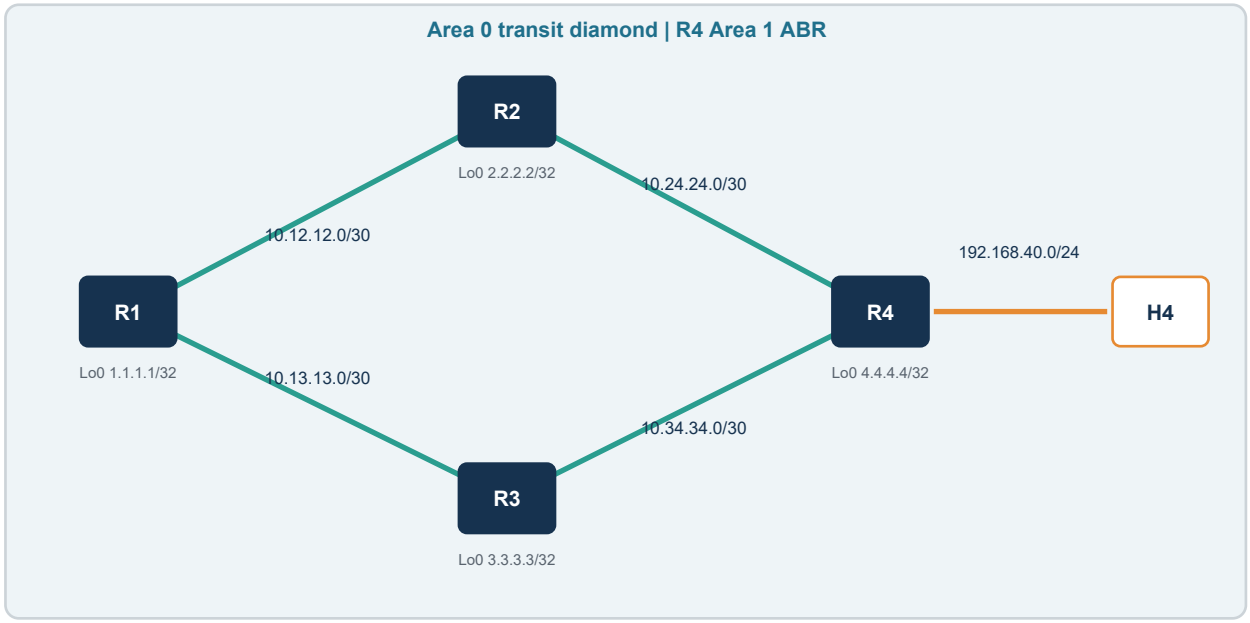
CCNP ENARSI

Lab 07

OSPF Path Preference, Cost, ECMP & LSA Analysis



Guided workbook | 5 approved IOL L3 nodes

Observe path choice, change one OSPF cost, prove ECMP and interpret Router/Summary LSAs.

Blueprint	Level	Estimated time	Validated platform
OSPF path selection / LSAs	Intermediate	120-160 min	EVE-NG / approved IOL L3

CLI annotations: GREEN - expected healthy result; YELLOW - warning or interpretation required; RED - fault or failed requirement. Colors are workbook annotations, not native CLI colors. Variable timers and ages may differ. Yellow/red items include a one-line reason.

1. Objective and production context

Two independent Area 0 paths connect R1 to the R4 area border router. Learn how OSPF route class and cumulative interface cost select the installed path, then create equal-cost paths and inspect the LSAs behind the result. The test prefix 192.168.40.0/24 is in Area 1; H4 represents a branch client. This lab addresses the ENARSI v1.1 OSPF route-selection and LSA objectives.

2. Observable learning outcomes

Verify four Area 0 adjacencies, identify R4 as ABR, read the O IA route to Area 1, prove R1 initially selects the lower-cost R2 path, change one interface cost, verify two equal-cost next hops, inspect Router and Summary LSAs, and prove bidirectional client reachability. Explain the difference between route class and path metric in an interview.

3. Production and interview scenario

A branch prefix is reachable through two transit routers. Operations wants deterministic primary forwarding first, then ECMP after approving equal costs. A FULL neighbor alone does not prove the preferred route or data-plane reachability. The change is confined to R1 Ethernet0/1 cost; no link or other service is deliberately broken. The dedicated troubleshooting lab is Lab 08.

4. Required prior knowledge

Know /30 point-to-point addressing, OSPF areas and ABR role, Type 1 Router and Type 3 Summary LSAs, interface cost addition, administrative distance, passive-interface behavior and how to read an O IA routing entry. Complete the OSPF adjacency and multi-area exercises before changing costs here.

