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Exploring the Inner Workings of OSPF

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BRKENT-1802

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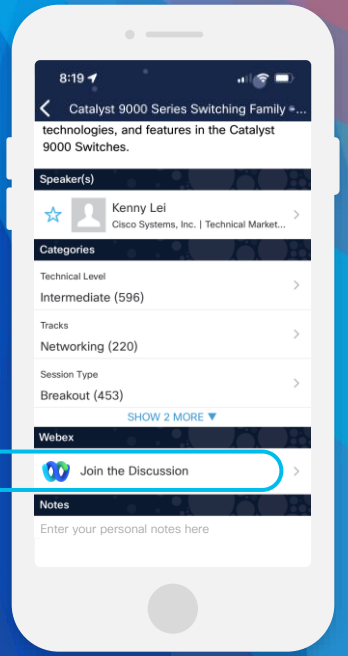

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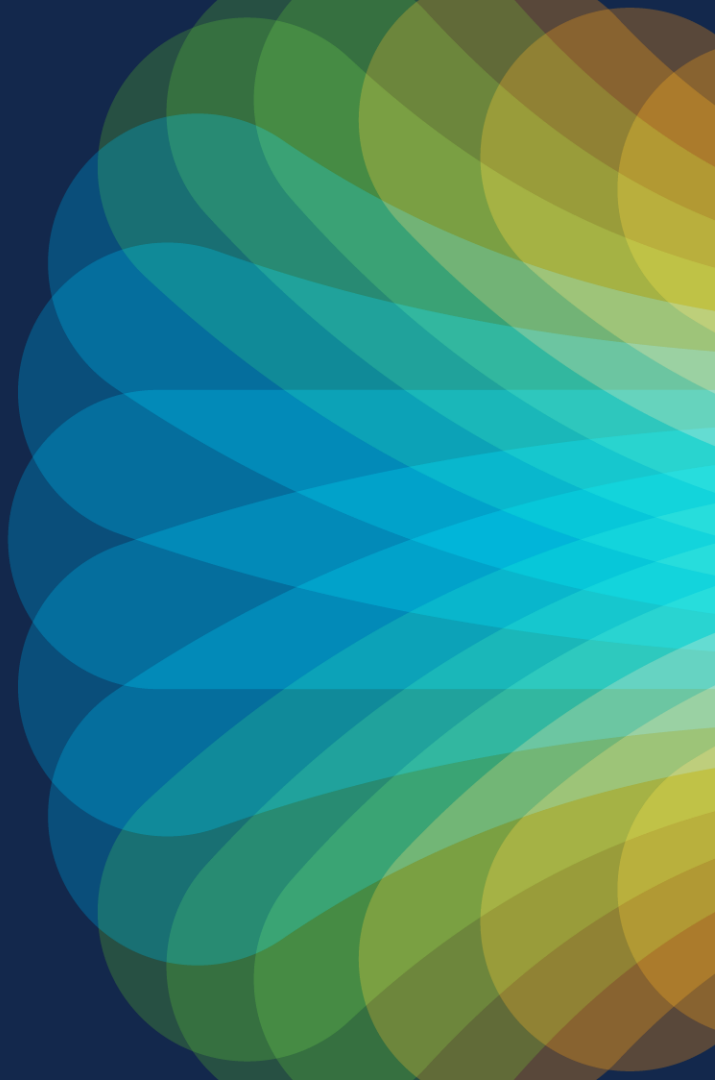
Agenda

- Why Routing?
- OSPF Packet Types
- Building OSPF Adjacencies
- LSA Types
- LSA Flooding Scope
- High Availability and MPLS TE
- OSPFv3 LSA Types
- Troubleshooting – DEMO!!

Why Routing?



```
R1#show ip interface brief | ex down
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet1/0        10.2.1.1        YES manual up                    up
FastEthernet1/1        10.3.1.1        YES manual up                    up



R1#show ip route
Codes: L - local, 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, H - NHRP
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C        10.2.1.0/24 is directly connected, FastEthernet1/0
L        10.2.1.1/32 is directly connected, FastEthernet1/0
C        10.3.1.0/24 is directly connected, FastEthernet1/1
L        10.3.1.1/32 is directly connected, FastEthernet1/1
```

Static vs Dynamic Routing

Static:

- Requires manual configuration of the routing tables on each device in the network.
- Suitable for small networks with a limited number of routes.
- Requires manual updates to the routing tables if changes occur in the network.
- Slower convergence.
- Simpler but less flexible.

Dynamic:

- Leverages routing protocols to automatically update routing tables.
- More scalable and can handle larger networks with more complex topologies.
- Automatically adapts to network changes.
- Faster convergence times.
- More complex but provides greater scalability, performance, and adaptability.

Routing Protocol Types

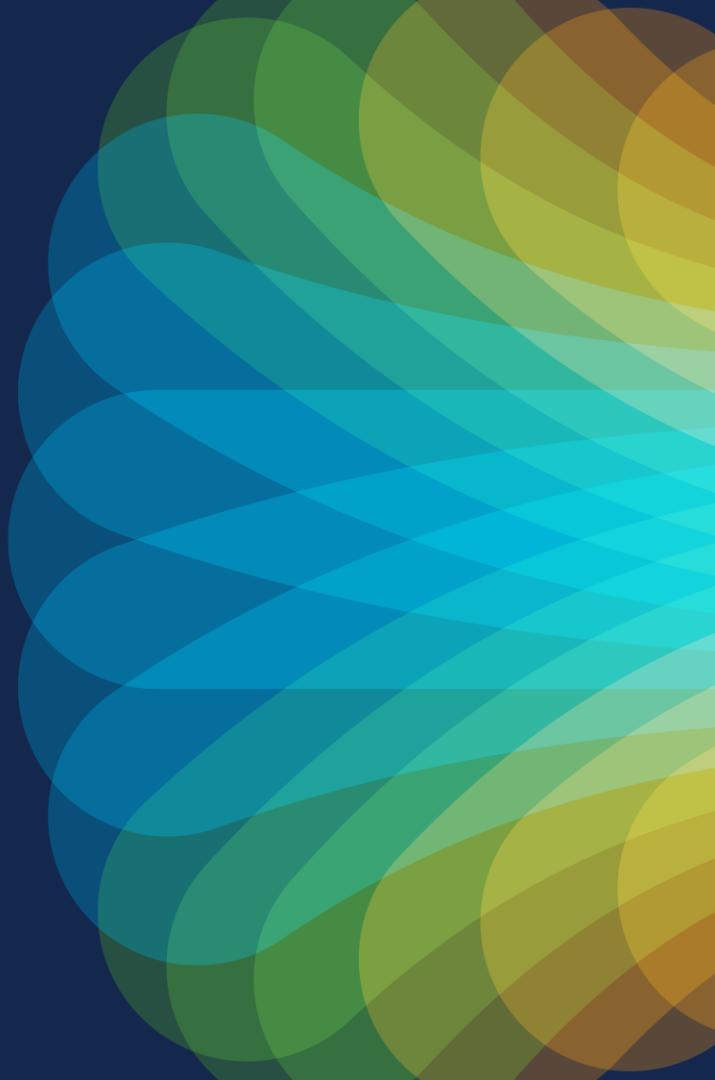
Link State:

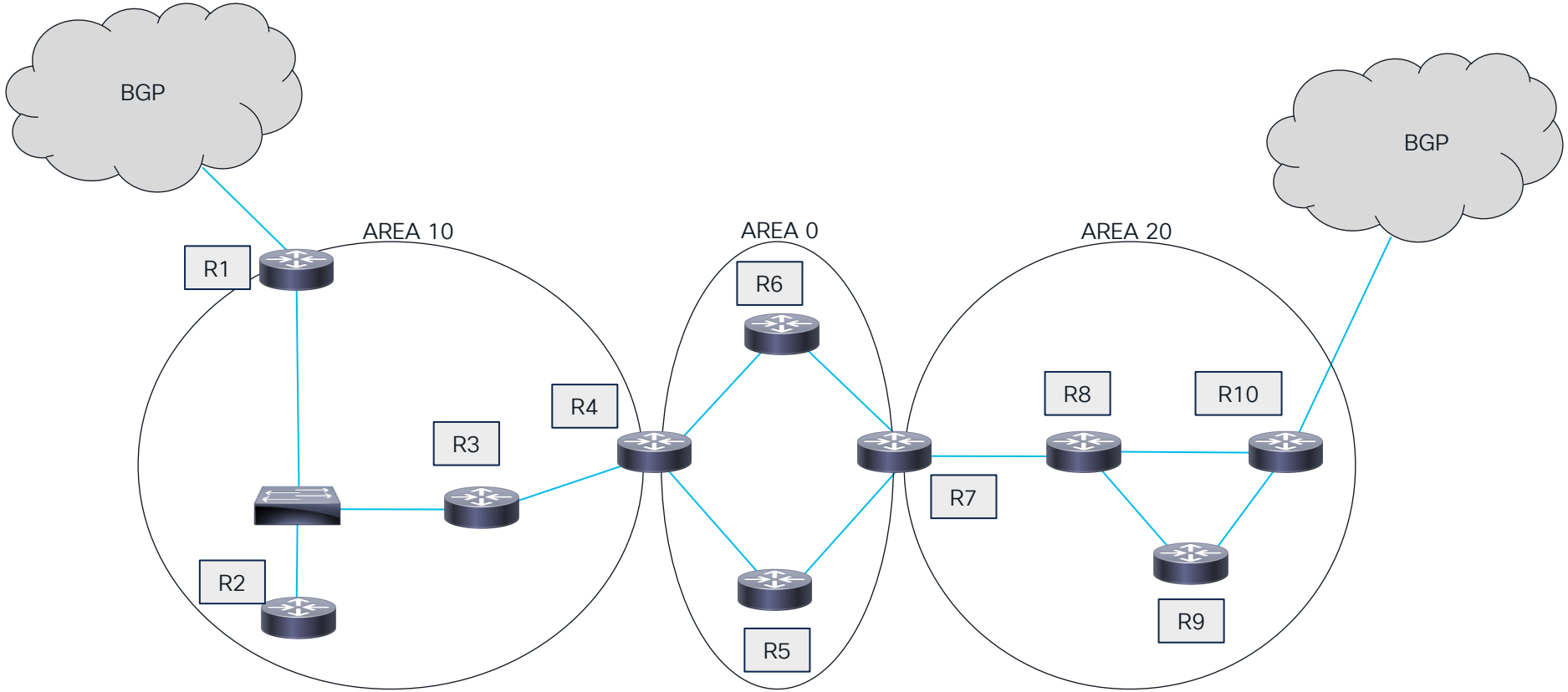
- Each router sends information about its own directly connected links to all other routers in the network.
- All routers use this information to build a complete map of the network topology.
- Routing decisions are then made based on this complete picture of the network, considering link speed, cost, and reliability.
- LS protocols: OSPF & IS-IS.

Distance Vector:

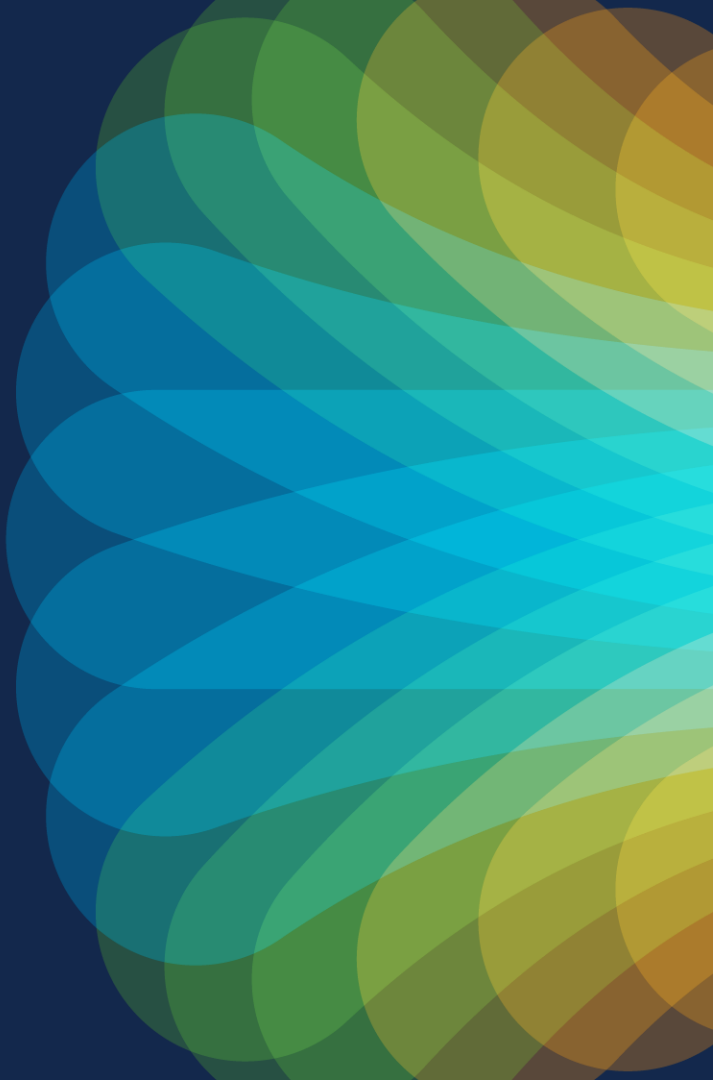
- Each router sends information about the distance (or metric) to its neighboring routers, which then forward this information to their neighbors, and so on.
- Routing decisions are made based on the shortest distance (or path) to the destination network, calculated using the information from neighboring routers.
- This approach is simpler but can lead to slow convergence times and routing loops.
- Example of distance-vector protocols: RIP.

