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OSPF LSA Types



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OSPF LSA Types:

- OSPF uses LSAs or Link State Advertisements to share information of each network & populate the LSDB (Link State Database).
- Cisco Router only supports LSA 1, 2, 3,4,5,7 and does not support other LSAs.

LSA Type:

Description

LSA Type 1-Router LSA (**Generated by All Router with in the area**)

LSA Type 2-Network LSA (**Generated by All DR within the area**)

LSA Type 3-Summary LSA (**Generated by ABR**)

LSA Type 4-Summary ASBR LSA (**Generated by ABR - advertise about the ASBR**)

LSA Type 5-Autonomous System External LSA (**Generated by ASBR**)

LSA Type 6-Multicast OSPF LSA (Not Supported and not used)

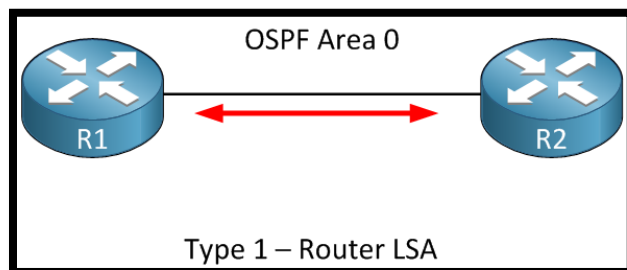
LSA Type 7-Not-So-Stubby-Areas LSA (As LSA Type 5 is not allowed in NSSA Areas, a solution to that was thought as LSA 7)

LSA Type 8-External Attributes LSA for BGP

LSA Type 9, 10,11-Opaque LSA

LSA Type 1: Router LSA:

- Every router within an area floods this LSA.
- The LSA consists of information about directly **connected links**.
- It is identified by **the Router ID** or the originating router.
- It floods within an area & **the LSA Type 1 does not cross the ABR.**
- It can be seen as **"O" routes in the routing table.**



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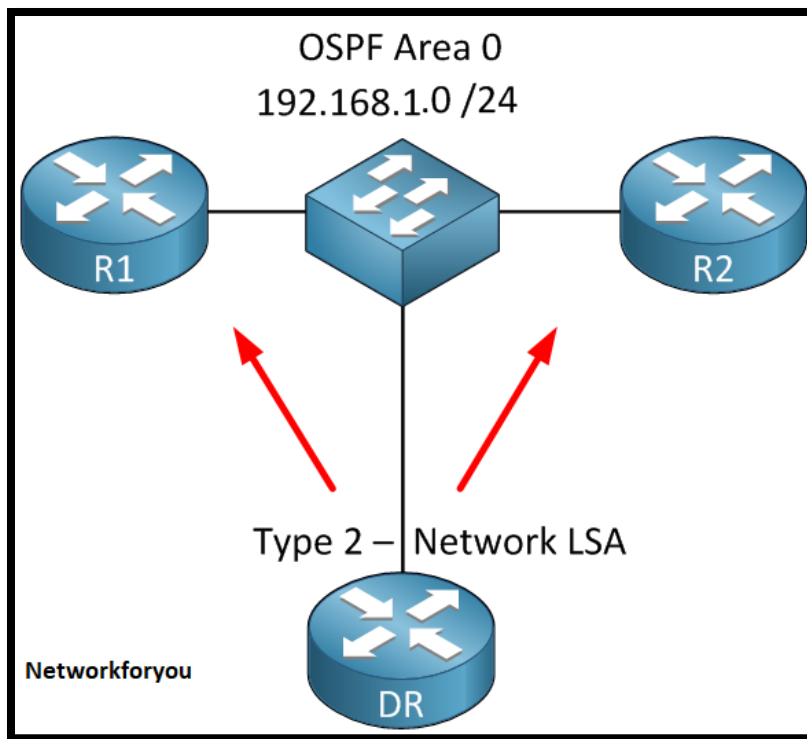
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LSA Type 2: Network LSA:

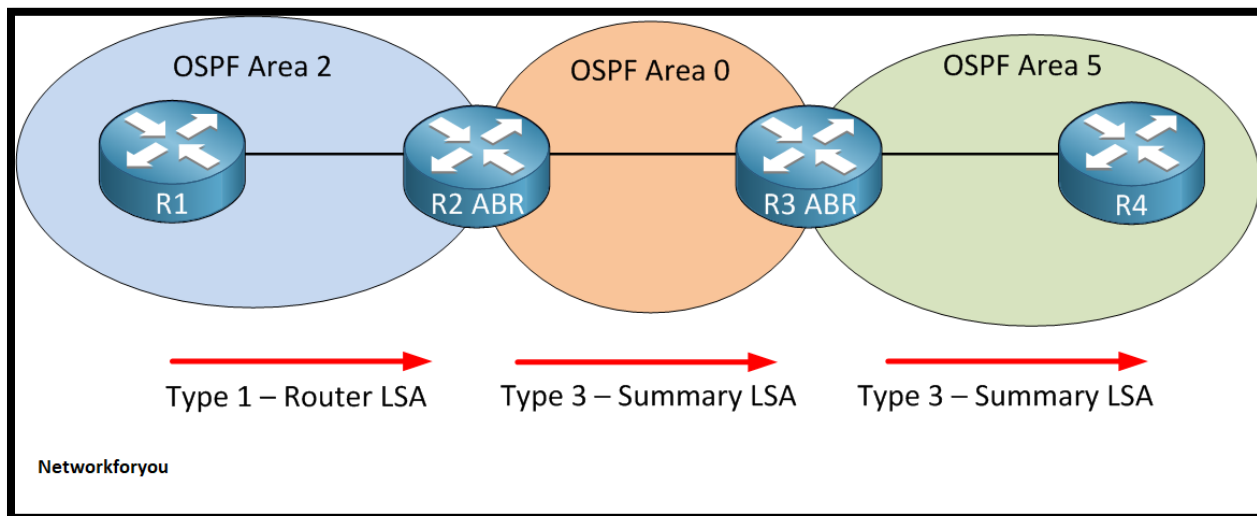
- Generated, by the **DR Router** on the broadcast network.
- It includes the network ID, **subnet mask** and the list of attached routers in the transit.
- In OSPF, there is one Network LSA or Type 2 LSA for each transit broadcast of NBMA (Non-Broadcast Multi-Access) Network.
- **This LSA also can be flooded only within the area and cannot cross the ABR.**
- **It can be seen this as "O" routes in the routing table.**





