

## OSPF Foundations Observation Lab – External E2 vs E1

### Objective

The purpose of this lab is to observe the impact of **Type 5 (External) E2 and E1 route designations**. The learner should focus on the changes that occur in the OSPF database and routing table. No troubleshooting is required for this exercise.

### Topology

RTR4 and RTR5 are **ABRs**. RTR1, RTR2, and RTR3 are **internal routers in Area 0**. RTR4 and RTR5 are also acting as **ASBRs**, redistributing the network 45.1.1.0/29 into the OSPF domain.

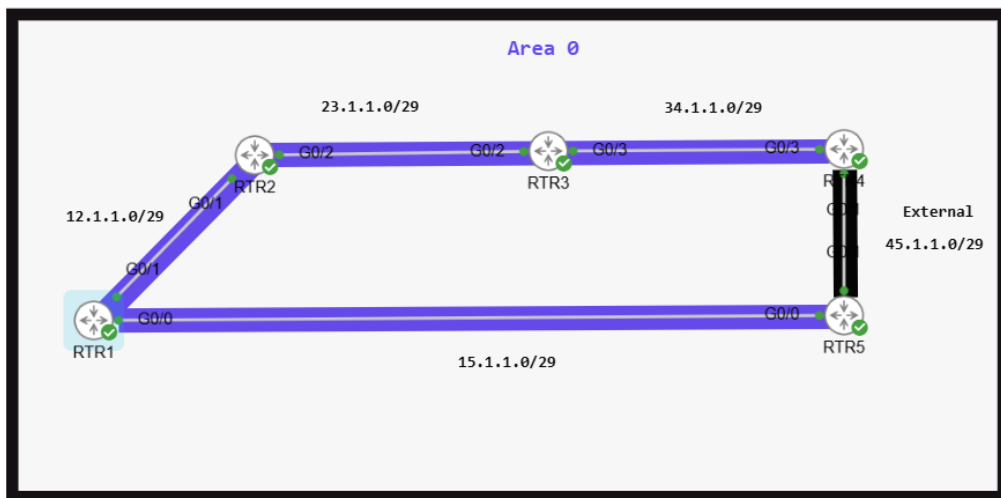


Figure 1 – Lab Topology

---

## Task 1 – View LSDB and Routing Table

View RTR1's LSDB and routing table

---

### Expected Behavior

- The LSDB contains two Type 5 E2 (External) LSA for network 45.1.1.0/29
  - RTR1 installs a single path through RTR2 for network 45.1.1.0/29
- 

### Verification

**Figure 2** shows two Type 5 E2 (External) LSAs. One from RTR4 and one from RTR5.

```

Type-5 AS External Link States

LS age: 612
Options: (No T0S-capability, DC, Upward)
LS Type: AS External Link
Link State ID: 45.1.1.0 (External Network Number )
Advertising Router: 4.4.4.4
LS Seq Number: 80000001
Checksum: 0xE285
Length: 36
Network Mask: /29
    Metric Type: 2 (Larger than any link state path)
    MTID: 0
    Metric: 20
    Forward Address: 0.0.0.0
    External Route Tag: 0

LS age: 616
Options: (No T0S-capability, DC, Upward)
LS Type: AS External Link
Link State ID: 45.1.1.0 (External Network Number )
Advertising Router: 5.5.5.5
LS Seq Number: 80000001
Checksum: 0xC49F
Length: 36
Network Mask: /29
    Metric Type: 2 (Larger than any link state path)
    MTID: 0
    Metric: 20
    Forward Address: 0.0.0.0
    External Route Tag: 0

RTR1#
```

*Figure 2 – RTR1 show ip ospf database external output*

**Figure 3** shows that while RTR1 has two LSAs for network 45.1.1.0/29 only the path through RTR2 was selected for the routing table.

```

45.0.0.0/29 is subnetted, 1 subnets
0 E2    45.1.1.0 [110/20] via 12.1.1.2, 00:07:36, GigabitEthernet0/1
RTR1#
```

*Figure 3 – RTR1 show ip route output*

**Figure 4** shows that the path through RTR2 was selected because the cost to reach the ASBR via RTR4 is less than the cost to reach the ASBR via RTR5

```
i 4.4.4.4 [3] via 12.1.1.2, GigabitEthernet0/1, ASBR, Area 0, SPF 4
i 5.5.5.5 [100] via 15.1.1.5, GigabitEthernet0/0, ASBR, Area 0, SPF 4
RTR1#
```

*Figure 4 – RTR1 show ip route output*

---

## Insight

When multiple ASBRs advertise the same external route with equal E2 metrics, OSPF must choose which ASBR to use as the exit point from the domain. In this case, since the external metrics are equal, OSPF compares the internal cost to reach each ASBR and selects the closest one. As a result, RTR1 prefers the path through RTR2 because it provides a lower-cost path to the ASBR.

