.3        340         0x80000001 0x00FAEC
10.0.7.4        10.0.7.4        442         0x80000001 0x00EBF5
R8#
```

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R7

R1 R2 R3 R4 R5 R6 R7 R8

```
R7#trace 10.0.7.8

Type escape sequence to abort.
Tracing the route to 10.0.7.8

  1 10.0.4.2 12 msec
    10.0.3.1 12 msec
    10.0.4.2 20 msec
  2 10.0.2.5 20 msec 20 msec 20 msec
  3 10.0.1.6 24 msec 40 msec 16 msec
  4 10.0.5.4 36 msec 36 msec 52 msec
  5 10.0.7.8 36 msec 52 msec 56 msec
R7#
R7#
R7#
R7#
R7#
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R7#
```

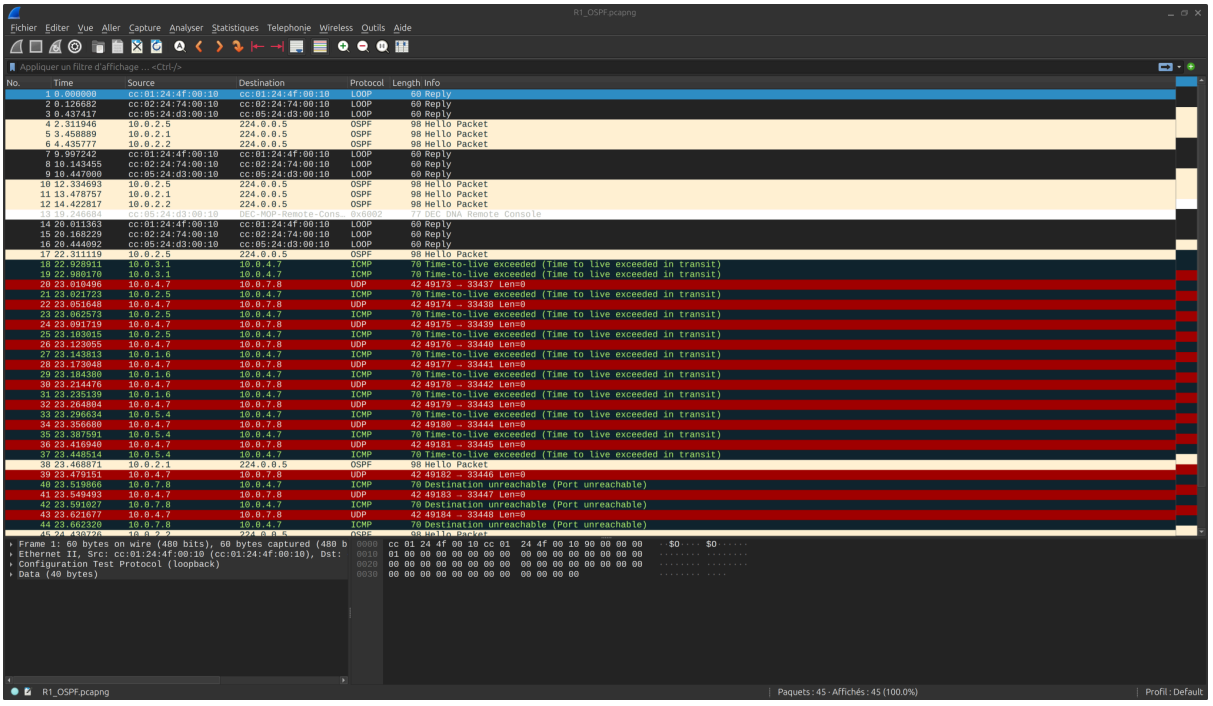

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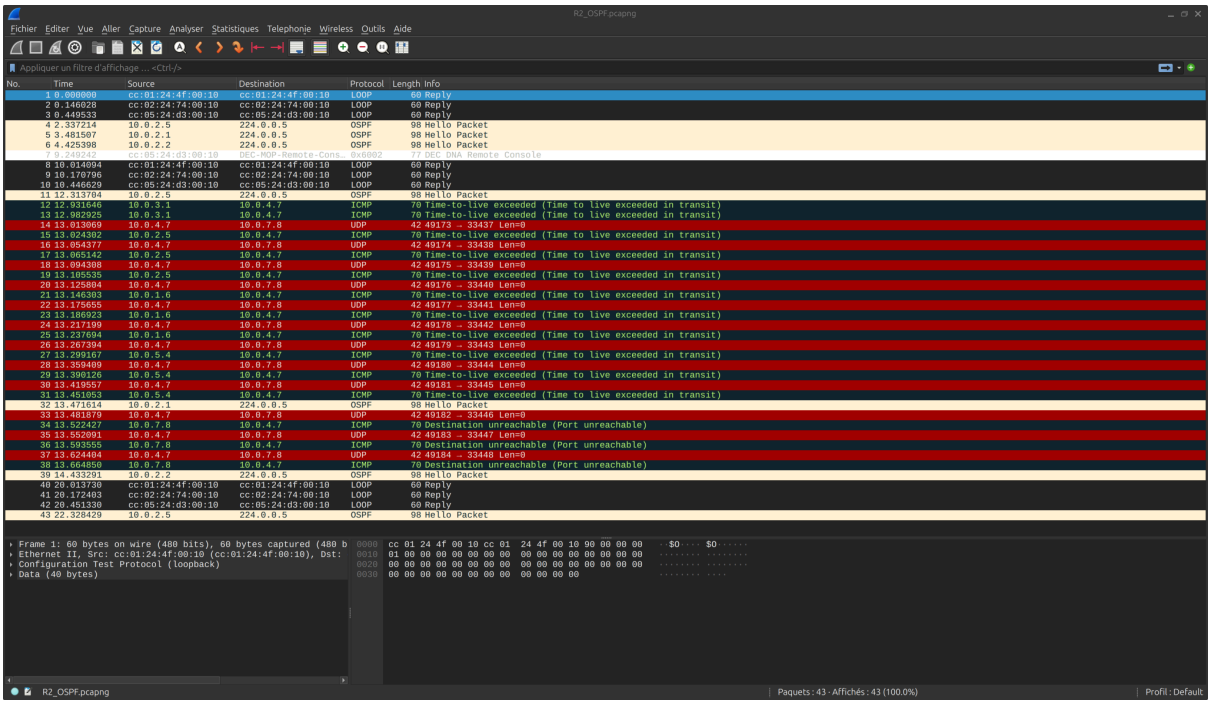

OSPF automatically finds the best paths between routers in an IP network, and it operates at Layer 3 (the network layer) of the OSI model.

Lab Questions :

•Why might an OSPF router handle more than one process?
A router can run multiple OSPF processes because each process is completely separate. This allows the router to manage different networks independently, without mixing their routing information. It is useful when separating departments, testing new configurations, or migrating from one routing setup to another.

• Why does OSPF need a Router ID?
OSPF requires a unique Router ID to identify each router in the protocol. The Router ID ensures that OSPF can uniquely track each router in the topology and maintain a consistent routing database.

• Pick a single link state advertisement packet captured by Wireshark, and interpret the information contained in the link state advertisement.
A captured LSA typically contains the advertising router's ID, the LSA type, sequence number, age, and link information. For example, a Type 1 Router-LSA lists the router's

interfaces, link metrics, and link types. This information describes how the router is connected to the rest of the network.