LSA Type 3: Summary LSA:

- **The Type 3 LSA is used to share the network information with other areas.**
- Inter-Area (IA). The ABR Router advertises these LSAs.
- These LSA are represented in the routing table as “OIA” routes.
- To flood the information through the Autonomous System, they are regenerated by the ABRs following subsequently.



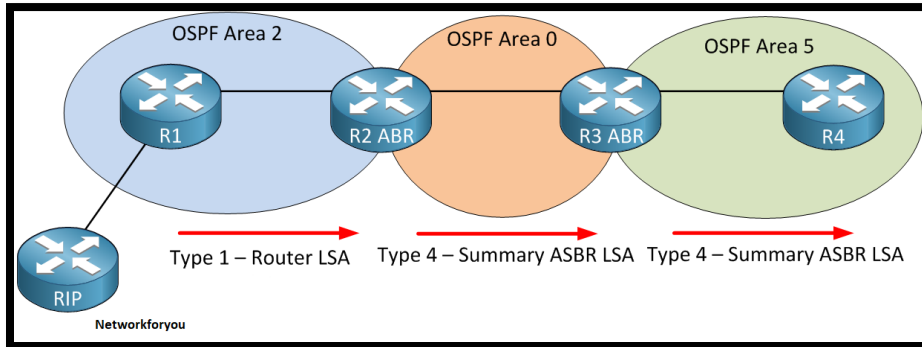
LSA Type 4: Summary ASBR LSA:

- **This LSA type is also known as Summary LSA** is used to **advertise about the ASBR to other area** in the same Autonomous System.
- **It is generated by the ABR of the originating area.**
- These types of LSAs are flooded throughout the Autonomous System.
- **These LSA will contain the Router ID of the ASBR only.**

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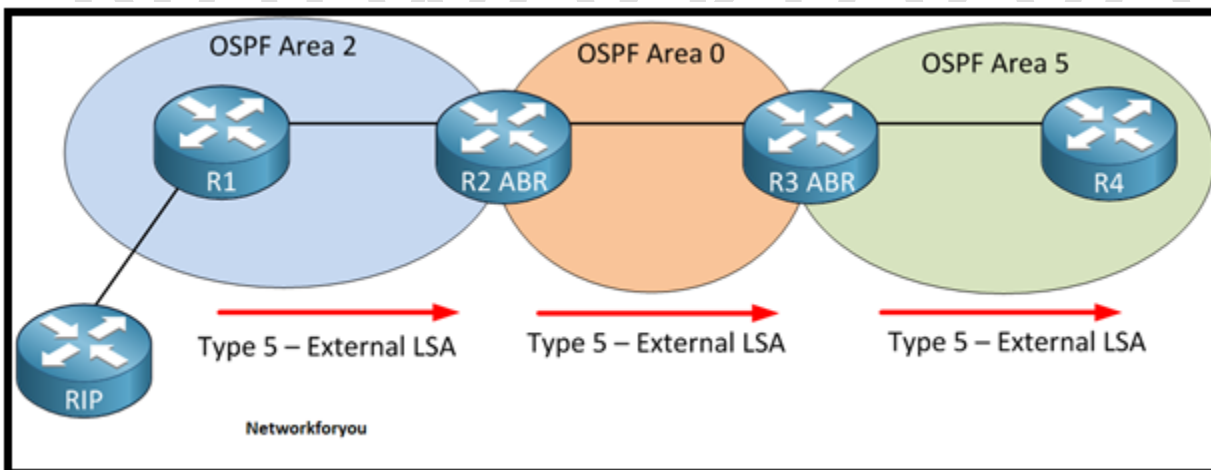
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LSA Type 5: External LSA:

- These are advertised by the ASBR only and owned by the ASBR.
- These LSAs are used to advertise networks from other Autonomous systems.
- These LSAs are flooded throughout the entire Autonomous System.
- The advertising router ID is not changed throughout the AS when it is propagating.
- An LSA Type 4 is used to find an ASBR. Routes are not summarized by default.



LSA Type 6 – Multicast OSPF LSA:

- These are used when routing using multicast (the MODPF Routing protocol).
- Cisco Routers do not support these LSAs.