Topology





OSPF Packet Types



Type 1 – Hello

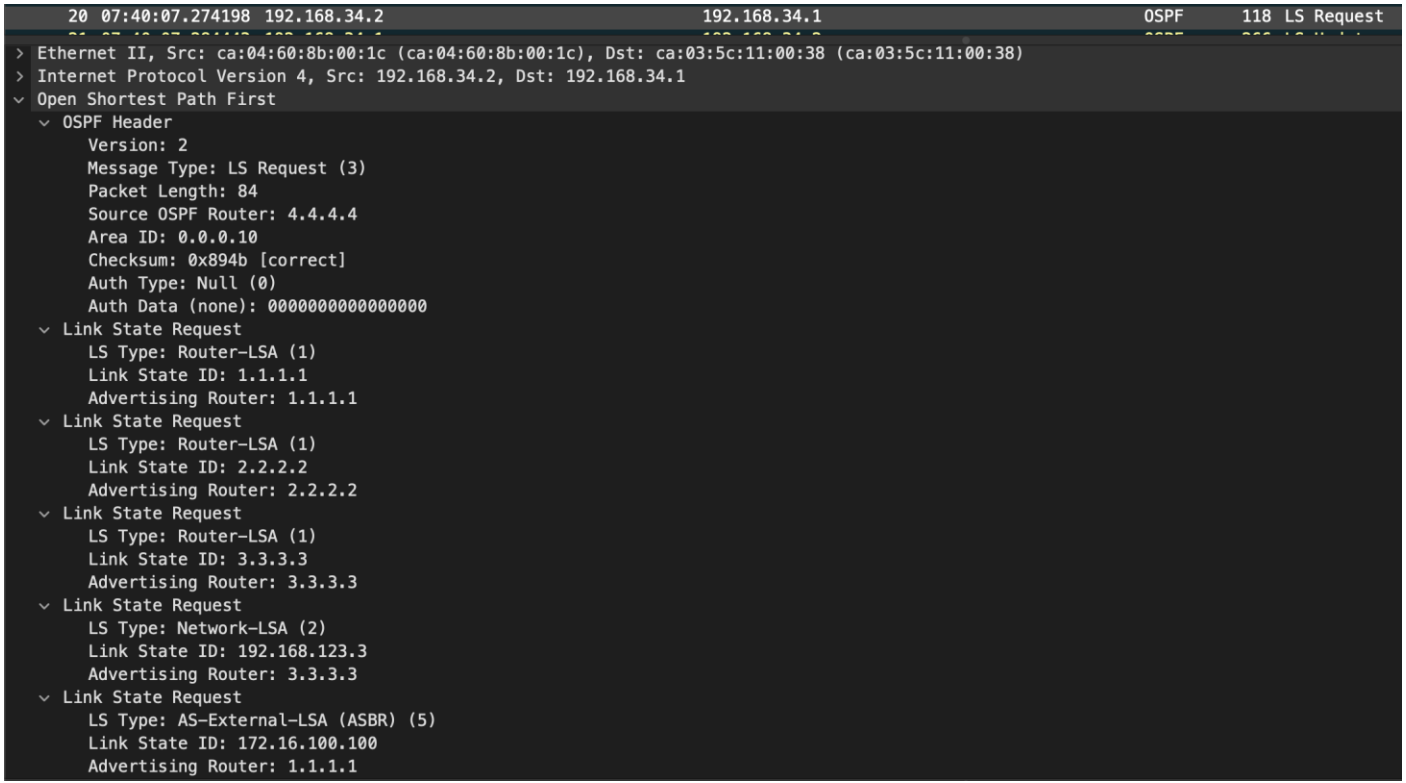
```
      7 07:39:54.765269 192.168.34.2                224.0.0.5                     OSPF      94 Hello Packet
      8 07:39:58.973880 192.168.34.1                224.0.0.5                     OSPF      94 Hello Packet

> Frame 7: 94 bytes on wire (752 bits), 94 bytes captured (752 bits) on interface -, id 0
> Ethernet II, Src: ca:04:60:8b:00:1c (ca:04:60:8b:00:1c), Dst: IPv4mcast_05 (01:00:5e:00:00:05)
> Internet Protocol Version 4, Src: 192.168.34.2, Dst: 224.0.0.5
v Open Shortest Path First
  v OSPF Header
      Version: 2
      Message Type: Hello Packet (1)
      Packet Length: 48
      Source OSPF Router: 4.4.4.4
      Area ID: 0.0.0.10
      Checksum: 0xdd86 [correct]
      Auth Type: Null (0)
      Auth Data (none): 0000000000000000
  v OSPF Hello Packet
      Network Mask: 255.255.255.252
      Hello Interval [sec]: 10
    > Options: 0x12, (L) LLS Data block, (E) External Routing
      Router Priority: 1
      Router Dead Interval [sec]: 40
      Designated Router: 0.0.0.0
      Backup Designated Router: 0.0.0.0
      Active Neighbor: 3.3.3.3
  > OSPF LLS Data Block
```

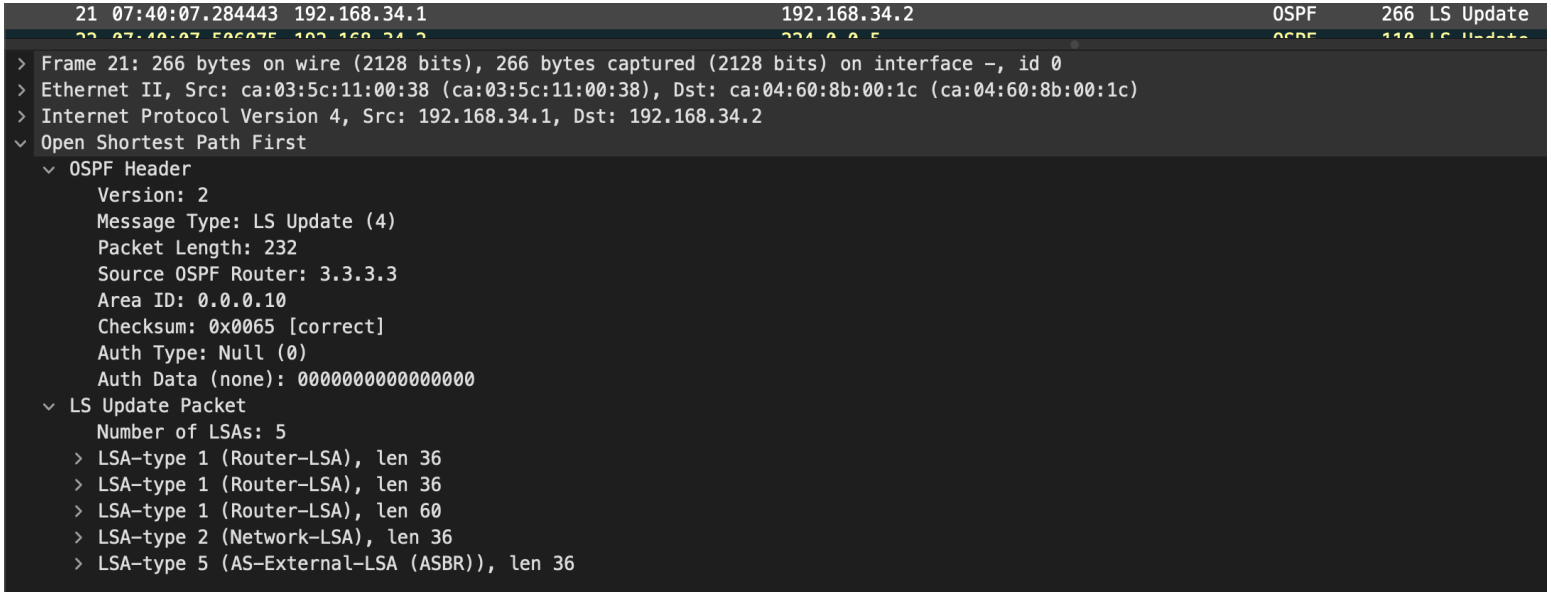
Type 2 – Database Description

```
    17 07:40:07.240525 192.168.34.1                    192.168.34.2                    OSPF     178 DB Description
> Frame 17: 178 bytes on wire (1424 bits), 178 bytes captured (1424 bits) on interface -, id 0
> Ethernet II, Src: ca:03:5c:11:00:38 (ca:03:5c:11:00:38), Dst: ca:04:60:8b:00:1c (ca:04:60:8b:00:1c)
> Internet Protocol Version 4, Src: 192.168.34.1, Dst: 192.168.34.2
v Open Shortest Path First
  v OSPF Header
      Version: 2
      Message Type: DB Description (2)
      Packet Length: 132
      Source OSPF Router: 3.3.3.3
      Area ID: 0.0.0.10
      Checksum: 0x52eb [correct]
      Auth Type: Null (0)
      Auth Data (none): 0000000000000000
  v OSPF DB Description
      Interface MTU: 1500
    > Options: 0x52, O, (L) LLS Data block, (E) External Routing
    v DB Description: 0x02, (M) More
        .... 0... = (R) OOBResync: Not set
        .... .0.. = (I) Init: Not set
        .... ..1. = (M) More: Set
        .... ...0 = (MS) Master: No
      DD Sequence: 8317
  > LSA-type 1 (Router-LSA), len 36
  > LSA-type 1 (Router-LSA), len 36
  > LSA-type 1 (Router-LSA), len 60
  > LSA-type 2 (Network-LSA), len 36
  > LSA-type 5 (AS-External-LSA (ASBR)), len 36
  > OSPF LLS Data Block
```