5.1 Deep analysis: path preference and cost

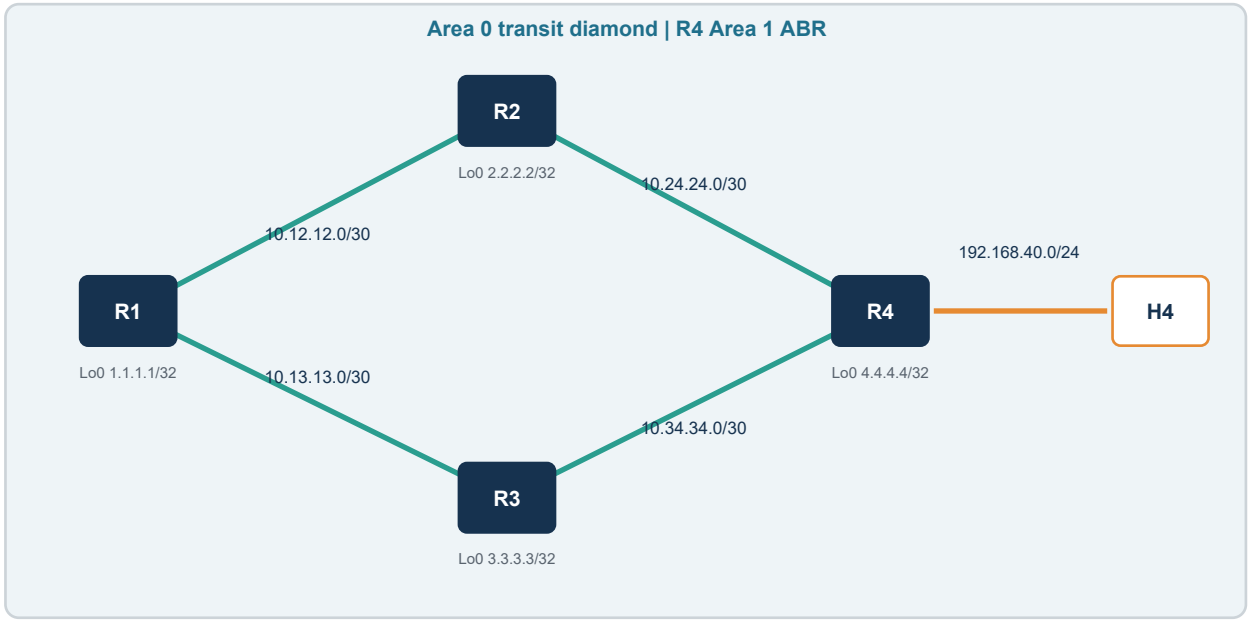
OSPF chooses among candidate paths within a route type using total cost. A lower cost wins; equal costs may install multiple next hops up to the platform maximum-paths setting. The cost applied on the outgoing interface contributes to the path from that router. Here R1-to-R2 and R1-to-R3 are configured with different costs while all other transit costs are 10. For the same Area 1 prefix advertised by R4, R1 initially prefers R2. The exercise then lowers only R1 Ethernet0/1 cost to match the R2 path. Do not infer ECMP from two neighbors; confirm two next hops in the route entry.

5.2 Deep analysis: topology LSAs and route classes

Each Area 0 router describes its links in a Type 1 Router LSA. Because the transit links use point-to-point network type, a Type 2 Network LSA is not expected for those links. R4 attaches to Area 1 and advertises its LAN toward Area 0 with a Type 3 Summary LSA. R1 therefore installs the LAN as O IA. Router-LSA topology evidence and Summary-LSA prefix evidence are different objects. R4 remains the only ABR; R2 and R3 are alternate Area 0 paths to that ABR. ECMP changes R1 SPF next-hop selection without changing the LAN prefix or duplicating it.

6. Topology and address plan

The four-router diamond is R1-R2-R4 and R1-R3-R4. Transit /30s are 10.12.12.0, 10.24.24.0, 10.13.13.0 and 10.34.34.0. R4 Ethernet0/2 connects to H4 Ethernet0/0 in 192.168.40.0/24. Loopback0 on Rn is n.n.n.n/32. Router links and loopbacks are Area 0; the R4 client LAN is Area 1. All five nodes use the approved IOL L3 image.



Node roles and addresses

Node	Role	Loopback / client address
R1	Source	1.1.1.1/32
R2	Transit	2.2.2.2/32
R3	Transit	3.3.3.3/32
R4	ABR / branch gateway	4.4.4.4/32
H4	Branch endpoint	192.168.40.10/24

Physical interface map

Endpoint A	Endpoint B	Subnet
R1 Ethernet0/0	R2 Ethernet0/0	10.12.12.0/30

Endpoint A	Endpoint B	Subnet
R2 Ethernet0/1	R4 Ethernet0/0	10.24.24.0/30
R1 Ethernet0/1	R3 Ethernet0/0	10.13.13.0/30
R3 Ethernet0/1	R4 Ethernet0/1	10.34.34.0/30
R4 Ethernet0/2	H4 Ethernet0/0	192.168.40.0/24

IPv4 address plan

Link	Router A address	Router B / H4 address
R1-R2	10.12.12.1/30	10.12.12.2/30
R2-R4	10.24.24.1/30	10.24.24.2/30
R1-R3	10.13.13.1/30	10.13.13.2/30
R3-R4	10.34.34.1/30	10.34.34.2/30
Area 1 LAN	192.168.40.1/24	192.168.40.10/24

7. Three starting states

raw is the unconfigured connected topology. save-ip-configuration includes names, IPv4 interfaces, H4 default route and no OSPF. save-config contains the final healthy ECMP configuration. All variants have exactly the same nodes, links, interface numbering and coordinates.