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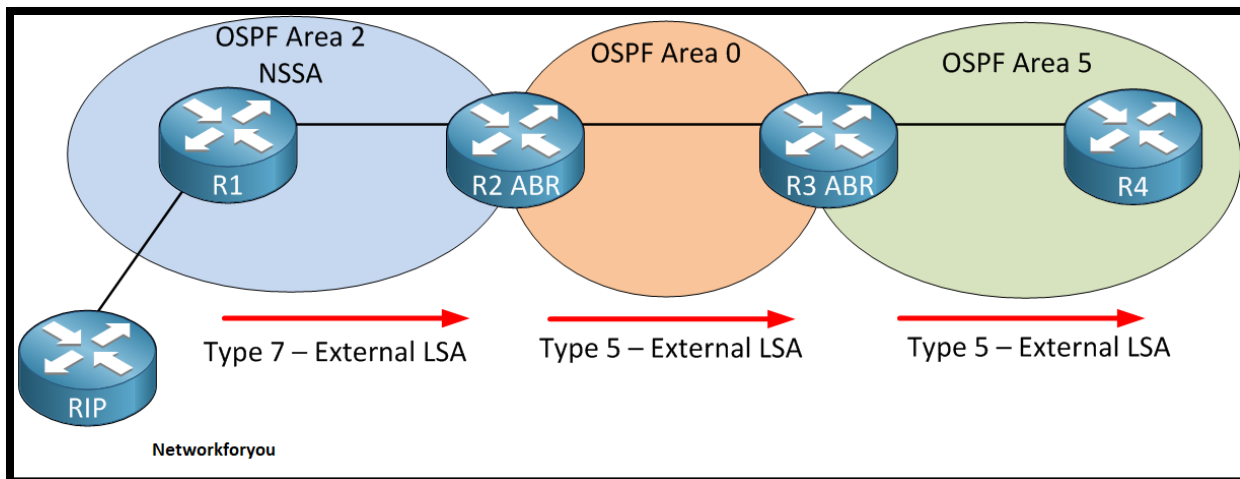
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LSA Type 7 – External LSA:

- As LSA Type 5 is not allowed in NSSA Areas, a solution to that was thought as LSA 7.
- It carries the similar information as a Type 5 LSA, but this is not blocked in the NSSA Area.
- When it reached the ABR, it is translated back to Type 5 LSA and flooded into other areas.



OSPF Area Types:

- An OSPF network can be divided into sub-domains called areas.
- An area is a logical collection of OSPF networks, routers, and links that have the same area identification.
- A router within an area must maintain a topological database for the area to which it belongs.
- The router does not have detailed information about network topology outside of its area, which thereby reduces the size of its database and routing overhead, speeds up convergence and most important if any network instability, it is limit to the specific area.

Backbone Area:

- The Backbone Area (Area 0 or Area 0.0.0.0) is the core of an OSPF network.
- All other areas are connected to it and all traffic between areas must pass through it.
- The backbone area is responsible for distributing routing information between nonbackbone areas.
- While all other OSPF areas must connect to the backbone area, either directly or through a virtual link.

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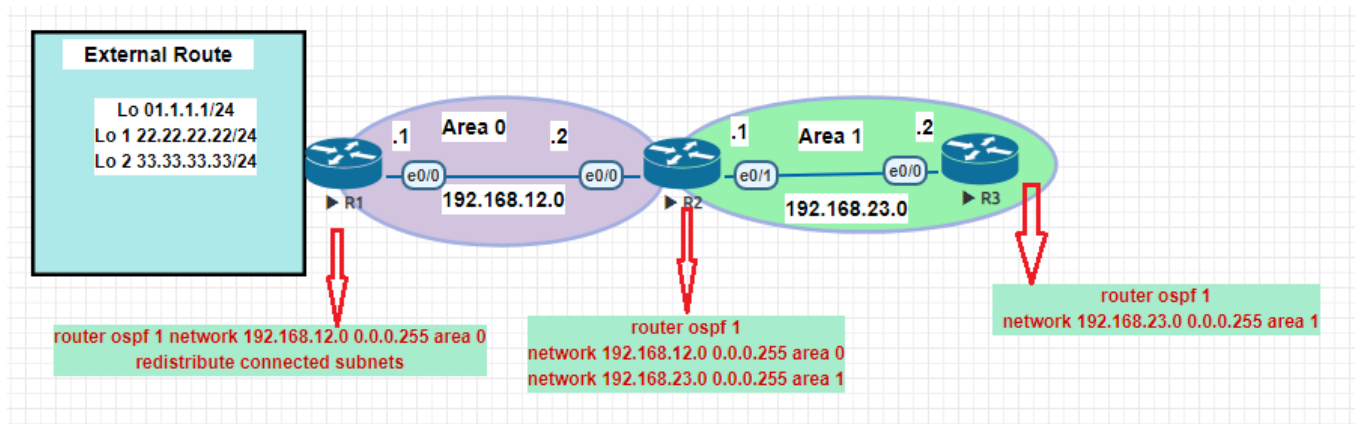
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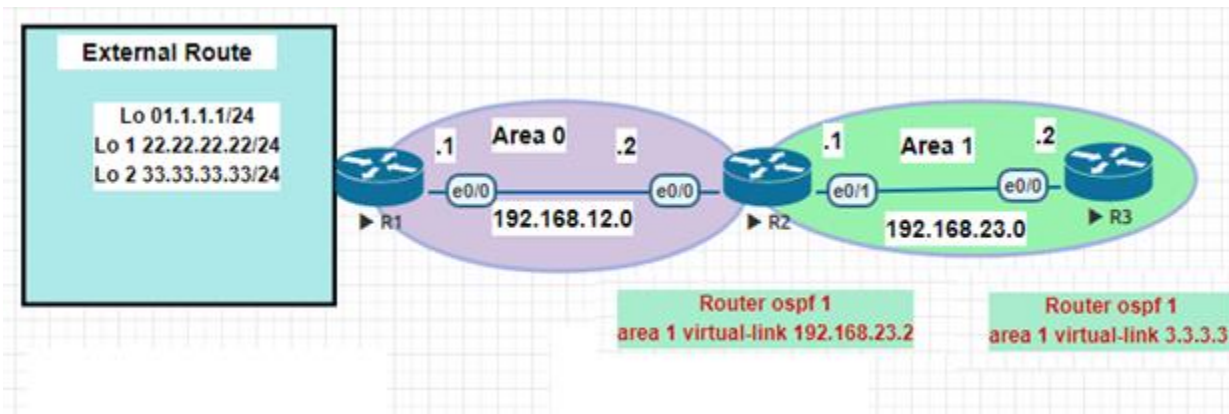
Normal Area:

- Normal Area are the non-zero defined areas where LSAs Type-1, 2, 3, 4 and 5 are allowed; this means that can accept Intra-Area, Inter-Area, and External routes.