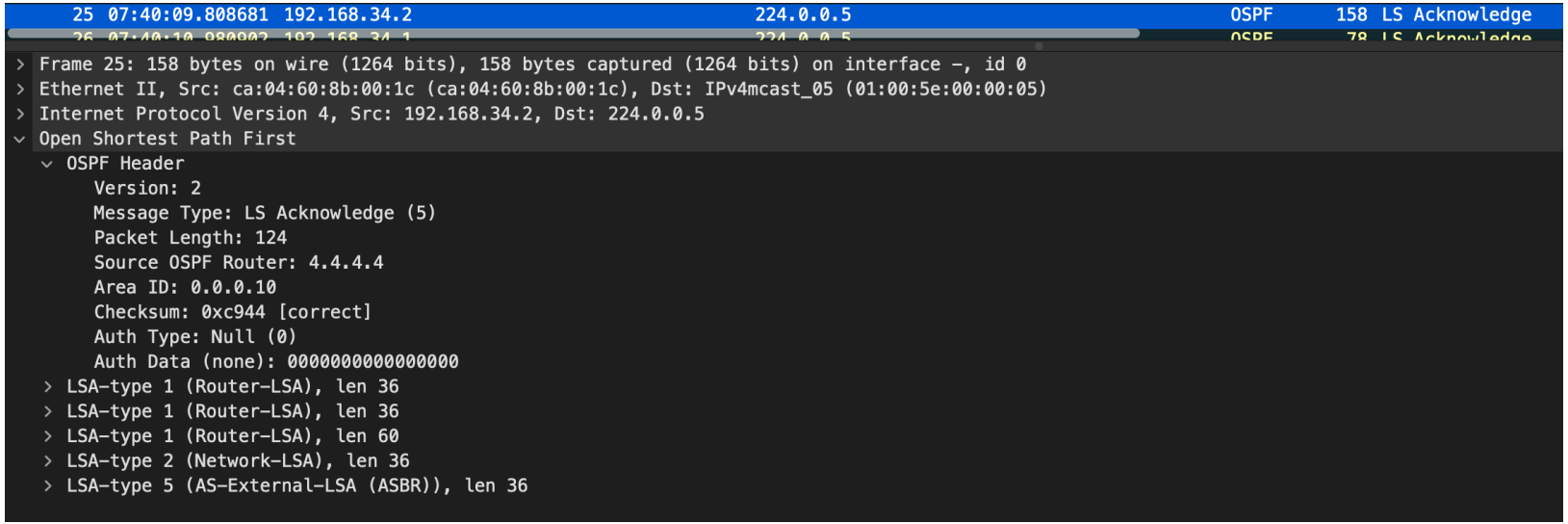
Type 3 – Link State Request



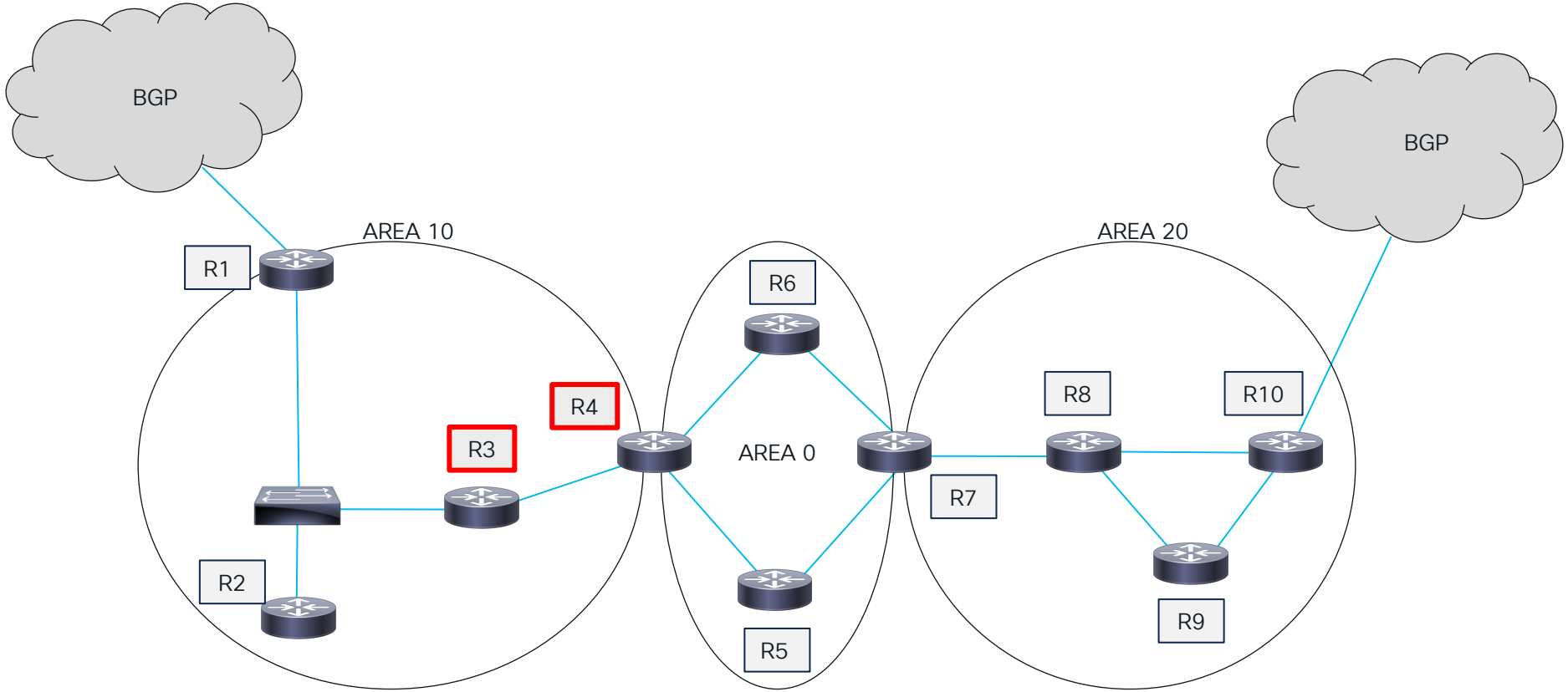
Type 4 – Link State Update



Type 5 – Link State Ack



Building OSPF Adjacencies



Type 1 – Hello

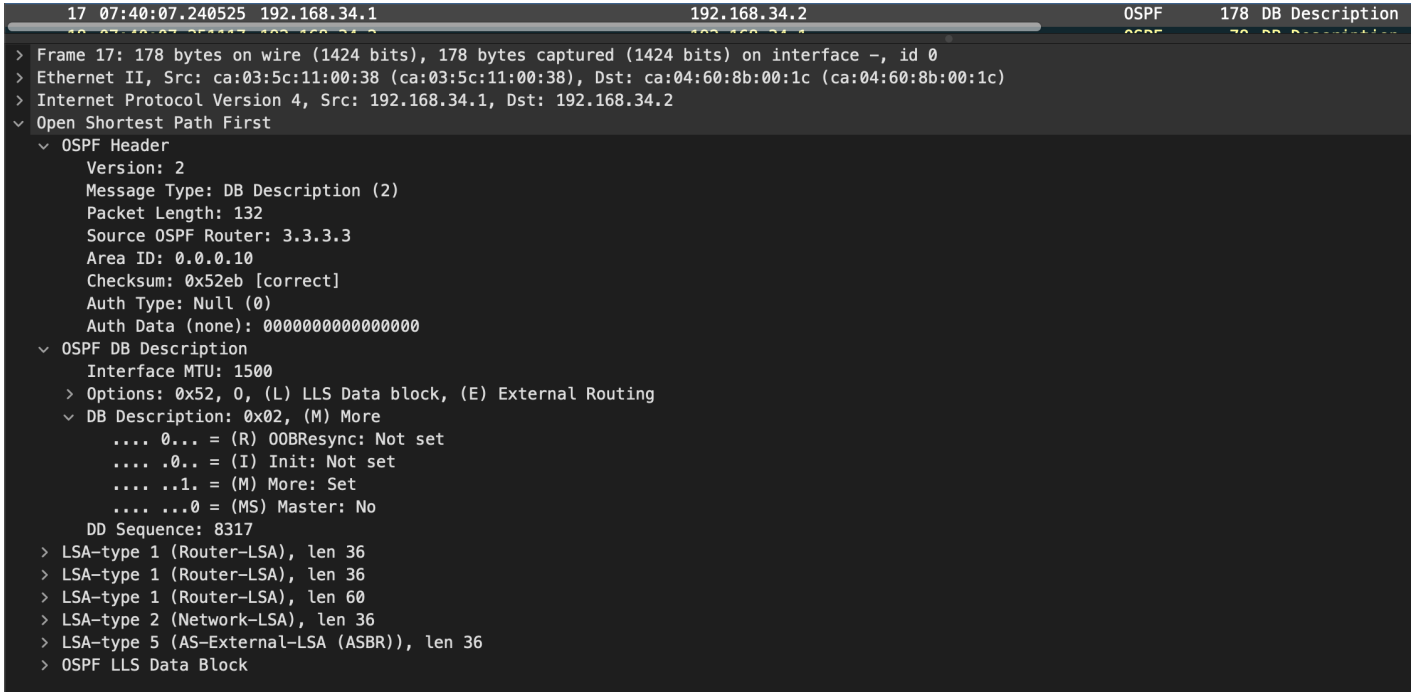
```
      7 07:39:54.765269  192.168.34.2                224.0.0.5                OSPF       94 Hello Packet
      8 07:39:58.973880  192.168.34.1                224.0.0.5                OSPF       94 Hello Packet

> Frame 7: 94 bytes on wire (752 bits), 94 bytes captured (752 bits) on interface -, id 0
> Ethernet II, Src: ca:04:60:8b:00:1c (ca:04:60:8b:00:1c), Dst: IPv4mcast_05 (01:00:5e:00:00:05)
> Internet Protocol Version 4, Src: 192.168.34.2, Dst: 224.0.0.5
v Open Shortest Path First
  v OSPF Header
      Version: 2
      Message Type: Hello Packet (1)
      Packet Length: 48
      Source OSPF Router: 4.4.4.4
      Area ID: 0.0.0.10
      Checksum: 0xdd86 [correct]
      Auth Type: Null (0)
      Auth Data (none): 0000000000000000
  v OSPF Hello Packet
      Network Mask: 255.255.255.252
      Hello Interval [sec]: 10
    > Options: 0x12, (L) LLS Data block, (E) External Routing
      Router Priority: 1
      Router Dead Interval [sec]: 40
      Designated Router: 0.0.0.0
      Backup Designated Router: 0.0.0.0
      Active Neighbor: 3.3.3.3
  > OSPF LLS Data Block
```


```
R4# debug ip ospf adjacency

*Apr 19 20:47:30.229: OSPF-101 ADJ   Gi1/0: Rcv DBD from 3.3.3.3 seq 0xAAD opt 0x52 flag 0x7 len 32  mtu 1500 state INIT
*Apr 19 20:47:30.229: OSPF-101 ADJ   Gi1/0: 2 Way Communication to 3.3.3.3, state 2WAY
*Apr 19 20:47:30.233: OSPF-101 ADJ   Gi1/0: Nbr 3.3.3.3: Prepare dbase exchange
*Apr 19 20:47:30.233: OSPF-101 ADJ   Gi1/0: Send DBD to 3.3.3.3 seq 0x2080 opt 0x52 flag 0x7 len 32
*Apr 19 20:47:30.237: OSPF-101 ADJ   Gi1/0: First DBD and we are not SLAVE
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: Rcv DBD from 3.3.3.3 seq 0x2080 opt 0x52 flag 0x2 len 312  mtu 1500 state
EXSTART
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: NBR Negotiation Done. We are the MASTER
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: Nbr 3.3.3.3: Summary list built, size 14
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: Send DBD to 3.3.3.3 seq 0x2081 opt 0x52 flag 0x1 len 312
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Rcv LS REQ from 3.3.3.3 length 36 LSA count 1
*Apr 19 20:47:30.301: OSPF-101 ADJ   G
R4#i1/0: Send LS UPD to 192.168.34.1 length 64 LSA count 1
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Rcv DBD from 3.3.3.3 seq 0x2081 opt 0x52 flag 0x0 len 32  mtu 1500 state
EXCHANGE
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Exchange Done with 3.3.3.3
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Send LS REQ to 3.3.3.3 length 36 LSA count 1
*Apr 19 20:47:30.313: OSPF-101 ADJ   Gi1/0: Rcv LS UPD from 3.3.3.3 length 76 LSA count 1
*Apr 19 20:47:30.313: OSPF-101 ADJ   Gi1/0: Synchronized with 3.3.3.3, state FULL
*Apr 19 20:47:30.317: %OSPF-5-ADJCHG: Process 101, Nbr 3.3.3.3 on GigabitEthernet1/0 from LOADING to FULL, Loading Done
*Apr 19 20:47:30.317: OSPF-101 ADJ   Gi1/0: Nbr 3.3.3.3: Clean-up dbase exchange
```

Type 2 – Database Description




```
R4# debug ip ospf adj

*Apr 19 20:47:30.229: OSPF-101 ADJ   Gi1/0: Rcv DBD from 3.3.3.3 seq 0xAAD opt 0x52 flag 0x7 len 32  mtu
1500 state INIT
*Apr 19 20:47:30.229: OSPF-101 ADJ   Gi1/0: 2 Way Communication to 3.3.3.3, state 2WAY
*Apr 19 20:47:30.233: OSPF-101 ADJ   Gi1/0: Nbr 3.3.3.3: Prepare dbase exchange
*Apr 19 20:47:30.233: OSPF-101 ADJ   Gi1/0: Send DBD to 3.3.3.3 seq 0x2080 opt 0x52 flag 0x7 len 32
*Apr 19 20:47:30.237: OSPF-101 ADJ   Gi1/0: First DBD and we are not SLAVE
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: Rcv DBD from 3.3.3.3 seq 0x2080 opt 0x52 flag 0x2 len 312  mtu
1500 state EXSTART
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: NBR Negotiation Done. We are the MASTER
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: Nbr 3.3.3.3: Summary list built, size 14
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: Send DBD to 3.3.3.3 seq 0x2081 opt 0x52 flag 0x1 len 312
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Rcv LS REQ from 3.3.3.3 length 36 LSA count 1
*Apr 19 20:47:30.301: OSPF-101 ADJ   G
R4#i1/0: Send LS UPD to 192.168.34.1 length 64 LSA count 1
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Rcv DBD from 3.3.3.3 seq 0x2081 opt 0x52 flag 0x0 len 32  mtu
1500 state EXCHANGE
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Exchange Done with 3.3.3.3
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Send LS REQ to 3.3.3.3 length 36 LSA count 1
*Apr 19 20:47:30.313: OSPF-101 ADJ   Gi1/0: Rcv LS UPD from 3.3.3.3 length 76 LSA count 1
*Apr 19 20:47:30.313: OSPF-101 ADJ   Gi1/0: Synchronized with 3.3.3.3, state FULL
*Apr 19 20:47:30.317: %OSPF-5-ADJCHG: Process 101, Nbr 3.3.3.3 on GigabitEthernet1/0 from LOADING to FULL,
Loading Done
*Apr 19 20:47:30.317: OSPF-101 ADJ   Gi1/0: Nbr 3.3.3.3: Clean-up dbase exchange
```

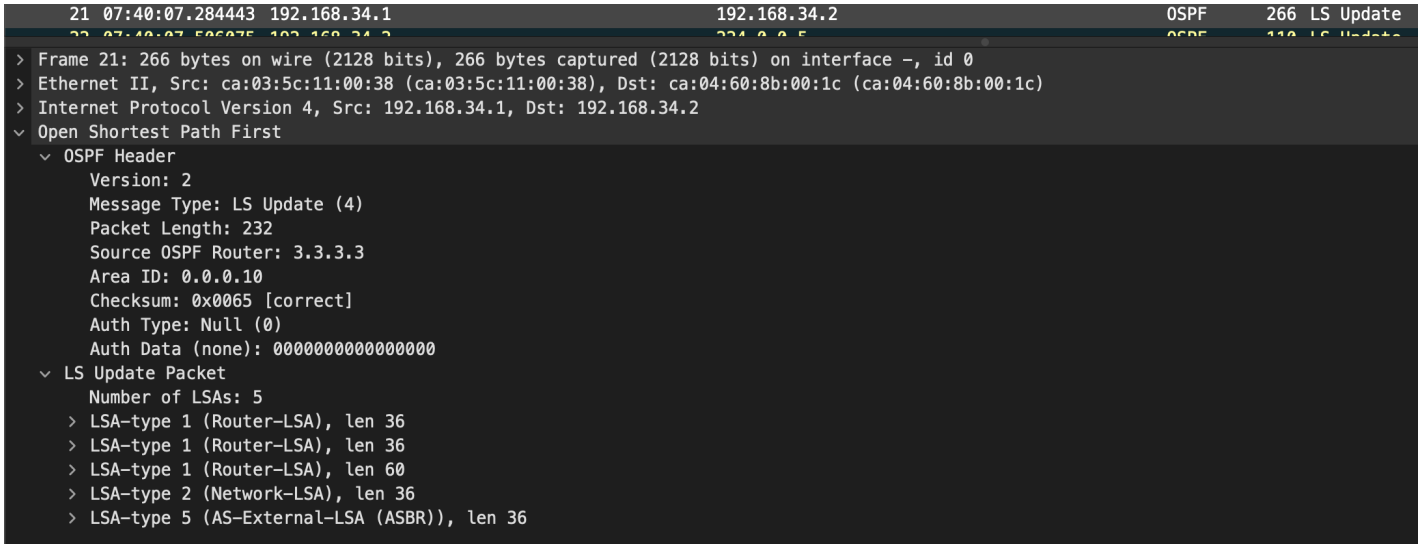

```
R4# debug ip ospf adj

*Apr 19 20:47:30.229: OSPF-101 ADJ   Gi1/0: Rcv DBD from 3.3.3.3 seq 0xAAD opt 0x52 flag 0x7 len 32  mtu
1500 state INIT
*Apr 19 20:47:30.229: OSPF-101 ADJ   Gi1/0: 2 Way Communication to 3.3.3.3, state 2WAY
*Apr 19 20:47:30.233: OSPF-101 ADJ   Gi1/0: Nbr 3.3.3.3: Prepare dbase exchange
*Apr 19 20:47:30.233: OSPF-101 ADJ   Gi1/0: Send DBD to 3.3.3.3 seq 0x2080 opt 0x52 flag 0x7 len 32
*Apr 19 20:47:30.237: OSPF-101 ADJ   Gi1/0: First DBD and we are not SLAVE
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: Rcv DBD from 3.3.3.3 seq 0x2080 opt 0x52 flag 0x2 len 312  mtu
1500 state EXSTART
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: NBR Negotiation Done. We are the MASTER
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: Nbr 3.3.3.3: Summary list built, size 14
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: Send DBD to 3.3.3.3 seq 0x2081 opt 0x52 flag 0x1 len 312
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Rcv LS REQ from 3.3.3.3 length 36 LSA count 1
*Apr 19 20:47:30.301: OSPF-101 ADJ   G
R4#i1/0: Send LS UPD to 192.168.34.1 length 64 LSA count 1
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Rcv DBD from 3.3.3.3 seq 0x2081 opt 0x52 flag 0x0 len 32  mtu
1500 state EXCHANGE
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Exchange Done with 3.3.3.3
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Send LS REQ to 3.3.3.3 length 36 LSA count 1
*Apr 19 20:47:30.313: OSPF-101 ADJ   Gi1/0: Rcv LS UPD from 3.3.3.3 length 76 LSA count 1
*Apr 19 20:47:30.313: OSPF-101 ADJ   Gi1/0: Synchronized with 3.3.3.3, state FULL
*Apr 19 20:47:30.317: %OSPF-5-ADJCHG: Process 101, Nbr 3.3.3.3 on GigabitEthernet1/0 from LOADING to FULL,
Loading Done
*Apr 19 20:47:30.317: OSPF-101 ADJ   Gi1/0: Nbr 3.3.3.3: Clean-up dbase exchange
```