Item	raw	save-ip-configuration	save-config
Topology	Same	Same	Same
Names / IPv4	Absent	Present	Present
OSPF	Absent	Absent	Healthy ECMP
Learner action	Build all	Build routing	Verify only

8.1 Configure R1 IPv4 baseline

Add the documented name, /30 or LAN interfaces and loopback. H4 also needs a default route to R4. These are prerequisite addresses, not the OSPF task.

R1

```
enable
conf t
hostname R1
no ip domain lookup
interface Loopback0
description ROUTER_ID_ANCHOR
ip address 1.1.1.1 255.255.255.255
interface Ethernet0/0
description TO_R2
ip address 10.12.12.1 255.255.255.252
no shutdown
interface Ethernet0/1
description TO_R3
ip address 10.13.13.1 255.255.255.252
no shutdown
end
```

8.2 Configure R2 IPv4 baseline

Add the documented name, /30 or LAN interfaces and loopback. H4 also needs a default route to R4. These are prerequisite addresses, not the OSPF task.

R2

```
enable
conf t
hostname R2
no ip domain lookup
interface Loopback0
description ROUTER_ID_ANCHOR
ip address 2.2.2.2 255.255.255.255
interface Ethernet0/0
description TO_R1
ip address 10.12.12.2 255.255.255.252
no shutdown
interface Ethernet0/1
description TO_R4
ip address 10.24.24.1 255.255.255.252
no shutdown
end
```

8.3 Configure R3 IPv4 baseline

Add the documented name, /30 or LAN interfaces and loopback. H4 also needs a default route to R4. These are prerequisite addresses, not the OSPF task.

R3

```
enable
conf t
hostname R3
no ip domain lookup
interface Loopback0
description ROUTER_ID_ANCHOR
ip address 3.3.3.3 255.255.255.255
interface Ethernet0/0
description TO_R1
ip address 10.13.13.2 255.255.255.252
no shutdown
interface Ethernet0/1
description TO_R4
ip address 10.34.34.1 255.255.255.252
no shutdown
end
```

8.4 Configure R4 IPv4 baseline

Add the documented name, /30 or LAN interfaces and loopback. H4 also needs a default route to R4. These are prerequisite addresses, not the OSPF task.

R4

```
enable
conf t
hostname R4
no ip domain lookup
interface Loopback0
description ROUTER_ID_ANCHOR
ip address 4.4.4.4 255.255.255.255
interface Ethernet0/0
description TO_R2
ip address 10.24.24.2 255.255.255.252
no shutdown
interface Ethernet0/1
description TO_R3
ip address 10.34.34.2 255.255.255.252
no shutdown
interface Ethernet0/2
description AREA_1_CLIENT_LAN
ip address 192.168.40.1 255.255.255.0
no shutdown
end
```

8.5 Configure H4 IPv4 baseline

Add the documented name, /30 or LAN interfaces and loopback. H4 also needs a default route to R4. These are prerequisite addresses, not the OSPF task.

H4

```
enable
conf t
hostname H4
no ip domain lookup
interface Ethernet0/0
description CLIENT_TO_R4
ip address 192.168.40.10 255.255.255.0
no shutdown
ip route 0.0.0.0 0.0.0.0 192.168.40.1
end
```

Wait at least 20 seconds for routing convergence before the next observation.

8.6 Verify R1 baseline

Confirm up/up interfaces and exact addresses. Router OSPF processes should be absent at this stage; H4 must reach only its directly attached gateway.

R1

```
enable
terminal length 0
show ip interface brief
show running-config | section router ospf
```

Actual CLI output - R1

```
R1# show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0/0            10.12.12.1      YES manual up                    up
Ethernet0/1            10.13.13.1      YES manual up                    up
Ethernet0/2            unassigned      YES unset  administratively down down
Ethernet0/3            unassigned      YES unset  administratively down down
Loopback0              1.1.1.1         YES manual up                    up
```

Actual CLI output - R1

```
R1# show running-config | section router ospf
```

8.7 Verify R2 baseline

Confirm up/up interfaces and exact addresses. Router OSPF processes should be absent at this stage; H4 must reach only its directly attached gateway.

R2

```
enable
terminal length 0
show ip interface brief
show running-config | section router ospf
```

Actual CLI output - R2

```
R2# show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0/0            10.12.12.2      YES manual up                    up
Ethernet0/1            10.24.24.1      YES manual up                    up
Ethernet0/2            unassigned      YES unset  administratively down down
Ethernet0/3            unassigned      YES unset  administratively down down
Loopback0              2.2.2.2         YES manual up                    up
```

Actual CLI output - R2

```
R2# show running-config | section router ospf
```

8.8 Verify R3 baseline

Confirm up/up interfaces and exact addresses. Router OSPF processes should be absent at this stage; H4 must reach only its directly attached gateway.