• Compare the output of the command “show ip OSPF database” from the Cisco routers. What do you notice?
All routers in the same OSPF area have the same information about the network. You can see the same LSAs with the same sequence numbers on all routers. This means OSPF has correctly shared the network topology between them.

• Analyze the output of the trace command from Step 8. What route do the packets take?
The route is a sequence of IP addresses from the first-hop router to the last recorded router:Source => 10.0.4.2 (Hop 1) => 10.0.2.5 (Hop 2) => 10.0.1.6 (Hop 3) => 10.0.5.4 (Hop 4) => 10.0.7.8 (Hop 5) => Destination

• Answer the following questions using the captured packets:

• What is the destination IP address of OSPF packets?
Destination IP address : 10.0.7.8

• Do routers forward OSPF packets? In other words, does Router1 receive OSPF packets sent by Router3?
No, routers do not forward OSPF packets across different subnets. The multicast addresses used by OSPF are link-local and are not routed beyond the immediate network segment. Therefore, Router1 does not receive the original OSPF packet sent by Router3 if they are separated by other routers . Instead, the OSPF routing *information* (LSAs) is propagated by flooding. Each router receives an LSA from a neighbor, adds it to its database, and then generates a new LSU packet to send to its own neighbors, ensuring the information reaches the entire area.

• What type of routing OSPF messages do you observe? The type of a OSPF message is indicated by the value of the field type. For each packet type that you observed, explain the role that this message type plays in the OSPF protocol.

Type (Value)	**Packet Name**	**Role in OSPF Protocol**
1	**Hello**	Used to discover neighbors, establish two-way communication, and maintain the ongoing neighbor relationship.