Type 3 – Link State Request

```
    20 07:40:07.274198 192.168.34.2                    192.168.34.1                    OSPF      118 LS Request
> Ethernet II, Src: ca:04:60:8b:00:1c (ca:04:60:8b:00:1c), Dst: ca:03:5c:11:00:38 (ca:03:5c:11:00:38)
> Internet Protocol Version 4, Src: 192.168.34.2, Dst: 192.168.34.1
v Open Shortest Path First
  v OSPF Header
      Version: 2
      Message Type: LS Request (3)
      Packet Length: 84
      Source OSPF Router: 4.4.4.4
      Area ID: 0.0.0.10
      Checksum: 0x894b [correct]
      Auth Type: Null (0)
      Auth Data (none): 0000000000000000
  v Link State Request
      LS Type: Router-LSA (1)
      Link State ID: 1.1.1.1
      Advertising Router: 1.1.1.1
  v Link State Request
      LS Type: Router-LSA (1)
      Link State ID: 2.2.2.2
      Advertising Router: 2.2.2.2
  v Link State Request
      LS Type: Router-LSA (1)
      Link State ID: 3.3.3.3
      Advertising Router: 3.3.3.3
  v Link State Request
      LS Type: Network-LSA (2)
      Link State ID: 192.168.123.3
      Advertising Router: 3.3.3.3
  v Link State Request
      LS Type: AS-External-LSA (ASBR) (5)
      Link State ID: 172.16.100.100
      Advertising Router: 1.1.1.1
```

Type 4 – Link State Update




```
R4# debug ip ospf adj

*Apr 19 20:47:30.229: OSPF-101 ADJ   Gi1/0: Rcv DBD from 3.3.3.3 seq 0xAAD opt 0x52 flag 0x7 len 32  mtu
1500 state INIT
*Apr 19 20:47:30.229: OSPF-101 ADJ   Gi1/0: 2 Way Communication to 3.3.3.3, state 2WAY
*Apr 19 20:47:30.233: OSPF-101 ADJ   Gi1/0: Nbr 3.3.3.3: Prepare dbase exchange
*Apr 19 20:47:30.233: OSPF-101 ADJ   Gi1/0: Send DBD to 3.3.3.3 seq 0x2080 opt 0x52 flag 0x7 len 32
*Apr 19 20:47:30.237: OSPF-101 ADJ   Gi1/0: First DBD and we are not SLAVE
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: Rcv DBD from 3.3.3.3 seq 0x2080 opt 0x52 flag 0x2 len 312  mtu
1500 state EXSTART
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: NBR Negotiation Done. We are the MASTER
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: Nbr 3.3.3.3: Summary list built, size 14
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: Send DBD to 3.3.3.3 seq 0x2081 opt 0x52 flag 0x1 len 312
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Rcv LS REQ from 3.3.3.3 length 36 LSA count 1
*Apr 19 20:47:30.301: OSPF-101 ADJ   G
R4#i1/0: Send LS UPD to 192.168.34.1 length 64 LSA count 1
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Rcv DBD from 3.3.3.3 seq 0x2081 opt 0x52 flag 0x0 len 32  mtu
1500 state EXCHANGE
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Exchange Done with 3.3.3.3
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Send LS REQ to 3.3.3.3 length 36 LSA count 1
*Apr 19 20:47:30.313: OSPF-101 ADJ   Gi1/0: Rcv LS UPD from 3.3.3.3 length 76 LSA count 1
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*Apr 19 20:47:30.317: %OSPF-5-ADJCHG: Process 101, Nbr 3.3.3.3 on GigabitEthernet1/0 from LOADING to FULL,
Loading Done
*Apr 19 20:47:30.317: OSPF-101 ADJ   Gi1/0: Nbr 3.3.3.3: Clean-up dbase exchange
```
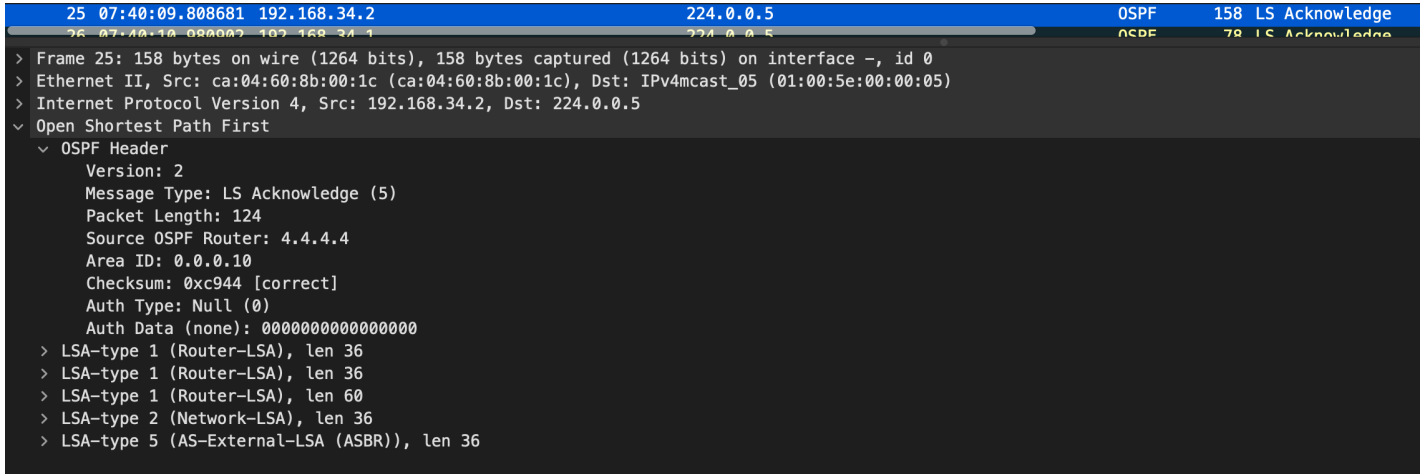
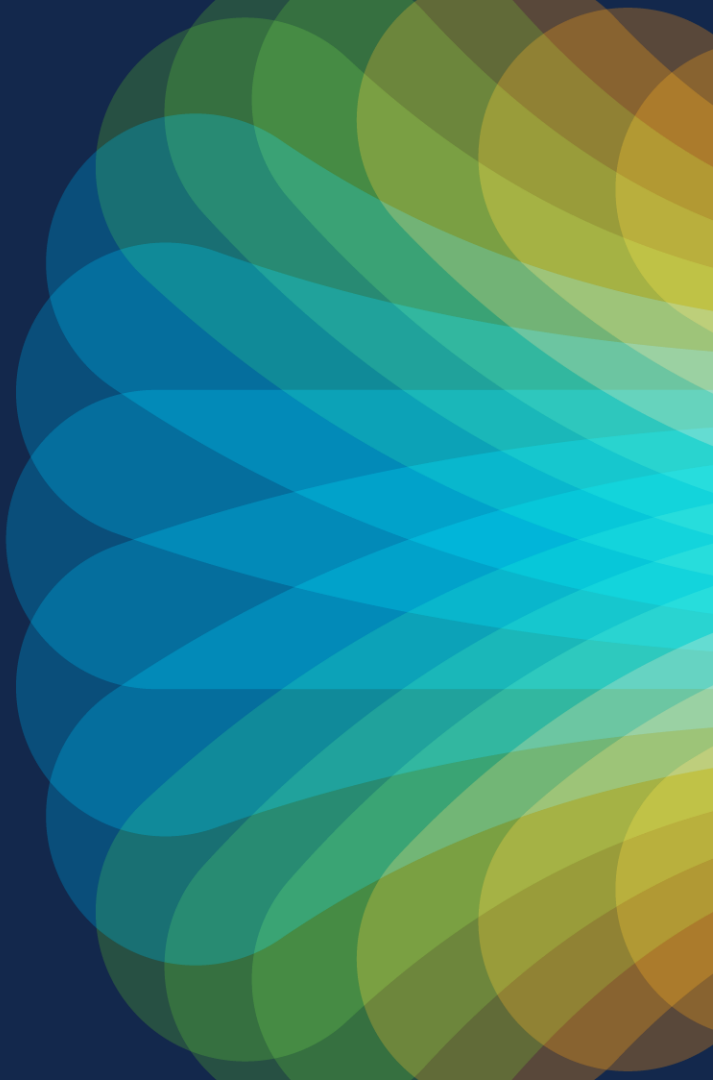

Type 5 – Link State Ack




```
R4# debug ip ospf adj

*Apr 19 20:47:30.229: OSPF-101 ADJ   Gi1/0: Rcv DBD from 3.3.3.3 seq 0xAAD opt 0x52 flag 0x7 len 32  mtu
1500 state INIT
*Apr 19 20:47:30.229: OSPF-101 ADJ   Gi1/0: 2 Way Communication to 3.3.3.3, state 2WAY
*Apr 19 20:47:30.233: OSPF-101 ADJ   Gi1/0: Nbr 3.3.3.3: Prepare dbase exchange
*Apr 19 20:47:30.233: OSPF-101 ADJ   Gi1/0: Send DBD to 3.3.3.3 seq 0x2080 opt 0x52 flag 0x7 len 32
*Apr 19 20:47:30.237: OSPF-101 ADJ   Gi1/0: First DBD and we are not SLAVE
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: Rcv DBD from 3.3.3.3 seq 0x2080 opt 0x52 flag 0x2 len 312  mtu
1500 state EXSTART
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: NBR Negotiation Done. We are the MASTER
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: Nbr 3.3.3.3: Summary list built, size 14
*Apr 19 20:47:30.277: OSPF-101 ADJ   Gi1/0: Send DBD to 3.3.3.3 seq 0x2081 opt 0x52 flag 0x1 len 312
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Rcv LS REQ from 3.3.3.3 length 36 LSA count 1
*Apr 19 20:47:30.301: OSPF-101 ADJ   G
R4#i1/0: Send LS UPD to 192.168.34.1 length 64 LSA count 1
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Rcv DBD from 3.3.3.3 seq 0x2081 opt 0x52 flag 0x0 len 32  mtu
1500 state EXCHANGE
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Exchange Done with 3.3.3.3
*Apr 19 20:47:30.301: OSPF-101 ADJ   Gi1/0: Send LS REQ to 3.3.3.3 length 36 LSA count 1
*Apr 19 20:47:30.313: OSPF-101 ADJ   Gi1/0: Rcv LS UPD from 3.3.3.3 length 76 LSA count 1
*Apr 19 20:47:30.313: OSPF-101 ADJ   Gi1/0: Synchronized with 3.3.3.3, state FULL
*Apr 19 20:47:30.317: %OSPF-5-ADJCHG: Process 101, Nbr 3.3.3.3 on GigabitEthernet1/0 from LOADING to FULL,
Loading Done
*Apr 19 20:47:30.317: OSPF-101 ADJ   Gi1/0: Nbr 3.3.3.3: Clean-up dbase exchange
```

LSA Types



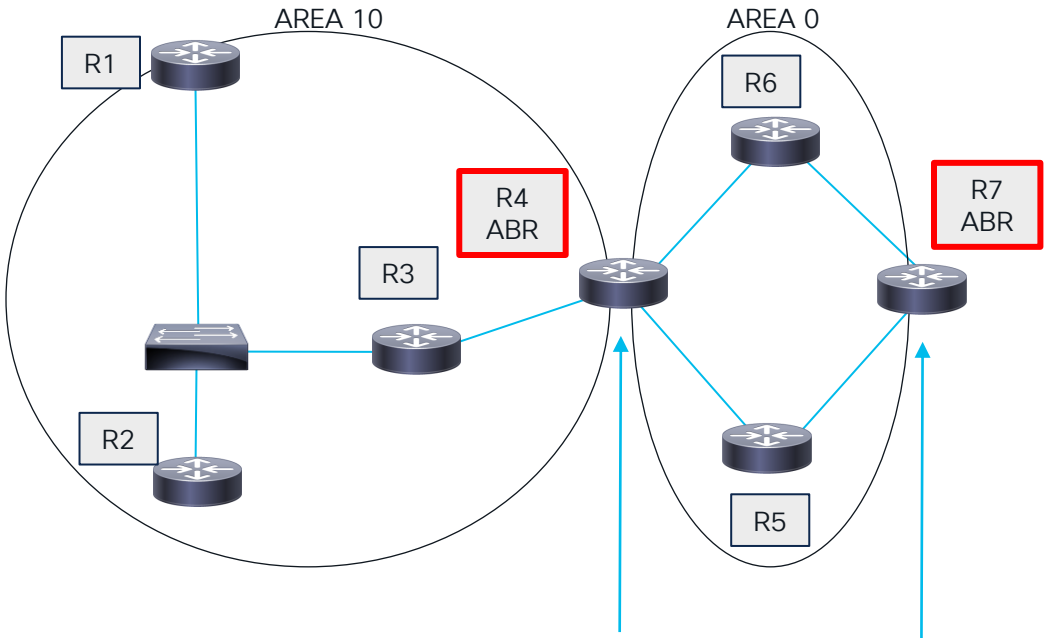
Type 1 – Router

```
R9#show ip ospf database router 8.8.8.8

            OSPF Router with ID (9.9.9.9) (Process ID
101)

Router Link States (Area 20)

  LS age: 1135
  Options: (No TOS-capability, DC)
  LS Type: Router Links
  Link State ID: 8.8.8.8
  Advertising Router: 8.8.8.8
  LS Seq Number: 8000000B
  Checksum: 0x9C3D
  Length: 48
  Number of Links: 2

    Link connected to: a Transit Network
     (Link ID) Designated Router address: 192.168.80.2
     (Link Data) Router Interface address: 192.168.80.1
      Number of MTID metrics: 0
       TOS 0 Metrics: 1

    Link connected to: a Transit Network
     (Link ID) Designated Router address: 192.168.89.2
     (Link Data) Router Interface address: 192.168.89.1
      Number of MTID metrics: 0
       TOS 0 Metrics: 1
```