---

## Task 2 – Engineer Path Selection

On RTR5, modify the metric for External routes to 10.

```
router ospf 1
 redistribute connected subnets metric 10
```

---

## Expected Behavior

- The path through RTR5 will replace the path through RTR2 in RTR1's routing table.

---

## Verification

**Figure 5** shows that the path through RTR5 is now the preferred path.

```
45.0.0.0/29 is subnetted, 1 subnets
0 E2 45.1.1.0 [110/10] via 15.1.1.5, 00:00:11, GigabitEthernet0/0
RTR1#
```

*Figure 5 – RTR1 show ip route output*

**Figure 6** shows the modified External LSA metric. The LSA advertised by RTR5 has a metric of 10 while RTR2 still has a default of 20.

```
LS age: 1055
Options: (No TOS-capability, DC, Upward)
LS Type: AS External Link
Link State ID: 45.1.1.0 (External Network Number )
Advertising Router: 4.4.4.4
LS Seq Number: 80000001
Checksum: 0xE285
Length: 36
Network Mask: /29
    Metric Type: 2 (Larger than any link state path)
    MTID: 0
    Metric: 20
    Forward Address: 0.0.0.0
    External Route Tag: 0

LS age: 203
Options: (No TOS-capability, DC, Upward)
LS Type: AS External Link
Link State ID: 45.1.1.0 (External Network Number )
Advertising Router: 5.5.5.5
LS Seq Number: 80000002
Checksum: 0x5E0F
Length: 36
Network Mask: /29
    Metric Type: 2 (Larger than any link state path)
    MTID: 0
    Metric: 10
    Forward Address: 0.0.0.0
    External Route Tag: 0

RTR1#
```

*Figure 6 – RTR1 show ip ospf database external*

---

## Insight

The path through RTR5 originally had an **equal external metric** to RTR2, so OSPF selected the path through RTR2 based on the **lower internal cost**. After lowering the external metric on RTR5, the path through RTR5, despite having a higher internal cost of 100, was preferred over the path through RTR2 with a cost of 20. This demonstrates that E2 routes are selected primarily based on the external metric, with internal cost only used as a **tiebreaker**.

This issue of external factors impacting internal path selection is resolved by using **External Type 1 (E1)** routes. With E1, OSPF considers both the **external metric** and the **internal cost to reach the ASBR**, combining them into a single total cost. This allows OSPF to return to its fundamental behavior of preferring the path with the lowest overall cost.

---

## Task 3 – Configure External Type 1 (E1)

On RTR2 and RTR5:

```
router ospf 1
 redistribute connected subnets metric-type 1
```

---

### Expected Behavior

- The path through RTR2 will again be selected as the best path

---

### Verification

**Figure 7** shows that the path through RTR2 is once again the preferred path.

```
45.0.0.0/29 is subnetted, 1 subnets
0 E1    45.1.1.0 [110/23] via 12.1.1.2, 00:00:46, GigabitEthernet0/1
RTR1#
```

*Figure 7 – RTR1 show ip ospf database external*

**Figure 8** shows that the Type 5 (External) LSAs are now advertised as External Type 1 (E1). Even though RTR5 has a lower external metric, it is no longer preferred. Because E1 includes the internal cost to reach the ASBR, the higher cost path through RTR5 is no longer optimal. As a result, the path through RTR2 is selected.

```
LS age: 90
Options: (No T0S-capability, DC, Upward)
LS Type: AS External Link
Link State ID: 45.1.1.0 (External Network Number )
Advertising Router: 4.4.4.4
LS Seq Number: 80000002
Checksum: 0x5D8A
Length: 36
Network Mask: /29
    Metric Type: 1 (Comparable directly to link state metric)
    MTID: 0
    Metric: 20
    Forward Address: 0.0.0.0
    External Route Tag: 0

LS age: 75
Options: (No T0S-capability, DC, Upward)
LS Type: AS External Link
Link State ID: 45.1.1.0 (External Network Number )
Advertising Router: 5.5.5.5
LS Seq Number: 80000003
Checksum: 0xD814
Length: 36
Network Mask: /29
    Metric Type: 1 (Comparable directly to link state metric)
    MTID: 0
    Metric: 10
    Forward Address: 0.0.0.0
    External Route Tag: 0

RTR1#
```

*Figure 8 – RTR1 show ip ospf database external*