2	**Database Description (DBD)**	Used during adjacency setup to exchange a summary of the local Link State Database (LSDB).
3	**Link State Request (LSR)**	Sent by a router after reviewing the DBDs to request a full copy of any LSA that it is missing or has an outdated version of.
4	**Link State Update (LSU)**	Contains one or more Link State Advertisements (LSAs). This packet is used to flood the LSA information across the OSPF area to announce topology changes or to reply to an LSR.
5	**Link State Acknowledgment (LSAck)**	Used to reliably acknowledge the receipt of LSU packets, ensuring that the topology information is successfully delivered.

In our Wireshark capture, we primarily see Hello packets. Since the network has likely already converged, these Type 1 OSPF messages are constantly being exchanged to maintain the established neighbor relationships

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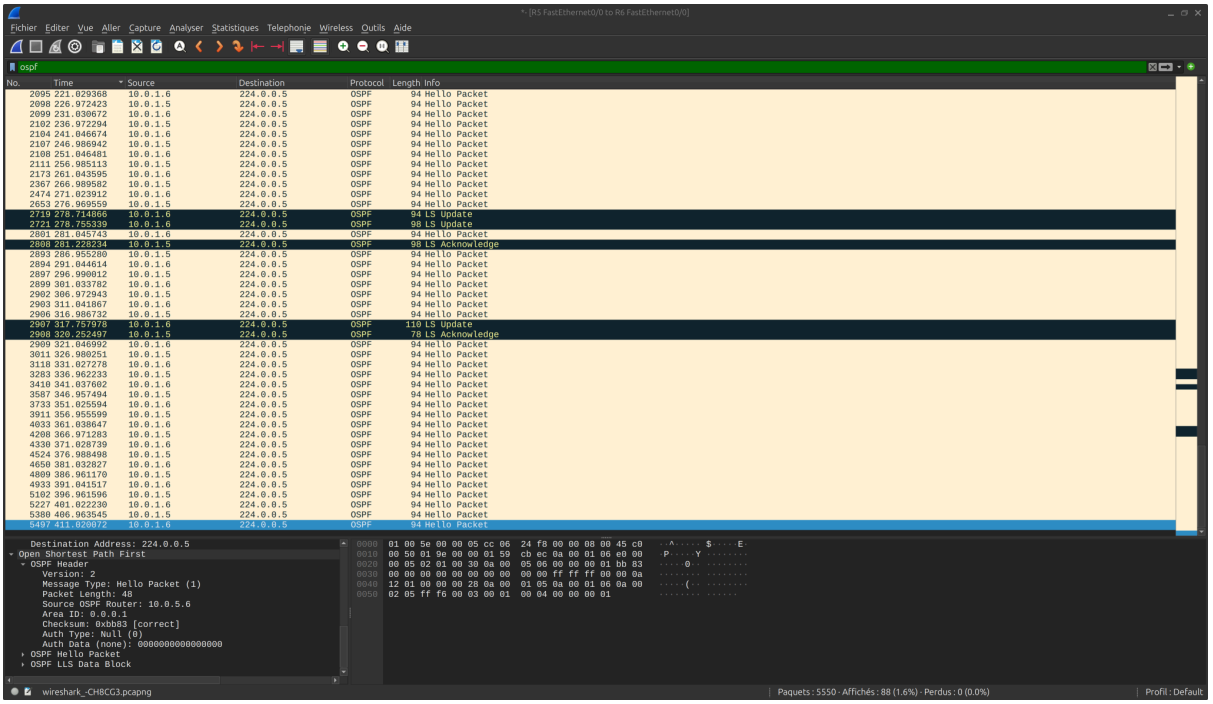
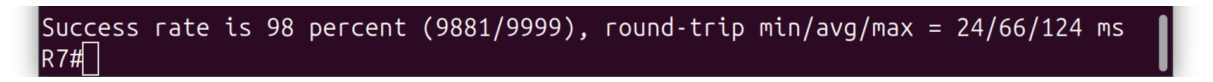
Exercise 1(B). Observing convergence of OSPF

Note : Path only includes router 4





Lab Questions:

• Count the number of lost packets and calculate the time it took OSPF to update the routing tables. (Assume the ping command issues an ICMP Echo Request message approximately once every second.)