Type 2 – Network

```
R3#show ip ospf database network 192.168.123.3

            OSPF Router with ID (3.3.3.3) (Process ID
101)

Net Link States (Area 10)

  Routing Bit Set on this LSA in topology Base with
MTID 0
  LS age: 1378
  Options: (No TOS-capability, DC)
  LS Type: Network Links
  Link State ID: 192.168.123.3 (address of Designated
Router)
  Advertising Router: 3.3.3.3
  LS Seq Number: 8000000E
  Checksum: 0x32EA
  Length: 36
  Network Mask: /24
Attached Router: 3.3.3.3
Attached Router: 1.1.1.1
Attached Router: 2.2.2.2
```

Type 3 – Summary




```
R6#show ip ospf database summary 192.168.80.0

      OSPF Router with ID (6.6.6.6) (Process ID 101)

Summary Net Link States (Area 0)

Routing Bit Set on this LSA in topology Base with
MTID 0
LS age: 1053
Options: (No TOS-capability, DC, Upward)
LS Type: Summary Links(Network)
Link State ID: 192.168.80.0 (summary Network Number)
Advertising Router: 7.7.7.7
LS Seq Number: 80000003
Checksum: 0x8FD6
Length: 28
Network Mask: /30
MTID: 0 Metric: 2
```

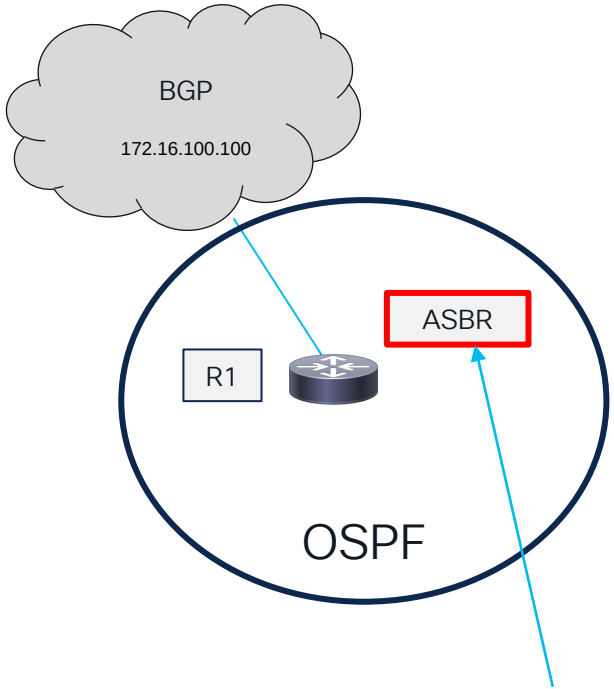
What's an ABR?

An Area Border Router, is a router that connects different areas within the same OSPF network, allowing the exchange of routing information between them and serving as a gateway for routing between areas.

Type 4 – ASBR Summary

```
R6#show ip ospf database asbr-summary

OSPF Router with ID (6.6.6.6) (Process ID 101)

Summary ASB Link States (Area 0)

Routing Bit Set on this LSA in topology Base with
MTID 0
LS age: 1400
Options: (No TOS-capability, DC, Upward)
LS Type: Summary Links(AS Boundary Router)
Link State ID: 1.1.1.1 (AS Boundary Router address)
Advertising Router: 4.4.4.4
LS Seq Number: 80000005
Checksum: 0xE041
Length: 28
Network Mask: /0
MTID: 0 Metric: 2
```

Type 5 – External




```
R1#show ip ospf database external 172.16.100.100
OSPF Router with ID (1.1.1.1) (Process ID 101)
Type-5 AS External Link States
LS age: 23
Options: (No TOS-capability, DC, Upward)
LS Type: AS External Link
Link State ID: 172.16.100.100 (External Network
Number )
Advertising Router: 1.1.1.1
LS Seq Number: 80000001
Checksum: 0xEE40
Length: 36
Network Mask: /32
Metric Type: 2 (Larger than any link state path)
MTID: 0
Metric: 1
Forward Address: 0.0.0.0
External Route Tag: 65530
```

What's an ASBR?

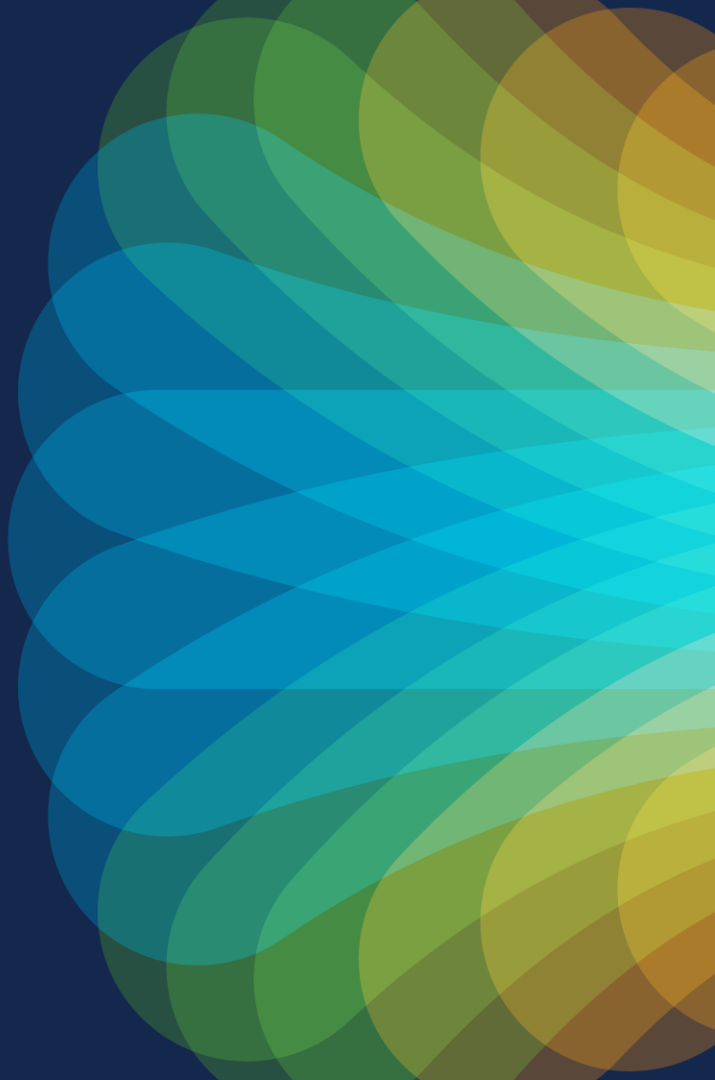
Autonomous System Border Router, is a router that connects different autonomous systems, facilitating the exchange of routing information between them and routing between networks with different routing protocols. (BGP <-> OSPF)

BGP routes are 'external' or outside the OSPF network.

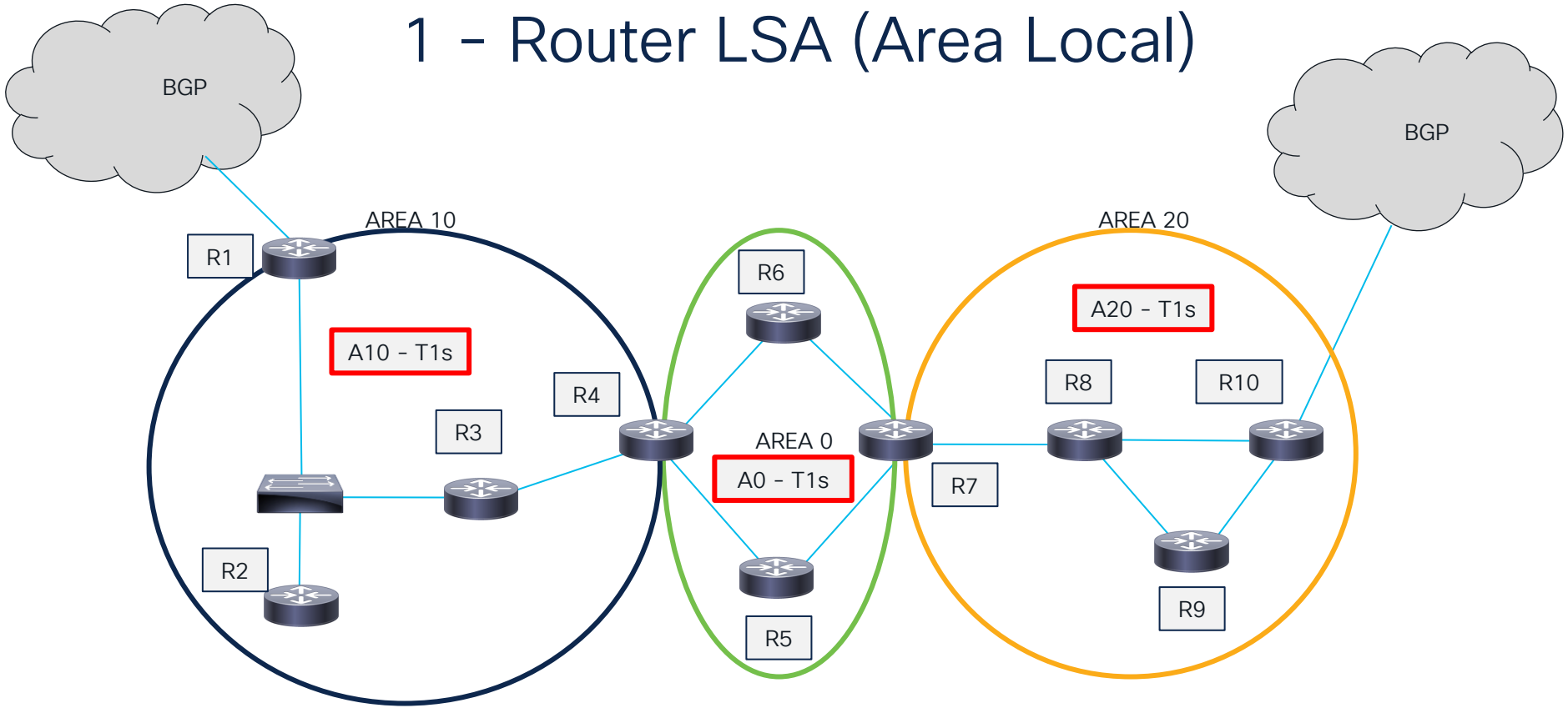
Type 7 – NSSA

```
R10#show ip ospf database nssa-external 172.16.200.200

            OSPF Router with ID (10.10.10.10) (Process ID 101)

Type-7 AS External Link States (Area 20)

  LS age: 262
  Options: (No TOS-capability, Type 7/5 translation, DC, Upward)
  LS Type: AS External Link
  Link State ID: 172.16.200.200 (External Network Number )
  Advertising Router: 10.10.10.10
  LS Seq Number: 80000001
  Checksum: 0xEFF7
  Length: 36
  Network Mask: /32
Metric Type: 1 (Comparable directly to link state metric)
MTID: 0
Metric: 10
Forward Address: 192.168.90.2
External Route Tag: 64512
```

LSA Flooding Scope

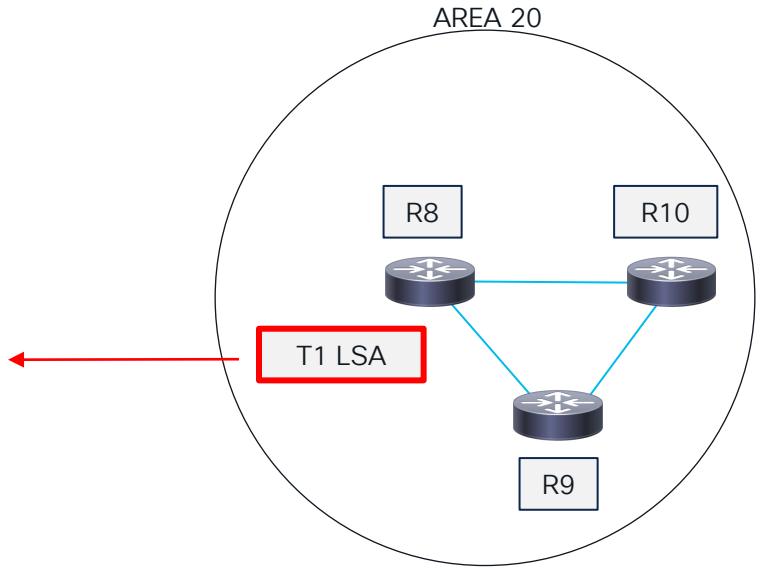


1 - Router LSA (Area Local)