R3

```
enable
terminal length 0
show ip interface brief
show running-config | section router ospf
```

Actual CLI output - R3

```
R3# show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0/0            10.13.13.2      YES manual up                    up
Ethernet0/1            10.34.34.1      YES manual up                    up
Ethernet0/2            unassigned      YES unset  administratively down down
Ethernet0/3            unassigned      YES unset  administratively down down
Loopback0              3.3.3.3         YES manual up                    up
```

Actual CLI output - R3

```
R3# show running-config | section router ospf
```

8.9 Verify R4 baseline

Confirm up/up interfaces and exact addresses. Router OSPF processes should be absent at this stage; H4 must reach only its directly attached gateway.

R4

```
enable
terminal length 0
show ip interface brief
show running-config | section router ospf
```

Actual CLI output - R4

```
R4# show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0/0            10.24.24.2      YES manual up                    up
Ethernet0/1            10.34.34.2      YES manual up                    up
Ethernet0/2            192.168.40.1    YES manual up                    up
Ethernet0/3            unassigned      YES unset  administratively down down
Loopback0              4.4.4.4         YES manual up                    up
```

Actual CLI output - R4

```
R4# show running-config | section router ospf
```

8.10 Verify H4 baseline

Confirm up/up interfaces and exact addresses. Router OSPF processes should be absent at this stage; H4 must reach only its directly attached gateway.

H4

```
enable
terminal length 0
show ip interface brief
show ip route 0.0.0.0
ping 192.168.40.1
```

Actual CLI output - H4

```
H4# show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0/0            192.168.40.10   YES manual up                    up
Ethernet0/1            unassigned      YES unset  administratively down down
Ethernet0/2            unassigned      YES unset  administratively down down
Ethernet0/3            unassigned      YES unset  administratively down down
```

Actual CLI output - H4

```
H4# show ip route 0.0.0.0
Routing entry for 0.0.0.0/0, supernet
  Known via "static", distance 1, metric 0, candidate default path
  Routing Descriptor Blocks:
  * 192.168.40.1
      Route metric is 0, traffic share count is 1
```

Actual CLI output - H4

```
H4# ping 192.168.40.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.40.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

9.1 Configure OSPF on R1

Assign a stable router ID and passive default. Activate Area 0 on router links and loopback. R4 alone activates the passive client LAN in Area 1. Explicit transit costs make path selection reproducible.

R1

```
enable
conf t
router ospf 10
router-id 1.1.1.1
passive-interface default
no passive-interface Ethernet0/0
no passive-interface Ethernet0/1
exit
interface Loopback0
ip ospf 10 area 0
interface Ethernet0/0
ip ospf network point-to-point
ip ospf cost 10
ip ospf 10 area 0
interface Ethernet0/1
ip ospf network point-to-point
ip ospf cost 40
ip ospf 10 area 0
end
```

9.2 Configure OSPF on R2

Assign a stable router ID and passive default. Activate Area 0 on router links and loopback. R4 alone activates the passive client LAN in Area 1. Explicit transit costs make path selection reproducible.

R2

```
enable
conf t
router ospf 10
router-id 2.2.2.2
passive-interface default
no passive-interface Ethernet0/0
no passive-interface Ethernet0/1
exit
interface Loopback0
ip ospf 10 area 0
interface Ethernet0/0
ip ospf network point-to-point
ip ospf cost 10
ip ospf 10 area 0
interface Ethernet0/1
ip ospf network point-to-point
ip ospf cost 10
ip ospf 10 area 0
end
```

9.3 Configure OSPF on R3

Assign a stable router ID and passive default. Activate Area 0 on router links and loopback. R4 alone activates the passive client LAN in Area 1. Explicit transit costs make path selection reproducible.

R3

```
enable
conf t
router ospf 10
router-id 3.3.3.3
passive-interface default
no passive-interface Ethernet0/0
no passive-interface Ethernet0/1
exit
interface Loopback0
ip ospf 10 area 0
interface Ethernet0/0
ip ospf network point-to-point
ip ospf cost 10
ip ospf 10 area 0
interface Ethernet0/1
ip ospf network point-to-point
ip ospf cost 10
ip ospf 10 area 0
end
```

9.4 Configure OSPF on R4

Assign a stable router ID and passive default. Activate Area 0 on router links and loopback. R4 alone activates the passive client LAN in Area 1. Explicit transit costs make path selection reproducible.

R4

```
enable
conf t
router ospf 10
router-id 4.4.4.4
passive-interface default
no passive-interface Ethernet0/0
no passive-interface Ethernet0/1
exit
interface Loopback0
ip ospf 10 area 0
interface Ethernet0/0
ip ospf network point-to-point
ip ospf cost 10
ip ospf 10 area 0
interface Ethernet0/1
ip ospf network point-to-point
ip ospf cost 10
ip ospf 10 area 0
interface Ethernet0/2
ip ospf 10 area 1
end
```

Wait at least 45 seconds for routing convergence before the next observation.

10.1 Verify R1 adjacencies

Require two FULL neighbors on the router-to-router links. Check the OSPF process and interface costs before interpreting selected routes.

R1

```
enable
terminal length 0
show ip ospf neighbor
show ip ospf interface brief
```

Actual CLI output - R1

```
R1# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
3.3.3.3           0   FULL/  -        00:00:31    10.13.13.2      Ethernet0/1
2.2.2.2           0   FULL/  -        00:00:37    10.12.12.2      Ethernet0/0
```

Actual CLI output - R1

```
R1# show ip ospf interface brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Lo0          10    0               1.1.1.1/32         1     LOOP  0/0
Et0/1        10    0               10.13.13.1/30      40    P2P   1/1
Et0/0        10    0               10.12.12.1/30      10    P2P   1/1
```

10.2 Verify R2 adjacencies

Require two FULL neighbors on the router-to-router links. Check the OSPF process and interface costs before interpreting selected routes.

R2

```
enable
terminal length 0
show ip ospf neighbor
show ip ospf interface brief
```

Actual CLI output - R2

```
R2# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
4.4.4.4           0   FULL/  -        00:00:32    10.24.24.2      Ethernet0/1
1.1.1.1           0   FULL/  -        00:00:35    10.12.12.1      Ethernet0/0
```

Actual CLI output - R2

```
R2# show ip ospf interface brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Lo0          10    0               2.2.2.2/32         1     LOOP  0/0
Et0/1        10    0               10.24.24.1/30      10    P2P   1/1
Et0/0        10    0               10.12.12.2/30      10    P2P   1/1
```

10.3 Verify R3 adjacencies

Require two FULL neighbors on the router-to-router links. Check the OSPF process and interface costs before interpreting selected routes.

R3

```
enable
terminal length 0
show ip ospf neighbor
show ip ospf interface brief
```

Actual CLI output - R3

```
R3# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
4.4.4.4           0   FULL/  -        00:00:30    10.34.34.2      Ethernet0/1
1.1.1.1           0   FULL/  -        00:00:36    10.13.13.1      Ethernet0/0
```

Actual CLI output - R3

```
R3# show ip ospf interface brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Lo0          10    0               3.3.3.3/32         1     LOOP  0/0
Et0/1        10    0               10.34.34.1/30      10    P2P   1/1
Et0/0        10    0               10.13.13.2/30      10    P2P   1/1
```

10.4 Verify R4 adjacencies

Require two FULL neighbors on the router-to-router links. Check the OSPF process and interface costs before interpreting selected routes.

R4

```
enable
terminal length 0
show ip ospf neighbor
show ip ospf interface brief
```

Actual CLI output - R4

```
R4# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
3.3.3.3           0   FULL/  -        00:00:38    10.34.34.1      Ethernet0/1
2.2.2.2           0   FULL/  -        00:00:36    10.24.24.1      Ethernet0/0
```

Actual CLI output - R4

```
R4# show ip ospf interface brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Lo0          10    0               4.4.4.4/32         1     LOOP  0/0
Et0/1        10    0               10.34.34.2/30      10    P2P   1/1
Et0/0        10    0               10.24.24.2/30      10    P2P   1/1
Et0/2        10    1               192.168.40.1/24    10    DR    0/0
```

11.1 Observe the initial preferred path

R1 should install one O IA next hop for 192.168.40.0/24 through R2 because its local R1-to-R3 cost is higher. Compare the complete route entry with interface cost before editing.

R1

```
enable
terminal length 0
show ip route 192.168.40.0
show ip ospf interface Ethernet0/0
show ip ospf interface Ethernet0/1
```

Actual CLI output - R1

```
R1# show ip route 192.168.40.0
Routing entry for 192.168.40.0/24
  Known via "ospf 10", distance 110, metric 30, type inter area
  Last update from 10.12.12.2 on Ethernet0/0, 00:00:39 ago
  Routing Descriptor Blocks:
  * 10.12.12.2, from 4.4.4.4, 00:00:39 ago, via Ethernet0/0
      Route metric is 30, traffic share count is 1
```

Actual CLI output - R1

```
R1# show ip ospf interface Ethernet0/0
Ethernet0/0 is up, line protocol is up
  Internet Address 10.12.12.1/30, Interface ID 2, Area 0
  Process ID 10, Router ID 1.1.1.1, Network Type POINT_TO_POINT, Cost: 10
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 2.2.2.2
```

Actual CLI output - R1

```
R1# show ip ospf interface Ethernet0/1
Ethernet0/1 is up, line protocol is up
  Internet Address 10.13.13.1/30, Interface ID 3, Area 0
  Process ID 10, Router ID 1.1.1.1, Network Type POINT_TO_POINT, Cost: 40
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 3.3.3.3
```

11.2 Inspect Area 0 Router LSAs

The Area 0 Router LSAs describe the graph used by SPF. Inspect R1 and R4 entries; R4 is an ABR, not a second copy of the branch prefix.

R1