The first image shows the statistics of the ping command issued from Router7:

- **Total packets sent:** 9999
- **Total packets received:** 9881
- **Success rate:** 98 %
- **Lost packets:** $9999 - 9881 = 118

Assuming the ping command issues an ICMP Echo Request message approximately once every second:

Time to Update (Convergence Time): The time it took OSPF to update the routing tables is approximately equal to the number of lost packets, or 118 seconds.

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• Use the saved Wireshark output to answer the following questions:

o How quickly are OSPF messages sent after the cable is disconnected? Compare with RIP from Lab 3.

OSPF messages (LSU) are sent almost immediately after the adjacent router detects the interface failure (link-down event). OSPF uses event-driven updates to react quickly to topology changes. This is much faster than RIP (Lab 3), which typically waits up to 30 seconds (by default) for a regular update timer to expire.

o How many OSPF messages are sent?

The number of OSPF messages sent for convergence is relatively low and involves a flash of non-Hello traffic: the detecting router sends an LSU (containing the LSA) to its neighbors. This packet is then flooded across the network, with each router acknowledging receipt with an LSAck (Link State Acknowledgment).

o Which type of OSPF packet is used for flooding link state information?

The OSPF packet type used for flooding link state information is the Link State Update (LSU) packet (Type 4). The LSU is the container that carries the actual Link State Advertisement (LSA), which details the topology change (the disconnected link).

o Describe the flooding of Link State Advertisements to all routers.

Flooding begins when the router that detects a change creates and sends an LSU to its neighbors. Each neighbor checks the LSA. If it's newer, it updates its database and forwards the LSU to all its other neighbors. This process ensures the LSA is distributed to every router in the area.

o Which type of encapsulation is used for OSPF packets (TCP, UDP, or other)? Why in your opinion this choice was made? Compare with the case of RIP messages.

OSPF packets use IP protocol directly (Protocol Number 89) for encapsulation; they do not use TCP or UDP. This choice is made because OSPF handles its own reliability using LSAck packets. This avoids TCP overhead while providing reliable delivery, unlike RIP which uses UDP.

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PART 2. Hierarchical Routing in OSPF

After following all steps, we can’t ping the others routers

Lab Questions:

• Compare the OSPF databases of the routers in this part to that from step 4 in PART 2 (exercise 1(A)).

I cannot answer the following question

• Explain the output of the command show ip ospf border-routers.

This command displays routers known as Area Border Routers (ABRs) and Autonomous System Boundary Routers (ASBRs). ABRs connect two or more areas, including the Backbone Area (Area 0). In your setup, Router5

• Compare the link state databases to those saved in Part 1. Observe any differences? List if any.

I cannot answer the following question

• Which information do routers in Area 1 have about Area 2? Which information do they have about the backbone area (Area 0)?

About Area 2: Area 1 routers have limited information about Area 2. They receive Summary LSAs from the ABR (Router5) which advertise the networks in Area 2, but not its detailed internal topology.

About Area 0 (Backbone): Routers in Area 1 have complete topology information about the Backbone Area (Area 0) because all inter-area traffic must traverse it.

• How much information do the routers in the backbone area (Area 0) have about the topology of Area 1 and Area 2?

Routers in Area 0 (Router5, Router6) have limited information about the internal topologies of Area 1 and Area 2. They receive Summary LSAs from the ABRs which advertise the network prefixes reachable within those areas. The detailed internal link-state topology of Area 1 and Area 2 is not flooded into the backbone.

• How do the IP routers in Area 1 know how to forward traffic to Area 2?

Area 1 routers forward traffic to Area 2 via the Area Border Router (ABR), which is Router5 in this configuration. Router5 sends Summary LSAs to Area 1 advertising Area 2 networks. Area 1 routers calculate the shortest path to the ABR, and all Area 2-bound traffic is sent to Router5 to be routed through Area 0

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• What would be the impact of changing the inverse network masks to 0.255.255.255?

Changing the inverse mask to `0.255.255.255` means the mask is `255.0.0.0`, resulting in the advertisement of the entire 10.0.0.0/8 network range. This would cause the router to advertise a vast network unnecessarily. It is poor practice as it leads to large, imprecise routing table entries and potential routing confusion, instead of advertising specific subnets

• Explore on you own (e.g. search for answers on the Cisco technical Support web page) : “how to create a virtual link between two routers”. How can virtual links be useful in hierarchical OSPF routing? Why a “transit area” cannot be a stub area?

Virtual Links (V-Link): A virtual link is configured between two ABRs to logically connect an area that lacks a physical connection to the Backbone Area (Area 0). They are crucial for maintaining the required star topology where all areas must be connected to Area 0.