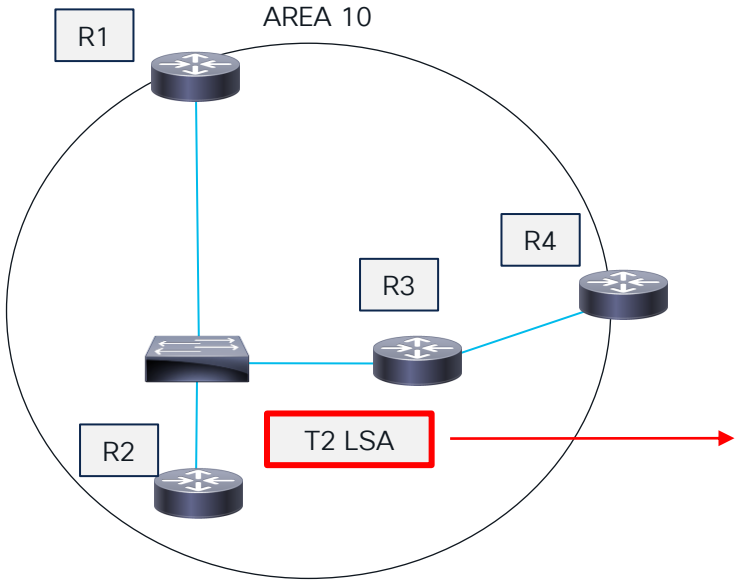


1 – Router LSA (Area Local)

```
R9#show ip ospf database router 8.8.8.8

            OSPF Router with ID (9.9.9.9) (Process ID 101)

Router Link States (Area 20)

  LS age: 1135
  Options: (No TOS-capability, DC)
  LS Type: Router Links
  Link State ID: 8.8.8.8
  Advertising Router: 8.8.8.8
  LS Seq Number: 8000000B
  Checksum: 0x9C3D
  Length: 48
  Number of Links: 2

    Link connected to: a Transit Network
     (Link ID) Designated Router address: 192.168.80.2
     (Link Data) Router Interface address: 192.168.80.1
      Number of MTID metrics: 0
       TOS 0 Metrics: 1

    Link connected to: a Transit Network
     (Link ID) Designated Router address: 192.168.89.2
     (Link Data) Router Interface address: 192.168.89.1
      Number of MTID metrics: 0
       TOS 0 Metrics: 1
```



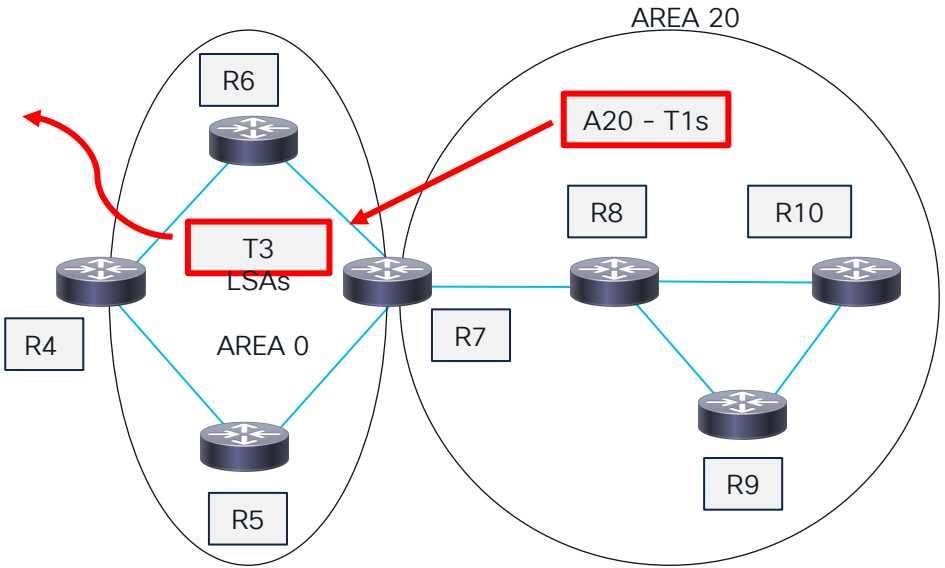
2 – Network LSA (Area Local)



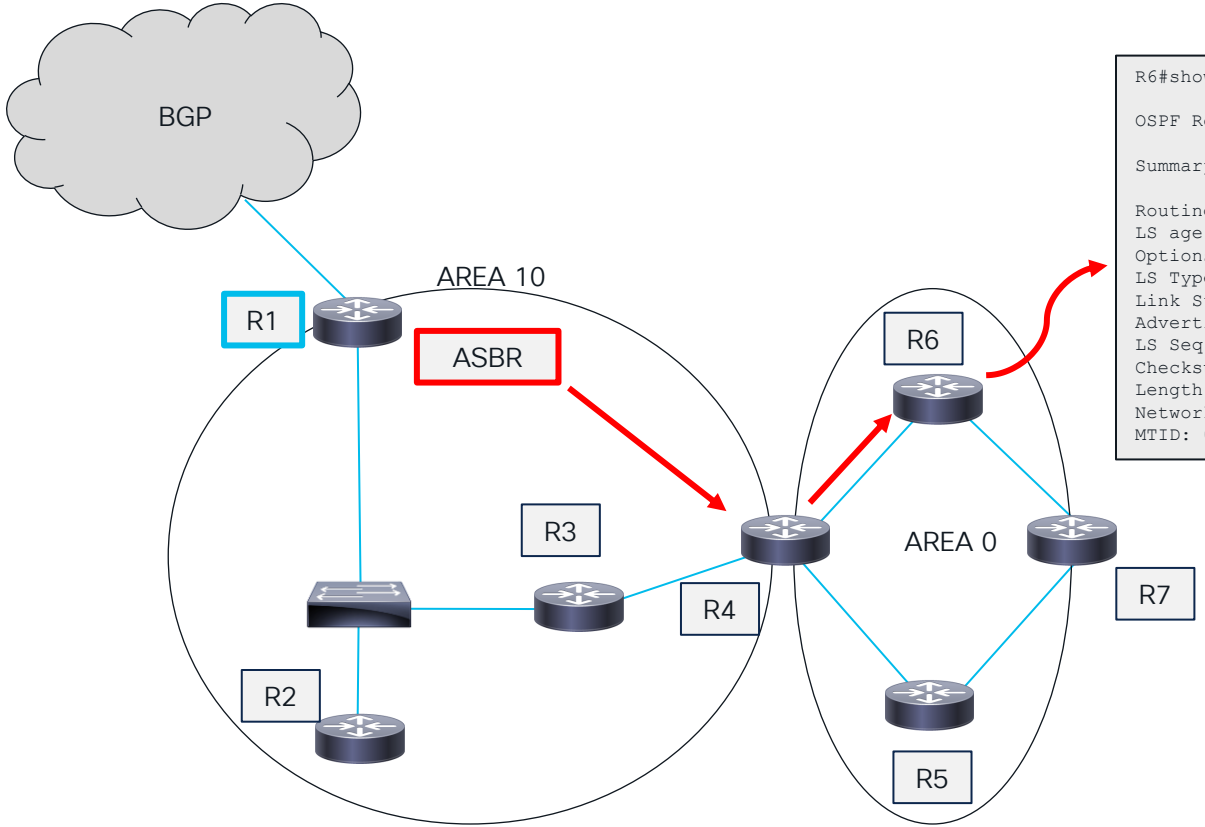

```
R3#show ip ospf database network 192.168.123.3

            OSPF Router with ID (3.3.3.3) (Process ID 101)

Net Link States (Area 10)

  Routing Bit Set on this LSA in topology Base with MTID 0
  LS age: 1378
  Options: (No TOS-capability, DC)
  LS Type: Network Links
  Link State ID: 192.168.123.3 (address of Designated Router)
  Advertising Router: 3.3.3.3
  LS Seq Number: 8000000E
  Checksum: 0x32EA
  Length: 36
  Network Mask: /24
Attached Router: 3.3.3.3
Attached Router: 1.1.1.1
Attached Router: 2.2.2.2
```

3- Summary LSA (Multi-area across ABR)

```
R6#show ip ospf database summary 192.168.80.0

     OSPF Router with ID (6.6.6.6) (Process ID 101)

Summary Net Link States (Area 0)

Routing Bit Set on this LSA in topology Base with
MTID 0
LS age: 1053
Options: (No TOS-capability, DC, Upward)
LS Type: Summary Links(Network)
Link State ID: 192.168.80.0 (summary Network Number)
Advertising Router: 7.7.7.7
LS Seq Number: 80000003
Checksum: 0x8FD6
Length: 28
Network Mask: /30
MTID: 0 Metric: 2
```

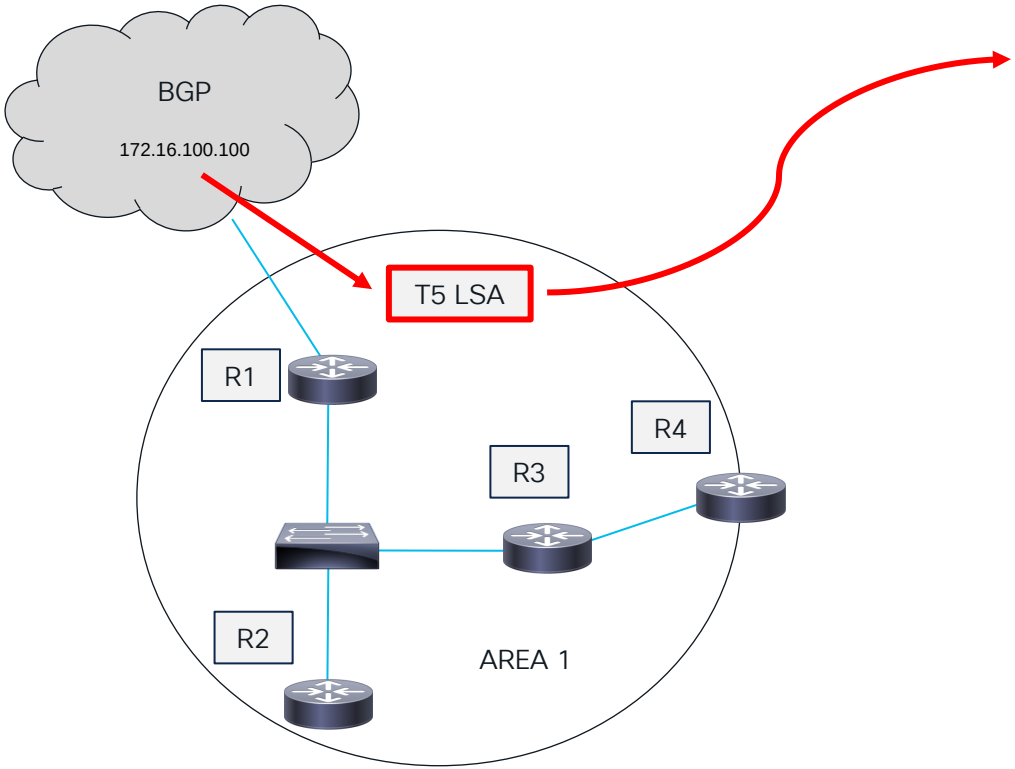


4 - ASBR Summary LSA (Multi-area across ABR)



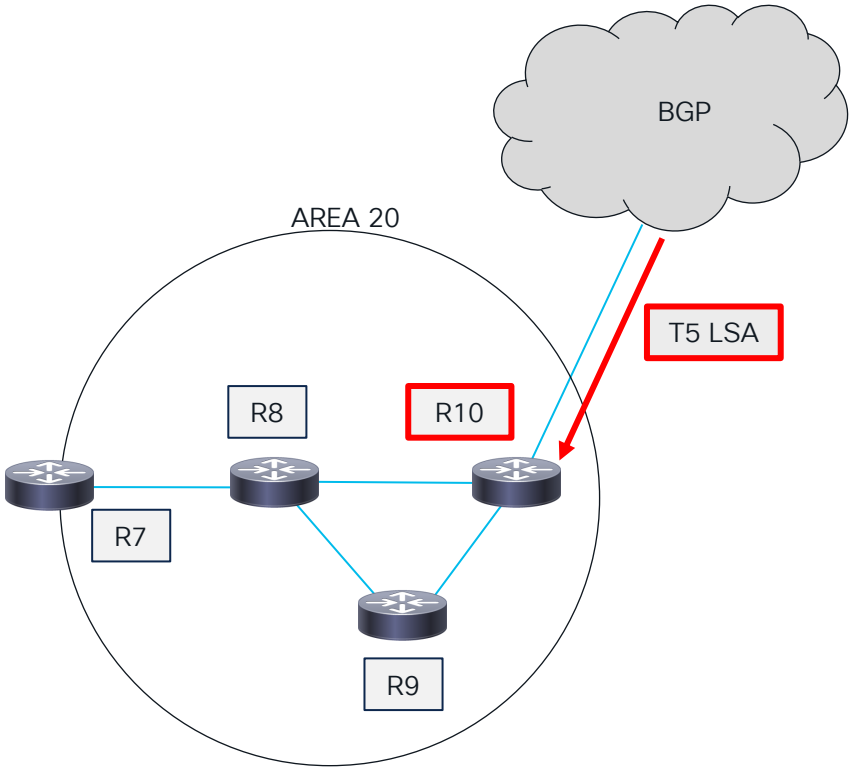

```
R6#show ip ospf database asbr-summary

OSPF Router with ID (6.6.6.6) (Process ID 101)

Summary ASB Link States (Area 0)

Routing Bit Set on this LSA in topology Base with MTID 0
LS age: 1400
Options: (No TOS-capability, DC, Upward)
LS Type: Summary Links(AS Boundary Router)
Link State ID: 1.1.1.1 (AS Boundary Router address)
Advertising Router: 4.4.4.4
LS Seq Number: 80000005
Checksum: 0xE041
Length: 28
Network Mask: /0
MTID: 0 Metric: 2
```