Transit Area:

- The area through which configure the virtual link, known as a transit area, must have full routing information.
- The transit area cannot be a stub area.



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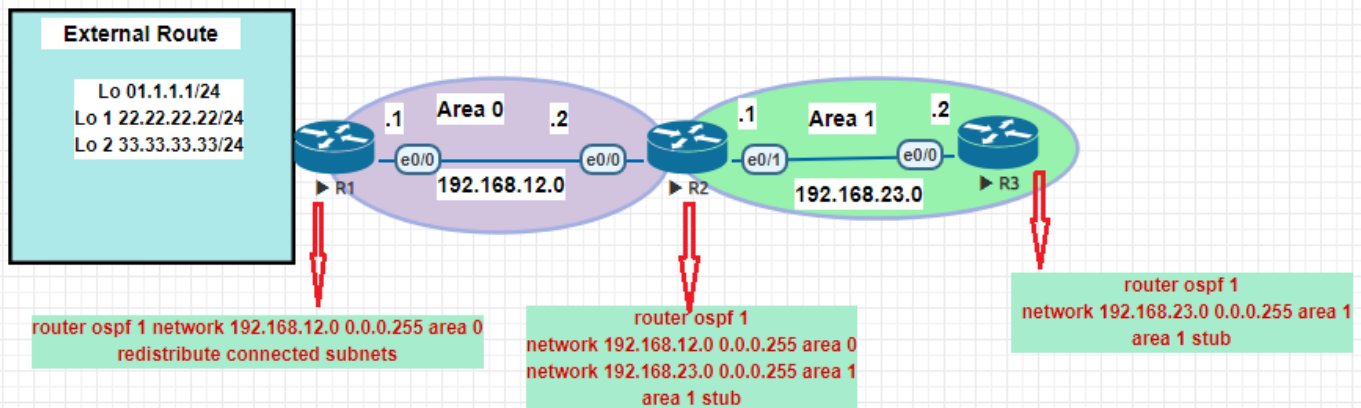
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Stub Area:

- Stub areas are typically used where the access to the rest of the network through a single link.
- For these type of networks is not necessary having and maintaining a full link state database.
- This area type can only accept intra-area, inter-area and the default route generated by default.
- **Stub areas allow only LSAs Type-1, 2 and 3.**
- Redistribution is not allowed in Stub Areas.
- The default route in a Stub area is generated by default and is injected in the area as Type-3 LSA.
- **If you configure an area as stub, it will block all type 5 external LSAs.**
- **No prefixes that redistributed into OSPF from another routing protocol are welcome in the stub area.**
- **Since you are not allowed to have type 5 external LSAs in the stub, area it is also impossible to have an ASBR in the stub area.**
- To configure a Stub Area use the Area [x] stub process command.
- **This command must be added to the routers belonging to the stub area and also, must be added to the ABR connecting the stub area**



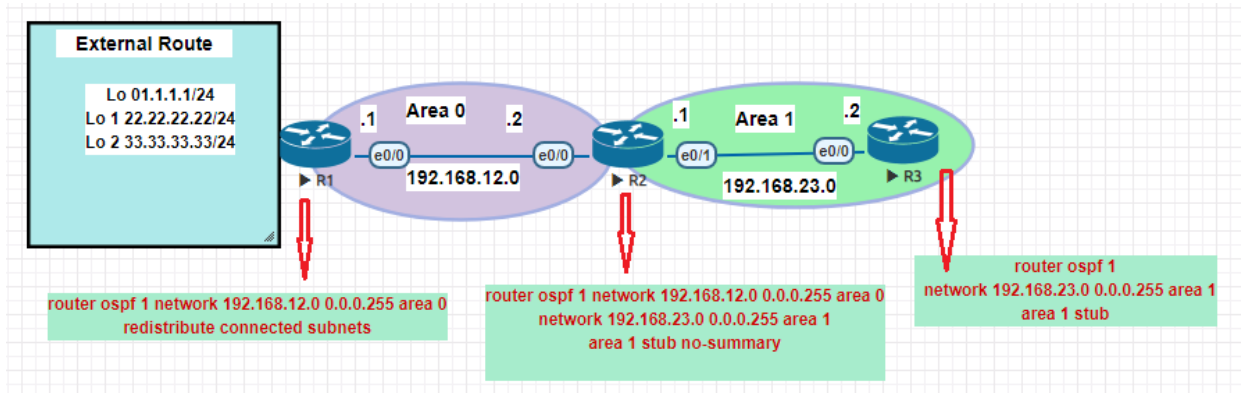
Totally Stub Area:

- It is an extension of **Stub Areas, which also filters summary LSA's.**
- That means that it does the **same filtering as Stub, and also filters Inter-Area prefixes.**
- **Totally Stub Area** type block **type 5 external LSAs and type 3 summary LSAs.**
- It is impossible to have an ASBR in the totally stub area since type 5 external LSAs are blocked.
- To configure a **Totally Stubby Area** use the **Area [x] stub no-summary** process command.
- This command with the **no-summary keyword is required only on the ABR connecting the area.**
- The router connecting to the ABR does not require but requires to be defined as a stub.

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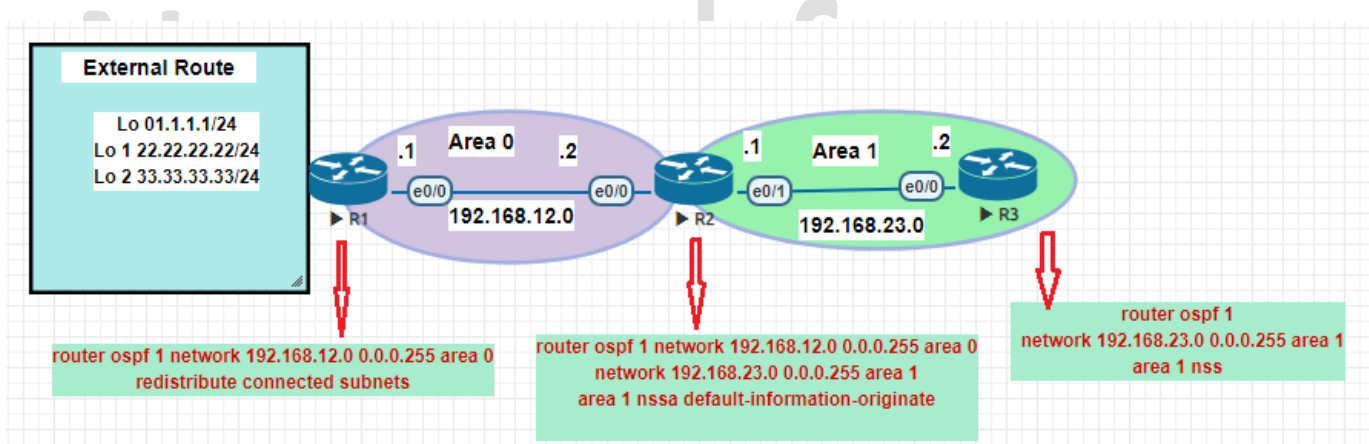
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Not So Stubby Area:

- The Not So Stubby Area (NSSA) is a type of stub area that can import external routes.
- If an area to be a stub area but has an ASBR in this area. Use the NSSA (Not-So-Stubby-Area).
- It allows having an ASBR within the area. Since we are not allowed to use the type 5 external LSA, it uses a new LSA type 7.



Totally Stubby NSSA:

- Totally Stubby NSSA is an extension to the NSSA.
- This type of area adds the flexibility of redistribution of external routes into the area while retaining its Totally Stubbed characteristic.
- This area type can only accept Intra-Area, External and the Default Route generated by default.
- Totally Stubby NSSA areas allow only LSAs Type-1, 2, 3 and 7.
- The default route in a Stub area is generated by default and is injected in the area as Type-3 LSA.
- To configure a Totally Stubby NSSA use the Area [x] nssa no-summary process command.
- This command with the no-summary keyword is required only on the ABR connecting the area.

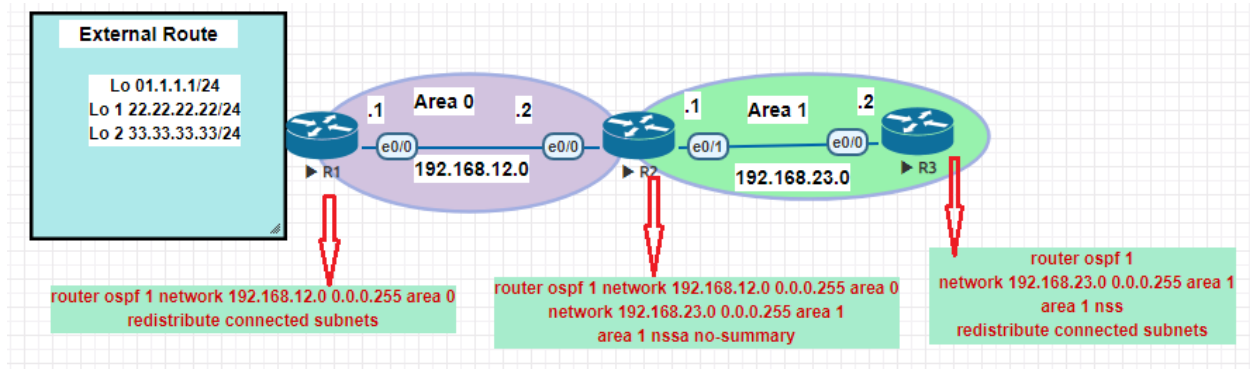
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- The router connecting to the ABR does not require the no-summary keyword but requires to be defined as NSSA.

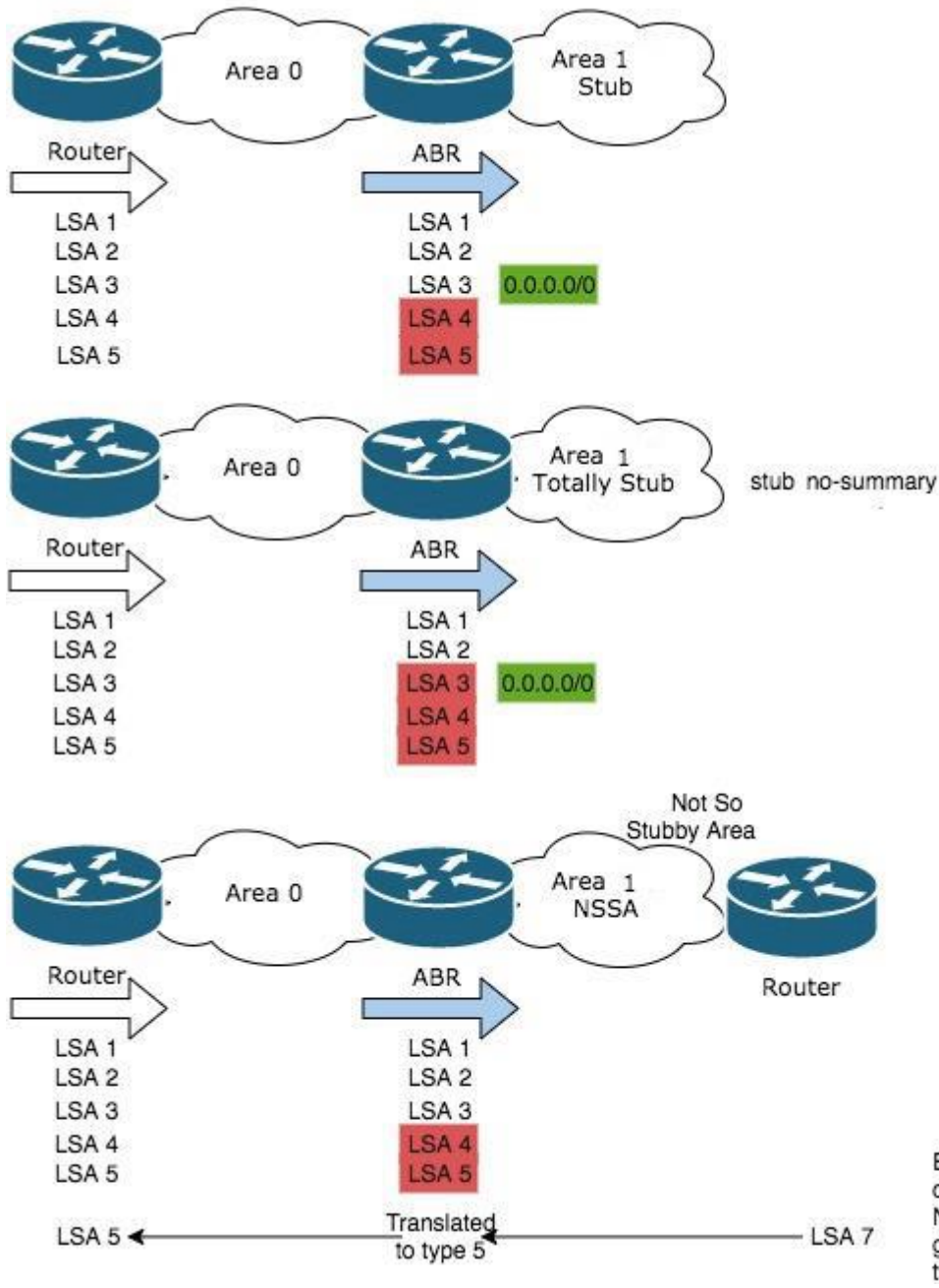


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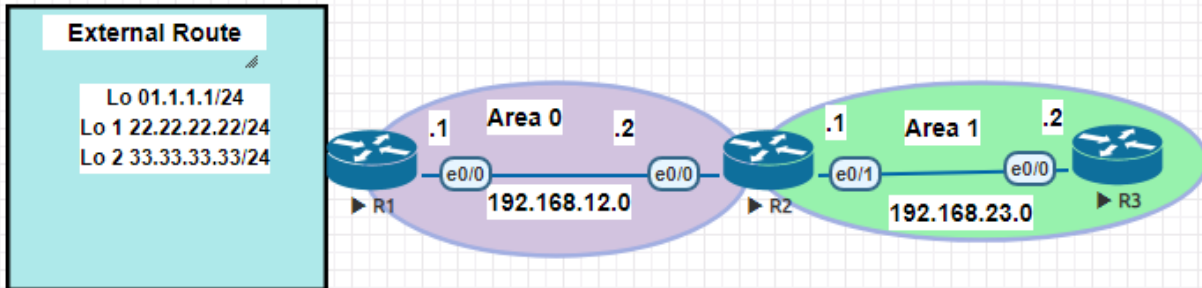


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Lab OSPF Area types:



R1 Configuration	R2 Configuration	R3 Configuration
<pre> en config t hostname R1 int e0/0 ip add 192.168.12.1 255.255.255.0 no sh int lo 0 ip add 1.1.1.1 255.255.255.0 int lo 1 ip add 22.22.22.22 255.255.255.0 int lo 2 ip add 33.33.33.33 255.255.255.0 </pre>	<pre> en config t hostname R2 int e0/0 ip add 192.168.12.2 255.255.255.0 no sh int e0/1 ip add 192.168.23.1 255.255.255.0 no sh </pre>	<pre> en config t hostname R3 int e0/0 ip add 192.168.23.2 255.255.255.0 no sh </pre>

Normal Area Configuration:

R1 Configuration

```

router ospf 1
network 192.168.12.0 0.0.0.255 area 0
redistribute connected subnets

```

R2 Configuration

```

router ospf 1
network 192.168.12.0 0.0.0.255 area 0
network 192.168.23.0 0.0.0.255 area 1

```

R3 Configuration

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```
router ospf 1
network 192.168.23.0 0.0.0.255 area 1
```

```
R3#sh ip route ospf
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, l - LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

1.0.0.0/24 is subnetted, 1 subnets
O E2   1.1.1.0 [110/20] via 192.168.23.1, 00:04:51, Ethernet0/0
22.0.0.0/24 is subnetted, 1 subnets
O E2   22.22.22.0 [110/20] via 192.168.23.1, 00:04:51, Ethernet0/0
33.0.0.0/24 is subnetted, 1 subnets
O E2   33.33.33.0 [110/20] via 192.168.23.1, 00:04:51, Ethernet0/0
O IA   192.168.12.0/24 [110/20] via 192.168.23.1, 00:04:51, Ethernet0/0
```

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```
R3#sh ip ospf database

      OSPF Router with ID (192.168.23.2) (Process ID 1)

      Router Link States (Area 1)

Link ID        ADV Router    Age           Seq#           Checksum Link count
192.168.23.1  192.168.23.1  420          0x80000003    0x00F827  1
192.168.23.2  192.168.23.2  419          0x80000003    0x00F32A  1

      Net Link States (Area 1)

Link ID        ADV Router    Age           Seq#           Checksum
192.168.23.2  192.168.23.2  419          0x80000001    0x00FA36

      Summary Net Link States (Area 1)

Link ID        ADV Router    Age           Seq#           Checksum
192.168.12.0  192.168.23.1  464          0x80000001    0x000438

      Summary ASB Link States (Area 1)

Link ID        ADV Router    Age           Seq#           Checksum
33.33.33.33   192.168.23.1  431          0x80000001    0x0038F3

      Type-5 AS External Link States

Link ID        ADV Router    Age           Seq#           Checksum Tag
1.1.1.0        33.33.33.33  498          0x80000001    0x00E137  0
22.22.22.0    33.33.33.33  498          0x80000001    0x00EAE E  0
33.33.33.0    33.33.33.33  498          0x80000001    0x005D5B  0
R3#
```

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```
R2#sh ip protocols
*** IP Routing is NSF aware ***

Routing Protocol is "application"
  Sending updates every 0 seconds
  Invalid after 0 seconds, hold down 0, flushed after 0
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Maximum path: 32
  Routing for Networks:
  Routing Information Sources:
    Gateway          Distance          Last Update
  Distance: (default is 4)

Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 192.168.23.1
  It is an area border router
  Number of areas in this router is 2. 2 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    192.168.12.0 0.0.0.255 area 0
    192.168.23.0 0.0.0.255 area 1
  Routing Information Sources:
    Gateway          Distance          Last Update
    33.33.33.33          110              00:09:04
  Distance: (default is 110)
```

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Stub Area Configuration:

R1 Configuration

```
router ospf 1
network 192.168.12.0 0.0.0.255 area 0
redistribute connected subnets
```

R2 Configuration

```
router ospf 1
network 192.168.12.0 0.0.0.255 area 0
network 192.168.23.0 0.0.0.255 area 1
area 1 stub
```

R3 Configuration

```
router ospf 1
network 192.168.23.0 0.0.0.255 area 1
area 1 stub
```

```
R3#sh ip route ospf
```

```
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, l - LISP
a - application route
+ - replicated route, % - next hop override
```

```
Gateway of last resort is 192.168.23.1 to network 0.0.0.0
```

```
O*IA 0.0.0.0/0 [110/11] via 192.168.23.1, 00:00:16, Ethernet0/0
O IA 192.168.12.0/24 [110/20] via 192.168.23.1, 00:00:26, Ethernet0/0
```

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```
R3#sh ip ospf database No more LSA 4 and 5

OSPF Router with ID (192.168.23.2) (Process ID 1)

Router Link States (Area 1)

Link ID          ADV Router      Age             Seq#            Checksum Link count
192.168.23.1    192.168.23.1   358            0x80000005     0x00130D 1
192.168.23.2    192.168.23.2   355            0x80000005     0x000E10 1

Net Link States (Area 1)

Link ID          ADV Router      Age             Seq#            Checksum
192.168.23.2    192.168.23.2   355            0x80000003     0x00151C

Summary Net Link States (Area 1)

Link ID          ADV Router      Age             Seq#            Checksum
0.0.0.0          192.168.23.1   377            0x80000001     0x00FDDBE
192.168.12.0    192.168.23.1   377            0x80000002     0x00201D
```

```
R2#sh ip protocols
*** IP Routing is NSF aware ***

Routing Protocol is "application"
  Sending updates every 0 seconds
  Invalid after 0 seconds, hold down 0, flushed after 0
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Maximum path: 32
  Routing for Networks:
  Routing Information Sources:
    Gateway         Distance      Last Update
  Distance: (default is 4)

Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 192.168.23.1
  It is an area border router
  Number of areas in this router is 2. 1 normal 1 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    192.168.12.0 0.0.0.255 area 0
    192.168.23.0 0.0.0.255 area 1
  Routing Information Sources:
    Gateway         Distance      Last Update
    33.33.33.33      110           00:07:47
  Distance: (default is 110)
```

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Totally Stub Area Configuration:

R1 Configuration

```
router ospf 1
network 192.168.12.0 0.0.0.255 area 0
redistribute connected subnets
```

R2 Configuration

```
router ospf 1
network 192.168.12.0 0.0.0.255 area 0
network 192.168.23.0 0.0.0.255 area 1
no area 1 stub
area 1 stub no-summary
```

R3 Configuration

```
router ospf 1
network 192.168.23.0 0.0.0.255 area 1
area 1 stub
```

```
R3#sh ip route ospf
```

```
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, l - LISP
a - application route
+ - replicated route, % - next hop override No more inter area route
```

```
Gateway of last resort is 192.168.23.1 to network 0.0.0.0
```

```
O*IA 0.0.0.0/0 [110/11] via 192.168.23.1, 00:11:57, Ethernet0/0
```

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```
R3#sh ip ospf database No more LSA 3,4, & 5 Convert to Default Route

OSPF Router with ID (192.168.23.2) (Process ID 1)

Router Link States (Area 1)