```
enable
terminal length 0
show ip ospf database router 1.1.1.1
show ip ospf database router 4.4.4.4
```

Actual CLI output - R1

```
R1# show ip ospf database router 1.1.1.1
            OSPF Router with ID (1.1.1.1) (Process ID 10)
Router Link States (Area 0)
  LS Type: Router Links
  Link State ID: 1.1.1.1
  Advertising Router: 1.1.1.1
  Number of Links: 5
       TOS 0 Metrics: 1
    Link connected to: another Router (point-to-point)
     (Link ID) Neighboring Router ID: 3.3.3.3
     (Link Data) Router Interface address: 10.13.13.1
       TOS 0 Metrics: 40
       TOS 0 Metrics: 40
    Link connected to: another Router (point-to-point)
     (Link ID) Neighboring Router ID: 2.2.2.2
     (Link Data) Router Interface address: 10.12.12.1
       TOS 0 Metrics: 10
       TOS 0 Metrics: 10
```

Actual CLI output - R1

```
R1# show ip ospf database router 4.4.4.4
            OSPF Router with ID (1.1.1.1) (Process ID 10)
Router Link States (Area 0)
  LS Type: Router Links
  Link State ID: 4.4.4.4
  Advertising Router: 4.4.4.4
  Area Border Router
  Number of Links: 5
       TOS 0 Metrics: 1
    Link connected to: another Router (point-to-point)
     (Link ID) Neighboring Router ID: 3.3.3.3
     (Link Data) Router Interface address: 10.34.34.2
       TOS 0 Metrics: 10
       TOS 0 Metrics: 10
    Link connected to: another Router (point-to-point)
     (Link ID) Neighboring Router ID: 2.2.2.2
     (Link Data) Router Interface address: 10.24.24.2
       TOS 0 Metrics: 10
       TOS 0 Metrics: 10
```

11.3 Inspect the Area 1 Summary LSA

The Type 3 Summary LSA names the Area 1 branch prefix advertised by ABR R4. Check its Advertising Router and network mask rather than treating the LSA sequence number as a metric.

R1

```
enable
terminal length 0
show ip ospf database summary 192.168.40.0
```

Actual CLI output - R1

```
R1# show ip ospf database summary 192.168.40.0
            OSPF Router with ID (1.1.1.1) (Process ID 10)
Summary Net Link States (Area 0)
  LS Type: Summary Links(Network)
  Link State ID: 192.168.40.0 (summary Network Number)
  Advertising Router: 4.4.4.4
  Network Mask: /24
MTID: 0  Metric: 10
```

12.1 Equalize R1 path cost

Set R1 Ethernet0/1 cost to 10. This is the only OSPF change in the exercise; the four physical links remain up and R4 keeps the branch in Area 1.

R1

```
enable
conf t
interface Ethernet0/1
ip ospf cost 10
end
```

Wait at least 35 seconds for routing convergence before the next observation.

12.2 Verify two installed next hops

Read the same R1 branch route after SPF. Two routing descriptor blocks and equal metric show ECMP; if only one is present, inspect the actual cost and next-hop reachability before changing anything else.

R1

```
enable
terminal length 0
show ip route 192.168.40.0
show ip ospf interface Ethernet0/1
show ip ospf database summary 192.168.40.0
```

Actual CLI output - R1

```
R1# show ip route 192.168.40.0
Routing entry for 192.168.40.0/24
  Known via "ospf 10", distance 110, metric 30, type inter area
  Last update from 10.13.13.2 on Ethernet0/1, 00:00:35 ago
  Routing Descriptor Blocks:
    10.13.13.2, from 4.4.4.4, 00:00:35 ago, via Ethernet0/1
      Route metric is 30, traffic share count is 1
  * 10.12.12.2, from 4.4.4.4, 00:01:16 ago, via Ethernet0/0
      Route metric is 30, traffic share count is 1
```

Actual CLI output - R1

```
R1# show ip ospf interface Ethernet0/1
Ethernet0/1 is up, line protocol is up
  Internet Address 10.13.13.1/30, Interface ID 3, Area 0
  Process ID 10, Router ID 1.1.1.1, Network Type POINT_TO_POINT, Cost: 10
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 3.3.3.3
```

Actual CLI output - R1

```
R1# show ip ospf database summary 192.168.40.0
            OSPF Router with ID (1.1.1.1) (Process ID 10)
Summary Net Link States (Area 0)
  LS Type: Summary Links(Network)
  Link State ID: 192.168.40.0 (summary Network Number)
  Advertising Router: 4.4.4.4
  Network Mask: /24
MTID: 0  Metric: 10
```

12.3 Compare routing-table view

A broad OSPF route list helps detect unintended route loss after the cost change. Confirm the branch prefix remains O IA and the local loopback remains connected.

R1

```
enable
terminal length 0
show ip route ospf
show ip route 4.4.4.4
```

Actual CLI output - R1

```
R1# show ip route ospf
Gateway of last resort is not set
      2.0.0.0/32 is subnetted, 1 subnets
O        2.2.2.2 [110/11] via 10.12.12.2, 00:01:21, Ethernet0/0
      3.0.0.0/32 is subnetted, 1 subnets
O        3.3.3.3 [110/11] via 10.13.13.2, 00:00:36, Ethernet0/1
      4.0.0.0/32 is subnetted, 1 subnets
O        4.4.4.4 [110/21] via 10.13.13.2, 00:00:36, Ethernet0/1
                 [110/21] via 10.12.12.2, 00:01:17, Ethernet0/0
      10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O        10.24.24.0/30 [110/20] via 10.12.12.2, 00:01:21, Ethernet0/0
O        10.34.34.0/30 [110/20] via 10.13.13.2, 00:00:36, Ethernet0/1
O IA  192.168.40.0/24 [110/30] via 10.13.13.2, 00:00:36, Ethernet0/1
                      [110/30] via 10.12.12.2, 00:01:17, Ethernet0/0
```

Actual CLI output - R1

```
R1# show ip route 4.4.4.4
Routing entry for 4.4.4.4/32
  Known via "ospf 10", distance 110, metric 21, type intra area
  Last update from 10.13.13.2 on Ethernet0/1, 00:00:36 ago
  Routing Descriptor Blocks:
    10.13.13.2, from 4.4.4.4, 00:00:36 ago, via Ethernet0/1
      Route metric is 21, traffic share count is 1
  * 10.12.12.2, from 4.4.4.4, 00:01:17 ago, via Ethernet0/0
      Route metric is 21, traffic share count is 1
```

13.1 Test R1-to-H4 forwarding

Ping the remote client from R1 Loopback0 to exercise the selected route plus H4 return path. This proves more than a transit-link probe.

R1

```
enable
terminal length 0
ping 192.168.40.10 source Loopback0
```

Actual CLI output - R1

```
R1# ping 192.168.40.10 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.40.10, timeout is 2 seconds:
Packet sent with a source address of 1.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 2/2/3 ms
```

13.2 Test H4-to-R1 return

The client must have its saved static default route and R4 must carry traffic back into Area 0. Test from H4 to the R1 loopback.

H4

```
enable
terminal length 0
show ip route 0.0.0.0
ping 1.1.1.1
```

Actual CLI output - H4

```
H4# show ip route 0.0.0.0
Routing entry for 0.0.0.0/0, supernet
  Known via "static", distance 1, metric 0, candidate default path
  Routing Descriptor Blocks:
  * 192.168.40.1
      Route metric is 0, traffic share count is 1
```

Actual CLI output - H4

```
H4# ping 1.1.1.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 1.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

14.1 Final R1 regression

Confirm all expected adjacencies, branch or return route and client reachability after the cost change. On R1, require both equal-cost branch next hops.

R1

```
enable
terminal length 0
show ip ospf neighbor
show ip route 192.168.40.0
ping 192.168.40.10 source Loopback0
```

Actual CLI output - R1

```
R1# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
3.3.3.3           0   FULL/  -        00:00:37    10.13.13.2      Ethernet0/1
2.2.2.2           0   FULL/  -        00:00:34    10.12.12.2      Ethernet0/0
```

Actual CLI output - R1

```
R1# show ip route 192.168.40.0
Routing entry for 192.168.40.0/24
  Known via "ospf 10", distance 110, metric 30, type inter area
  Last update from 10.13.13.2 on Ethernet0/1, 00:00:37 ago
  Routing Descriptor Blocks:
    10.13.13.2, from 4.4.4.4, 00:00:37 ago, via Ethernet0/1
      Route metric is 30, traffic share count is 1
  * 10.12.12.2, from 4.4.4.4, 00:01:18 ago, via Ethernet0/0
      Route metric is 30, traffic share count is 1
```

Actual CLI output - R1

```
R1# ping 192.168.40.10 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.40.10, timeout is 2 seconds:
Packet sent with a source address of 1.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

14.2 Final R2 regression

Confirm all expected adjacencies, branch or return route and client reachability after the cost change. On R1, require both equal-cost branch next hops.

R2

```
enable
terminal length 0
show ip ospf neighbor
show ip route 192.168.40.0
ping 192.168.40.10 source Loopback0
```

Actual CLI output - R2

```
R2# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
4.4.4.4           0   FULL/  -        00:00:39    10.24.24.2      Ethernet0/1
1.1.1.1           0   FULL/  -        00:00:33    10.12.12.1      Ethernet0/0
```

Actual CLI output - R2

```
R2# show ip route 192.168.40.0
Routing entry for 192.168.40.0/24
  Known via "ospf 10", distance 110, metric 20, type inter area
  Last update from 10.24.24.2 on Ethernet0/1, 00:01:19 ago
  Routing Descriptor Blocks:
  * 10.24.24.2, from 4.4.4.4, 00:01:19 ago, via Ethernet0/1
      Route metric is 20, traffic share count is 1
```

Actual CLI output - R2

```
R2# ping 192.168.40.10 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.40.10, timeout is 2 seconds:
Packet sent with a source address of 2.2.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 2/2/3 ms
```

14.3 Final R3 regression

Confirm all expected adjacencies, branch or return route and client reachability after the cost change. On R1, require both equal-cost branch next hops.

R3

```
enable
terminal length 0
show ip ospf neighbor
show ip route 192.168.40.0
ping 192.168.40.10 source Loopback0
```

Actual CLI output - R3

```
R3# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
4.4.4.4           0   FULL/  -        00:00:39    10.34.34.2      Ethernet0/1
1.1.1.1           0   FULL/  -        00:00:34    10.13.13.1      Ethernet0/0
```

Actual CLI output - R3

```
R3# show ip route 192.168.40.0
Routing entry for 192.168.40.0/24
  Known via "ospf 10", distance 110, metric 20, type inter area
  Last update from 10.34.34.2 on Ethernet0/1, 00:01:18 ago
  Routing Descriptor Blocks:
  * 10.34.34.2, from 4.4.4.4, 00:01:18 ago, via Ethernet0/1
      Route metric is 20, traffic share count is 1
```

Actual CLI output - R3

```
R3# ping 192.168.40.10 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.40.10, timeout is 2 seconds:
Packet sent with a source address of 3.3.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 2/2/3 ms
```

14.4 Final R4 regression

Confirm all expected adjacencies, branch or return route and client reachability after the cost change. On R1, require both equal-cost branch next hops.

R4

```
enable
terminal length 0
show ip ospf neighbor
show ip route 1.1.1.1
ping 192.168.40.10 source Loopback0
```

Actual CLI output - R4

```
R4# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
3.3.3.3           0   FULL/  -        00:00:35    10.34.34.1      Ethernet0/1
2.2.2.2           0   FULL/  -        00:00:34    10.24.24.1      Ethernet0/0
```

Actual CLI output - R4

```
R4# show ip route 1.1.1.1
Routing entry for 1.1.1.1/32
  Known via "ospf 10", distance 110, metric 21, type intra area
  Last update from 10.34.34.1 on Ethernet0/1, 00:01:19 ago
  Routing Descriptor Blocks:
    10.34.34.1, from 1.1.1.1, 00:01:19 ago, via Ethernet0/1
      Route metric is 21, traffic share count is 1
  * 10.24.24.1, from 1.1.1.1, 00:01:21 ago, via Ethernet0/0
      Route metric is 21, traffic share count is 1
```

Actual CLI output - R4

```
R4# ping 192.168.40.10 source Loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.40.10, timeout is 2 seconds:
Packet sent with a source address of 4.4.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

14.5 Final H4 regression

Without changing configuration, confirm H4 address, static default and reachability to the R1 loopback.

H4

```
enable
terminal length 0
show ip interface brief
show ip route 0.0.0.0
ping 1.1.1.1
```

Actual CLI output - H4

```
H4# show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0/0            192.168.40.10   YES manual up                    up
Ethernet0/1            unassigned      YES unset  administratively down down
Ethernet0/2            unassigned      YES unset  administratively down down
Ethernet0/3            unassigned      YES unset  administratively down down
```

Actual CLI output - H4

```
H4# show ip route 0.0.0.0
Routing entry for 0.0.0.0/0, supernet
  Known via "static", distance 1, metric 0, candidate default path
  Routing Descriptor Blocks:
  * 192.168.40.1
      Route metric is 0, traffic share count is 1
```

Actual CLI output - H4

```
H4# ping 1.1.1.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 1.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 3/3/4 ms
```

15.1 Save R1 healthy state

Save only after all final checks pass; the separate save-config file must already contain this verified state.

R1

```
enable
write memory
```

15.2 Save R2 healthy state

Save only after all final checks pass; the separate save-config file must already contain this verified state.

R2

```
enable
write memory
```

15.3 Save R3 healthy state

Save only after all final checks pass; the separate save-config file must already contain this verified state.

R3

```
enable
write memory
```

15.4 Save R4 healthy state

Save only after all final checks pass; the separate save-config file must already contain this verified state.

R4

```
enable
write memory
```

15.5 Save H4 healthy state

Save only after all final checks pass; the separate save-config file must already contain this verified state.

H4

```
enable
write memory
```

16. Interview and diagnostic review

Explain why R1 initially used R2, why a local interface cost change can produce two next hops, why the branch route is O IA, and which Router and Summary LSA fields support the conclusion. The learner should distinguish equal-cost forwarding from packet-by-packet load balancing; the latter is not established by this lab.

17. Validation scope and reference

CLI excerpts come from the matching RAW stage on the approved IOL image. Neighbor timers, LSA ages and packet times vary. Independent IP-start and final save-config checks are recorded in the release report.

Reference: Cisco 300-410 ENARSI v1.1 exam blueprint.