5 – External LSA (Domain)



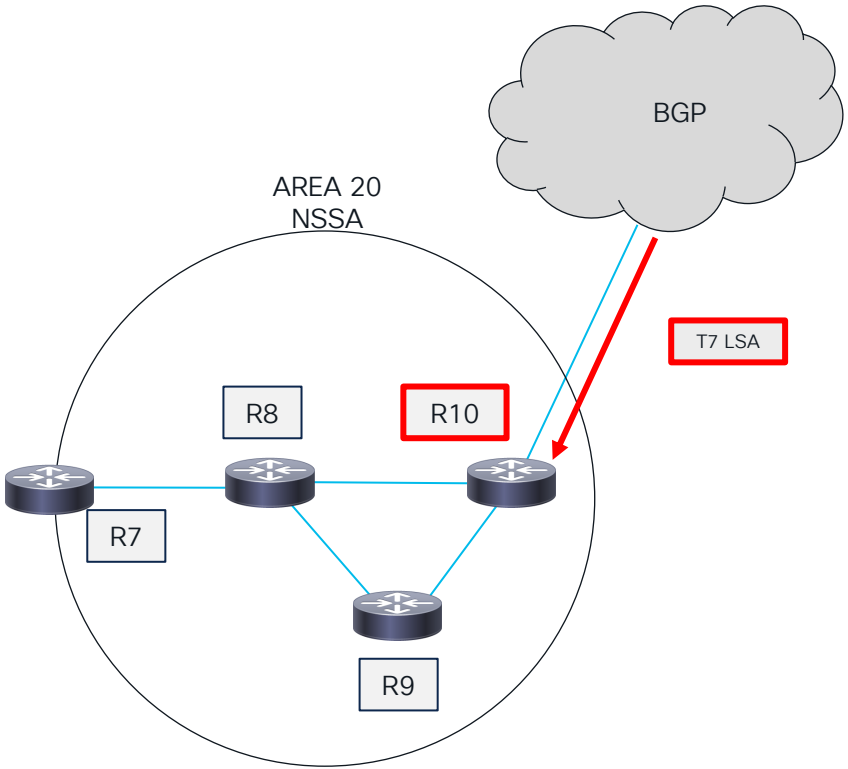

```
R1#show ip ospf database external 172.16.100.100
OSPF Router with ID (1.1.1.1) (Process ID 101)
Type-5 AS External Link States
LS age: 23
Options: (No TOS-capability, DC, Upward)
LS Type: AS External Link
Link State ID: 172.16.100.100 (External Network Number )
Advertising Router: 1.1.1.1
LS Seq Number: 80000001
Checksum: 0xEE40
Length: 36
Network Mask: /32
Metric Type: 2 (Larger than any link state path)
MTID: 0
Metric: 1
Forward Address: 0.0.0.0
External Route Tag: 65530
```

7- Before NSSA



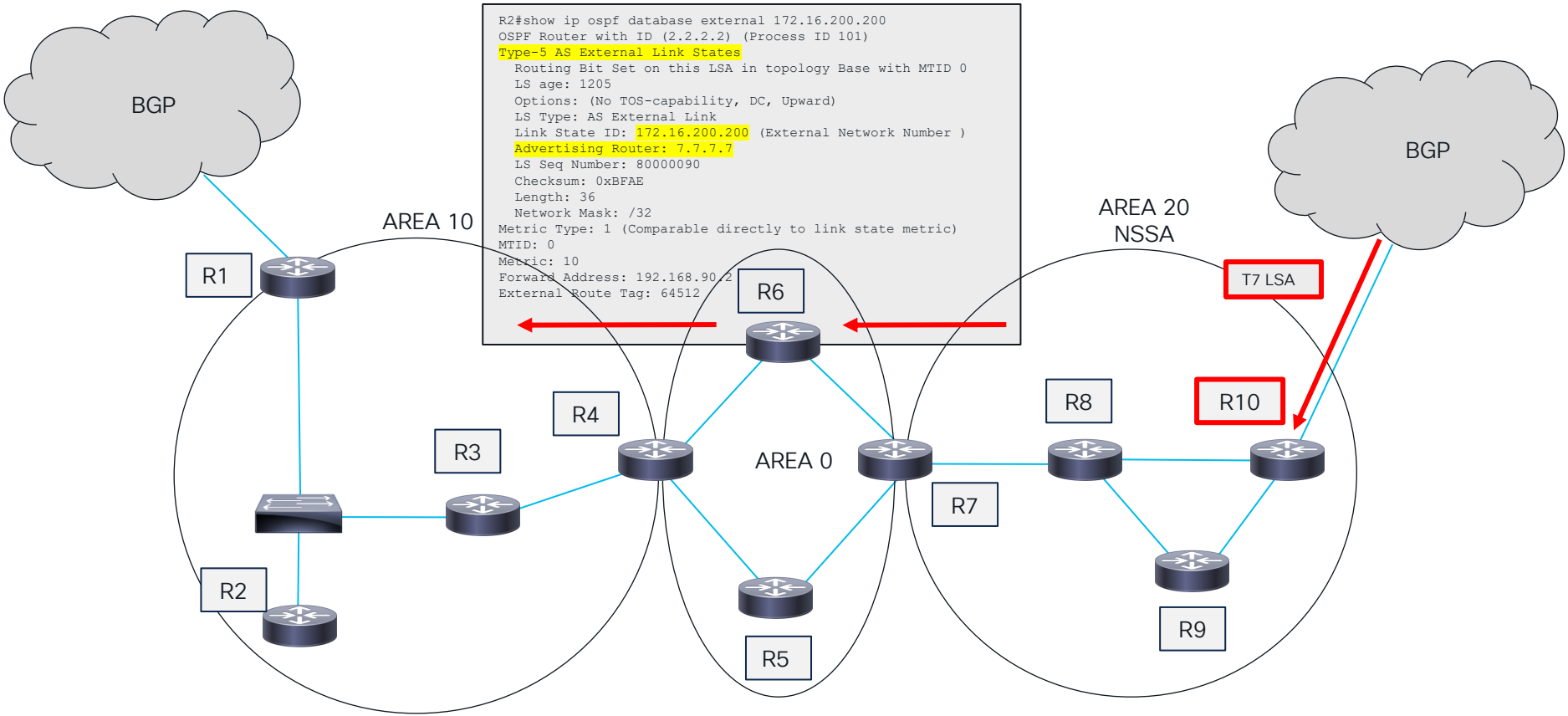

```
R10#show ip ospf database
            OSPF Router with ID (10.10.10.10) (Process ID 101)
Router Link States (Area 20)

Link ID         ADV Router      Age         Seq#       Checksum Link
count
7.7.7.7         7.7.7.7         1516        0x80000005 0x005E26 1
8.8.8.8         8.8.8.8         1472        0x80000005 0x001718 4
9.9.9.9         9.9.9.9         1442        0x80000003 0x000F8A 3
10.10.10.10     10.10.10.10     37          0x80000007 0x006167 2

Net Link States (Area 20)
Link ID         ADV Router      Age         Seq#       Checksum
192.168.78.1    7.7.7.7         1516        0x80000003 0x001E0C
192.168.80.1    8.8.8.8         1472        0x80000003 0x0070A7
192.168.90.2    10.10.10.10     1370        0x80000003 0x00CD33

Summary Net Link States (Area 20)
Link ID         ADV Router      Age         Seq#       Checksum
192.168.34.0    7.7.7.7         762         0x80000004 0x0093FE
192.168.45.0    7.7.7.7         762         0x80000004 0x001078
192.168.46.0    7.7.7.7         762         0x80000004 0x000582
192.168.57.0    7.7.7.7         762         0x80000004 0x0081FB
192.168.67.0    7.7.7.7         762         0x80000004 0x001360
192.168.123.0   7.7.7.7         1778        0x80000005 0x00D65D

Summary ASB Link States (Area 20)
Link ID         ADV Router      Age         Seq#       Checksum
1.1.1.1         7.7.7.7         1778        0x80000005 0x009A79

Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
172.16.100.100  1.1.1.1         593         0x80000004 0x00E843
65530
172.16.200.200  10.10.10.10     12          0x80000002 0x009F17
64512
```

7 – After NSSA

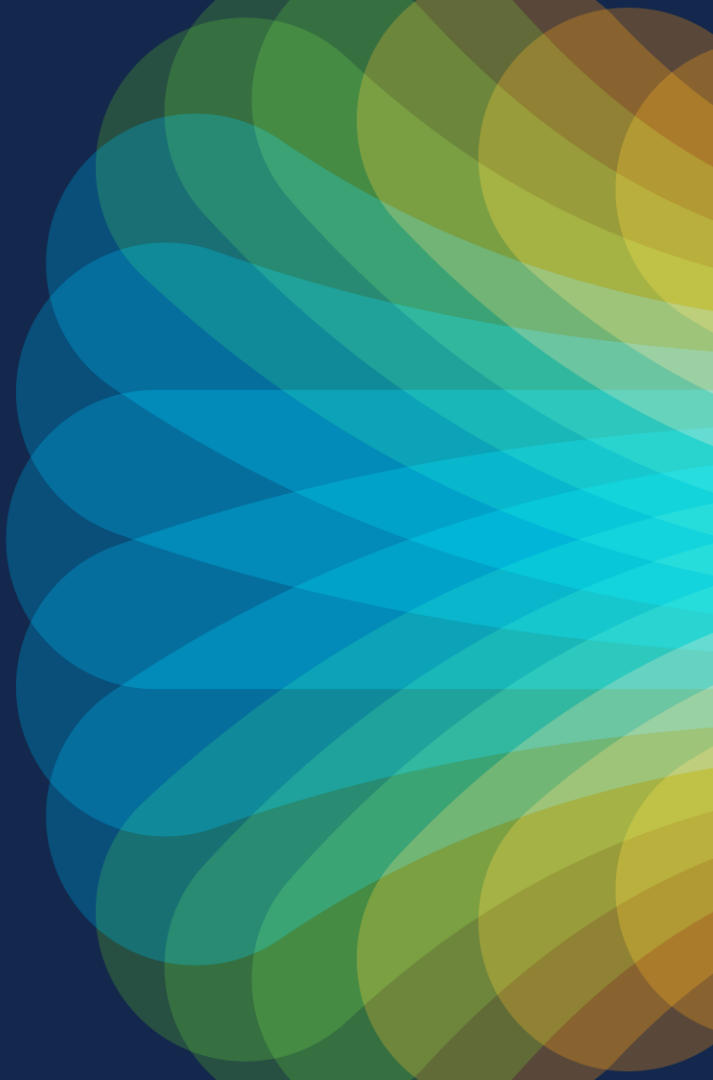



```
R10#show ip ospf database

            OSPF Router with ID (10.10.10.10) (Process ID 101)

Router Link States (Area 20)

Link ID         ADV Router      Age         Seq#       Checksum
Link count
7.7.7.7         7.7.7.7         122         0x80000007 0x001069 1
8.8.8.8         8.8.8.8         124         0x80000009 0x00EC36 4
9.9.9.9         9.9.9.9         128         0x80000007 0x00ACE2 3
10.10.10.10     10.10.10.10     134         0x8000000A 0x0017A7 2

Net Link States (Area 20)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.78.2    8.8.8.8         124         0x80000001 0x008F91
192.168.80.2    10.10.10.10     151         0x80000001 0x00B357
192.168.90.2    10.10.10.10     129         0x80000005 0x006F89

Summary Net Link States (Area 20)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.34.0    7.7.7.7         127         0x80000005 0x003754
192.168.45.0    7.7.7.7         127         0x80000005 0x00B3CD
192.168.46.0    7.7.7.7         127         0x80000005 0x00A8D7
192.168.57.0    7.7.7.7         127         0x80000005 0x002551
192.168.67.0    7.7.7.7         127         0x80000005 0x00B6B5
192.168.123.0   7.7.7.7         69          0x80000007 0x0078B3

Type-7 AS External Link States (Area 20)

Link ID         ADV Router      Age         Seq#       Checksum
Tag
0.0.0.0         7.7.7.7         14          0x80000001 0x003A5B 0
172.16.200.200  10.10.10.10     180         0x80000001 0x00EFF7
64512
```

7- NSSA External LSA



High Availability and MPLS TE



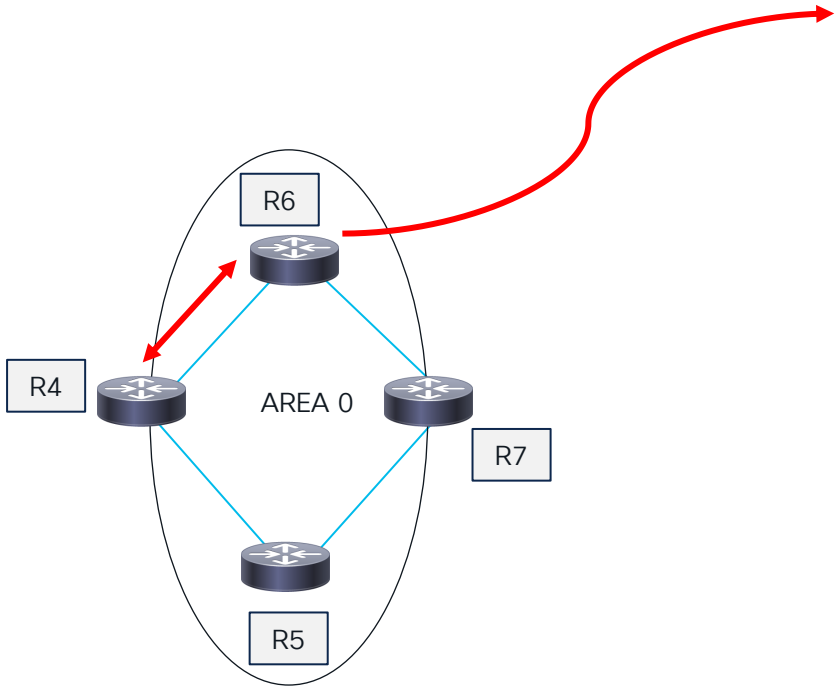
9 – Grace LSA

```
▷ Internet Protocol Version 4, Src: 192.168.199.5 (192.168.199.5), Dst: 224.0.0.5 (224.0.0.5)
▽ Open Shortest Path First
  ▽ OSPF Header
      Version: 2
      Message Type: LS Update (4)
      Packet Length: 72
      Source OSPF Router: 10.129.70.13 (10.129.70.13)
      Area ID: 0.0.0.0 (0.0.0.0) (Backbone)
      Checksum: 0x2da4 [correct]
      Auth Type: Null (0)
      Auth Data (none): 0000000000000000
  ▽ LS Update Packet
      Number of LSAs: 1
    ▽ Opaque LSA, Link-local scope
        .000 0000 0000 0000 = LS Age (seconds): 0
        0... .... .... .... = Do Not Age Flag: 0
      ▷ Options: 0x02 (E)
        LS Type: Opaque LSA, Link-local scope (9)
        Link State ID Opaque Type: grace-LSA (3)
        Link State ID Opaque ID: 0
        Advertising Router: 10.129.70.13 (10.129.70.13)
        Sequence Number: 0x80000001
        Checksum: 0x2186
        Length: 44
      ▷ Grace Period: 120 seconds
      ▷ Restart Reason: Unknown (0)
      ▷ Restart IP: 192.168.199.5 (192.168.199.5)
```