Why a Transit Area Cannot be a Stub Area: A transit area is used to pass traffic between other areas and must carry Summary LSAs. A stub area is designed to minimize LSA traffic by blocking many LSAs, making it unsuitable for transmitting inter-area traffic.

• Can you think of a single command that would allow to enable assign all interfaces on a given router to a specific area, e.g., area 0?

Yes, you can use a single, less specific network command in OSPF configuration mode:

```
Router(config-router)# network 0.0.0.0 255.255.255.255 area 0
```

This command matches all IP addresses on the router and assigns them to Area 0, effectively enabling OSPF on every active interface in that area.

• Is it possible to set up different passwords for different OSPF areas? Is it possible to set up different passwords within the same OSPF area?

Different Passwords for Different OSPF Areas: Yes, it's possible. OSPF authentication is configured per interface. Since different areas connect to different interfaces, you can apply unique passwords to interfaces belonging to different areas.

Different Passwords within the Same OSPF Area: Yes, configuration-wise. However, all routers on the same physical segment (subnet) must use the identical password and key ID to establish a successful neighbor adjacency.

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PART 3. Configuring The Border Gateway Protocol (BGP)

```
R1(config)#no ip routing
R1(config)#ip routing
R1(config)#in
R1(config)#interface fas
R1(config)#interface fastEthernet 0/0
R1(config-if)#no shutdown
R1(config-if)#ip address 10.0.1.1 255.255.255.0
R1(config-if)#interface fastethernet1/0
R1(config-if)#ip address 10.0.4.1 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#router bgp 100
R1(config-router)#neighbor 10.0.4.2 remote-as 200
R1(config-router)#neighbor 10.0.4.3 remote-as 300
R1(config-router)#end
R1# cl
*Mar  1 00:47:19.767: %SYS-5-CONFIG_I: Configured from console by console
R1# clear ip bgp *
R1#
*Mar  1 00:47:23.843: %BGP-5-ADJCHANGE: neighbor 10.0.4.2 Up
R1#show ip
*Mar  1 00:47:25.031: %BGP-5-ADJCHANGE: neighbor 10.0.4.2 Down User reset
R1#show ip route
Codes: C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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

     10.0.0.0/24 is subnetted, 2 subnets
C       10.0.1.0 is directly connected, FastEthernet0/0
C       10.0.4.0 is directly connected, FastEthernet1/0
R1#
*Mar  1 00:47:27.111: %BGP-5-ADJCHANGE: neighbor 10.0.4.2 Up
R1#
```

BGP isn’t working, for all 3 routers, we followed all the steps given in the document.
For the lab questions, we looked at others groups Wireshark captures.

1. Describe the different types of BGP messages that you observe in the Wireshark window on PC4.

BGP uses four primary message types:

- **OPEN:** Used to establish and configure the BGP peering session.
- **KEEPALIVE:** Sent periodically to maintain the connection and prevent timeout.
- **UPDATE:** Used to exchange routing information. This message carries all path attributes.
- **NOTIFICATION:** Sent when an error is detected or to gracefully close a BGP session.

2. Which BGP message(s) contain(s) the AS-PATH information? Use a BGP message to illustrate your answer.

The UPDATE message carries the AS-PATH information. The AS-PATH is an ordered list of Autonomous Systems the route has traversed.

If Router R3 (AS 300) sends an UPDATE message for network 10.3.3.0/24 to R2 (AS 200), the AS-PATH attribute will be: 300.

3. What transport protocol does BGP use to carry its messages? Why this choice was made?

BGP uses TCP (Transmission Control Protocol) on port 179. BGP needs reliable, ordered delivery of its critical routing updates. TCP provides this reliability, sequencing, and flow control, allowing BGP to focus solely on route processing.

4. What is the IP address of the next-hop attribute for AS 100 on Router 2?

The Next-Hop attribute is the IP address of the immediate neighbor that advertised the route. The Next-Hop for any route received by R2 from AS 100 will be: 10.0.4.1.

5. What are the BGP peers in this topology?

Based on the configurations for R1 (AS 100), R2 (AS 200), and R3 (AS 300), the established external BGP peer relationships are:

R1 and R2: IP Addresses: 10.0.4.1 (AS 100) and 10.0.4.2 (AS 200)

R2 and R3: IP Addresses: 10.0.4.2 (AS 200) and 10.0.4.3 (AS 300)

R2 acts as a transit router, connecting the other two Autonomous Systems.