Link ID          ADV Router      Age             Seq#            Checksum Link count
192.168.23.1    192.168.23.1   151            0x80000007     0x000F0F 1
192.168.23.2    192.168.23.2   844            0x80000005     0x000E10 1

Net Link States (Area 1)

Link ID          ADV Router      Age             Seq#            Checksum
192.168.23.2    192.168.23.2   844            0x80000003     0x00151C

Summary Net Link States (Area 1)

Link ID          ADV Router      Age             Seq#            Checksum
0.0.0.0          192.168.23.1   154            0x80000003     0x00F9C0
```

Stub Area & Totally Stub Area Problem

R1 Configuration

```
router ospf 1
network 192.168.12.0 0.0.0.255 area 0
redistribute connected subnets
```

R2 Configuration

```
router ospf 1
network 192.168.12.0 0.0.0.255 area 0
network 192.168.23.0 0.0.0.255 area 1
no area 1 stub
area 1 stub no-summary
```

R3 Configuration

```
router ospf 1
network 192.168.23.0 0.0.0.255 area 1
area 1 stub
int lo 3
ip add 3.3.3.3 255.255.255.0

router ospf 1
redistribute connected subnets
*Oct 20 06:46:02.269: %OSPF-4-ASBR_WITHOUT_VALID_AREA: Router is currently an AS
BR while having only one area which is a stub area
```

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```
R2#sh ip route ospf
```

```
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, l - LISP  
a - application route  
+ - replicated route, % - next hop override
```

No route for network 3.3.3.0/24

Gateway of last resort is not set

```
1.0.0.0/24 is subnetted, 1 subnets  
O E2 1.1.1.0 [110/20] via 192.168.12.1, 00:27:19, Ethernet0/0  
22.0.0.0/24 is subnetted, 1 subnets  
O E2 22.22.22.0 [110/20] via 192.168.12.1, 00:27:19, Ethernet0/0  
33.0.0.0/24 is subnetted, 1 subnets  
O E2 33.33.33.0 [110/20] via 192.168.12.1, 00:27:19, Ethernet0/0
```

```
R1#sh ip route ospf
```

```
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, l - LISP  
a - application route  
+ - replicated route, % - next hop override
```

No route for network 3.3.3.0/24

Gateway of last resort is not set

```
O IA 192.168.23.0/24 [110/20] via 192.168.12.2, 01:01:37, Ethernet0/0
```

Not So Stubby Area

R1 Configuration

```
router ospf 1  
network 192.168.12.0 0.0.0.255 area 0  
redistribute connected subnets
```

R2 Configuration

```
router ospf 1  
network 192.168.12.0 0.0.0.255 area 0  
network 192.168.23.0 0.0.0.255 area 1  
no area 1 stub  
no area 1 stub no-summary
```

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area 1 nssa default-information-originate

R3 Configuration

```
router ospf 1
network 192.168.23.0 0.0.0.255 area 1
no area 1 stub
area 1 nss
```

```
router ospf 1
redistribute connected subnets
```

```
R1#sh ip route ospf
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, l - LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      3.0.0.0/24 is subnetted, 1 subnets
O E2    3.3.3.0 [110/20] via 192.168.12.2, 00:00:03, Ethernet0/0
O IA 192.168.23.0/24 [110/20] via 192.168.12.2, 00:00:04, Ethernet0/0
```

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```
R2#sh ip protocols
*** IP Routing is NSF aware ***

Routing Protocol is "application"
  Sending updates every 0 seconds
  Invalid after 0 seconds, hold down 0, flushed after 0
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Maximum path: 32
  Routing for Networks:
  Routing Information Sources:
    Gateway         Distance      Last Update
  Distance: (default is 4)

Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 192.168.23.1
  It is an area border and autonomous system boundary router
  Redistributing External Routes from,
  Number of areas in this router is 2. 1 normal 0 stub 1 nssa
  Maximum path: 4
  Routing for Networks:
    192.168.12.0 0.0.0.255 area 0
    192.168.23.0 0.0.0.255 area 1
```

Totally Stubby NSSA
R1 Configuration
router ospf 1 network 192.168.12.0 0.0.0.255 area 0 redistribute connected subnets
R2 Configuration
router ospf 1 network 192.168.12.0 0.0.0.255 area 0 network 192.168.23.0 0.0.0.255 area 1 no area 1 nssa default-information-originate area 1 nssa no-summary
R3 Configuration
router ospf 1 network 192.168.23.0 0.0.0.255 area 1 area 1 nss

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```
router ospf 1
redistribute connected subnets
```

```
R3#sh ip route ospf
```

```
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, l - LISP
a - application route
+ - replicated route, % - next hop override  No more inter-Area only default
```

```
Gateway of last resort is 192.168.23.1 to network 0.0.0.0
```

```
O*IA 0.0.0.0/0 [110/11] via 192.168.23.1, 00:00:27, Ethernet0/0
```

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```
R2#sh ip protocols
*** IP Routing is NSF aware ***

Routing Protocol is "application"
  Sending updates every 0 seconds
  Invalid after 0 seconds, hold down 0, flushed after 0
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Maximum path: 32
  Routing for Networks:
  Routing Information Sources:
    Gateway          Distance          Last Update
  Distance: (default is 4)

Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 192.168.23.1
  It is an area border and autonomous system boundary router
  Redistributing External Routes from,
  Number of areas in this router is 2. 1 normal 0 stub 1 nssa
  Maximum path: 4
  Routing for Networks:
    192.168.12.0 0.0.0.255 area 0
    192.168.23.0 0.0.0.255 area 1
  Routing Information Sources:
    Gateway          Distance          Last Update
    33.33.33.33          110              00:00:53
    192.168.23.2          110              00:00:53
  Distance: (default is 110)
```

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