Graceful LSA.png

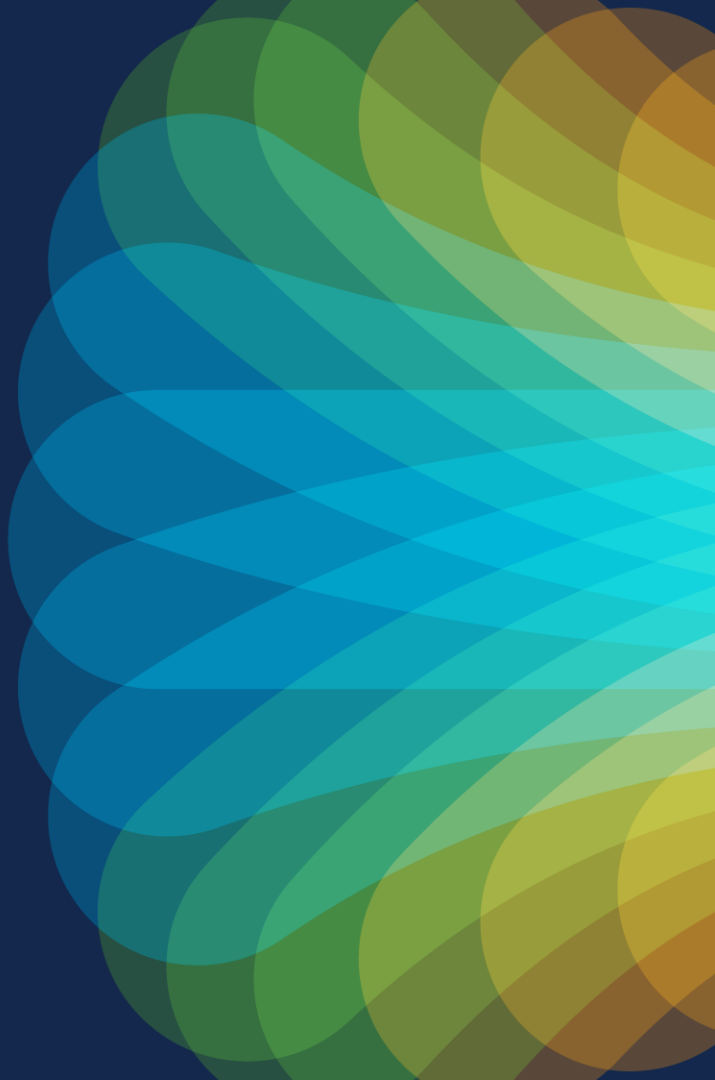
Restarting!!!

10 - Opaque Link Area




```
R6#sh ip ospf database opaque-area
OSPF Router with ID (6.6.6.6) (Process ID 101)
Type-10 Opaque Link Area Link States (Area 0)
  LS age: 417
  Options: (No TOS-capability, DC)
  LS Type: Opaque Area Link
  Link State ID: 1.0.0.0
  Opaque Type: 1
  Opaque ID: 0
  Advertising Router: 6.6.6.6
  LS Seq Number: 80000001
  Checksum: 0x33D4
  Length: 28
  Fragment number : 0
        MPLS TE router ID : 10.1.1.6
        Number of Links : 0
  LS age: 417
  Options: (No TOS-capability, DC)
  LS Type: Opaque Area Link
  Link State ID: 1.0.0.2
  Opaque Type: 1
  Opaque ID: 2
  Advertising Router: 6.6.6.6
  LS Seq Number: 80000001
  Checksum: 0xE10B
  Length: 132
  Fragment number : 2
    Link connected to Point-to-Point network
      Link ID : 4.4.4.4
      Interface Address : 192.168.46.2
      Neighbor Address : 192.168.46.1
      Admin Metric : 1
      Maximum bandwidth : 125000000
      Maximum reservable bandwidth : 128000
      Number of Priority : 8
      Priority 0 : 128000      Priority 1 : 128000
      Priority 2 : 128000      Priority 3 : 128000
      Priority 4 : 128000      Priority 5 : 128000
      Priority 6 : 128000      Priority 7 : 128000
      Affinity Bit : 0x0
      IGP Metric : 1



    Number of Links : 1
```

OSPFv3 LSA Types



OSPFv3 LSA Types

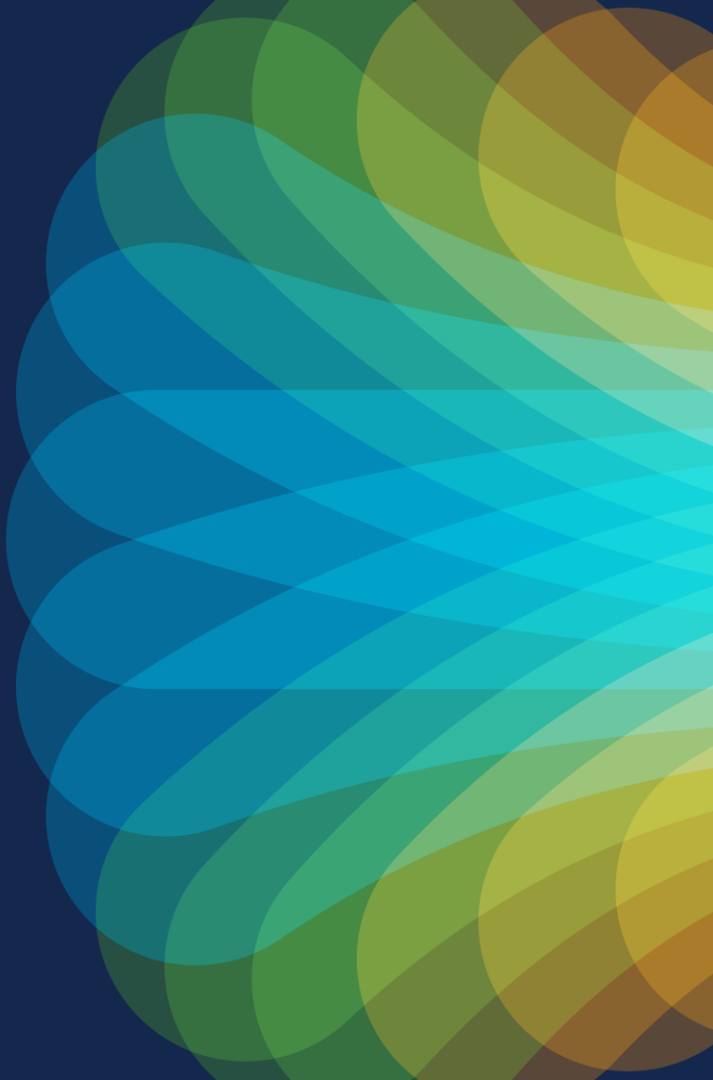
- 1 - Router LSA: Describes a router's directly connected links.
- 2 - Network LSA: Describes a network segment and attached routers.
- 3 - Inter-Area Prefix LSA: Advertises prefixes of networks in another area.
- 4 - Inter-Area Router LSA: Advertises the existence of an ASBR in another area.
- 5 - Autonomous System External LSA: Advertises a route to a destination outside the OSPF domain.
- 7 - NSSA External LSA: Advertises a route to a destination outside the NSSA.
- 8 - Link Local LSA: Advertises a router interface's link-local address.
- 9 - Intra-Area Prefix LSA: Advertises prefixes within a single area.

- Denotes New LSA type

New OSPFv3 LSA Types

- Type 8 Link Local LSA: advertises the link-local address of a router interface, which is used for neighbor discovery and communication in IPv6 networks.
- Type 9 Intra-Area Prefix LSA: associates a list of IPv6 address prefixes with a transit network link by referencing a network-LSA, or associates a list of IPv6 address prefixes with a router by referencing a router-LSA.

Troubleshooting



Demo

Fill out your session surveys!

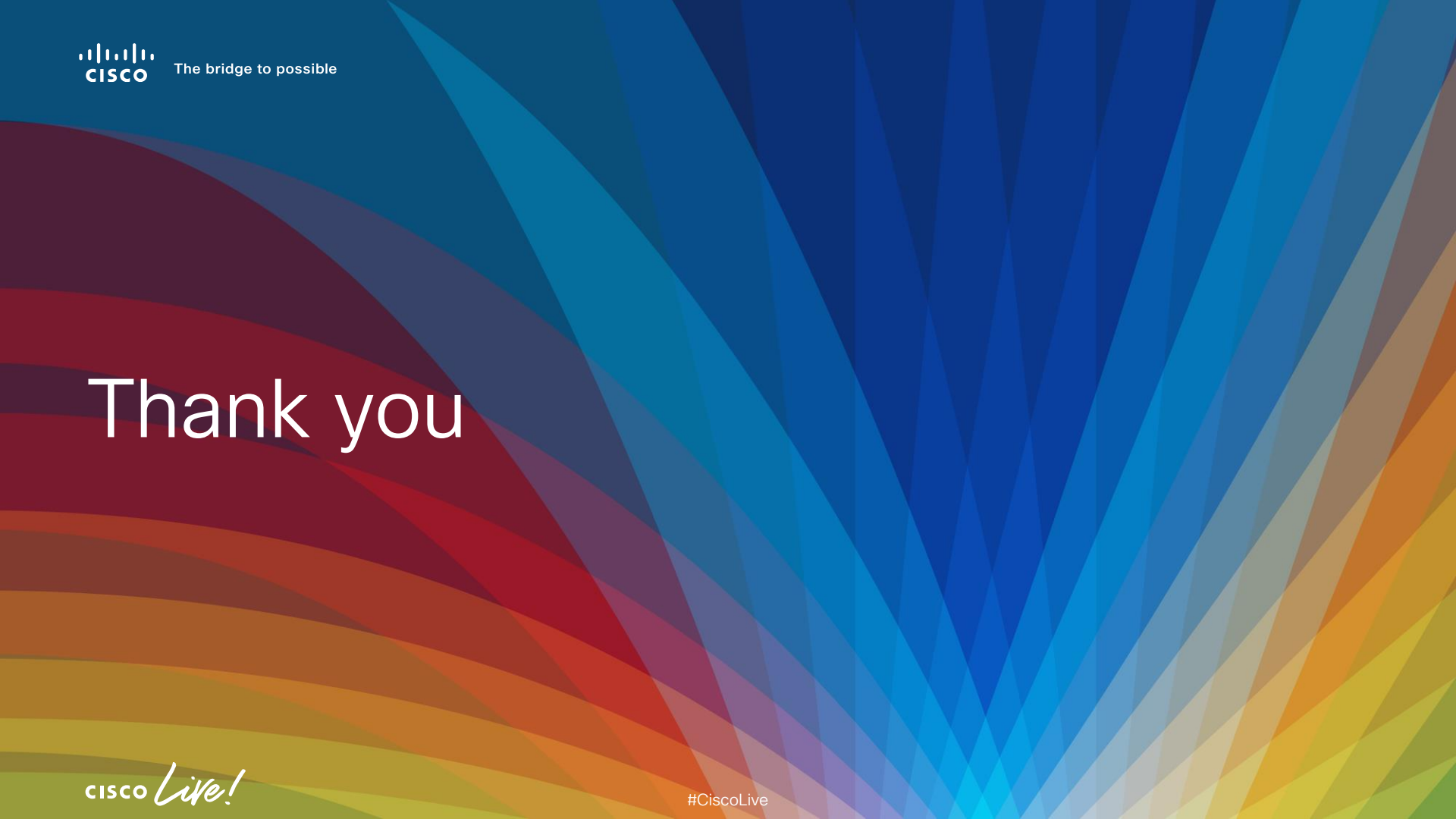
Attendees who fill out a minimum of four session surveys and the overall event survey will get **Cisco Live-branded socks** (while supplies last)!

Attendees will also earn 100 points in the **Cisco Live Game** for every survey completed.

These points help you get on the leaderboard and increase your chances of winning daily and grand prizes

Continue your education

- Visit the Cisco Showcase for related demos
- Book your one-on-one Meet the Engineer meeting
- Attend the interactive education with DevNet, Capture the Flag, and Walk-in Labs
- Visit the On-Demand Library for more sessions at www.CiscoLive.com/on-demand


cisco
The bridge to possible
Thank you
cisco Live!
#CiscoLive


cisco Live!
Let's go
#CiscoLive

Cisco Live
Challenge

Gamify your Cisco Live experience!

Get points for attending this session!

How:

1. Open the Cisco Events App.
2. Click on 'Cisco Live Challenge' in the side menu.
3. Click on View Your Badges at the top.
4. Click the + at the bottom of the screen and scan the QR code: