

OSPF Stub Areas

- Summarization saves resources by taking multiple longer match prefixes and combining them into a smaller amount of shorter matches
 - e.g two routes 100.0.0.0/16 and 100.1.0.0/16 become one route 100.0.0.0/15
- Using the same logic, OSPF stub areas reduce NLRI by taking prefixes of the same LSA type and combining them into the *shortest* match possible, a default route

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How OSPF Stub Areas Work

- Stub areas use the common transit point of the OSPF topology, the ABR, to stop LSAs from entering the area
 - Type-3, Type-4, and/or Type-5 filtered depending on stub type
- The reachability information removed is then replaced with a default route
 - Still allows reachability to removed routes (in most cases)

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OSPF Stub Area Types

- Four stub area types control which routes (LSAs) can enter the area
- Stub Area
 - Stops external routes
- Totally Stubby Area
 - Stops inter-area and external routes
- Not-So-Stubby Area (NSSA)
 - Stops external routes but allows local redistribution
- Not-So-Totally-Stubby Area
 - Stops inter-area and external routes but allows local redistribution
- All routers in the area must agree on the stub flag

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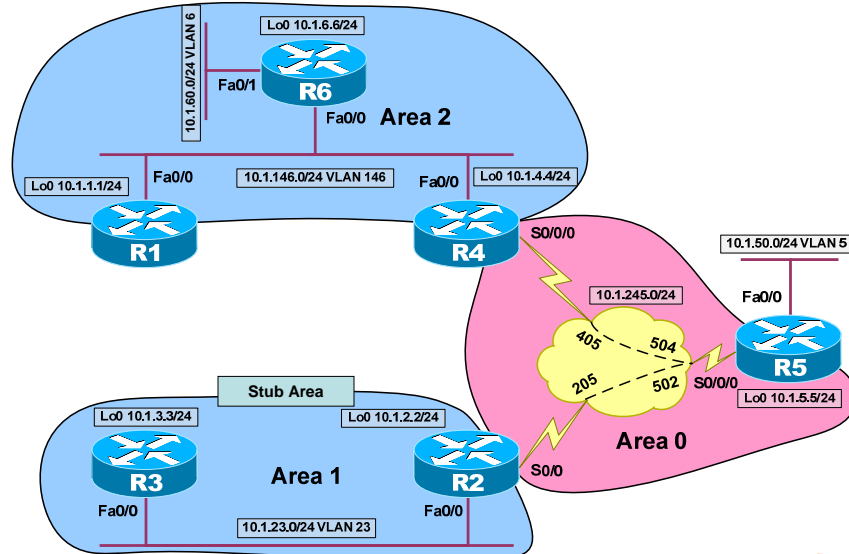
OSPF Stub Areas

- Stub Area logic
 - I know how to get to my ABR
 - My ABR knows how to get to the ASBRs
 - The ASBRs knows how to get to the external routes
 - If I default to the ABR, I don't need the specific external routes
- **area [area-id] stub** on all routers in the area
- Result
 - ABR removes LSAs 4 (ASBR) & 5 (External)
 - ABR originates default route

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OSPF Stub Area Example



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Stub Area Configuration & Verification

```
R2#
router ospf 1
 area 1 stub

R3#
router ospf 1
 area 1 stub

R2#show ip route ospf
 10.0.0.0/8 is variably subnetted, 17 subnets, 4 masks
O IA 10.1.6.6/32 [110/66] via 10.1.245.4, 00:00:04, Serial0/0
O 10.1.5.5/32 [110/65] via 10.1.245.5, 00:00:19, Serial0/0
O IA 10.1.4.4/32 [110/65] via 10.1.245.4, 00:00:04, Serial0/0
O 10.1.3.3/32 [110/2] via 10.1.23.3, 00:00:04, FastEthernet0/0
O IA 10.1.1.1/32 [110/66] via 10.1.245.4, 00:00:04, Serial0/0
O 10.1.35.0/24 [110/2] via 10.1.23.3, 00:00:04, FastEthernet0/0
O 10.1.34.0/24 [110/2] via 10.1.23.3, 00:00:04, FastEthernet0/0
O 10.1.33.0/24 [110/2] via 10.1.23.3, 00:00:04, FastEthernet0/0
O 10.1.32.0/24 [110/2] via 10.1.23.3, 00:00:04, FastEthernet0/0
O 10.1.32.0/22 is a summary, 00:00:04, Null0
O IA 10.1.60.0/24 [110/66] via 10.1.245.4, 00:00:04, Serial0/0
O E2 10.1.50.0/24 [110/20] via 10.1.245.5, 00:00:04, Serial0/0
O E2 10.1.104.0/21 [110/20] via 10.1.245.4, 00:00:04, Serial0/0
O IA 10.1.146.0/24 [110/65] via 10.1.245.4, 00:00:04, Serial0/0

R3#show ip route ospf
 10.0.0.0/8 is variably subnetted, 14 subnets, 2 masks
O IA 10.1.6.6/32 [110/67] via 10.1.23.2, 00:00:04, FastEthernet0/0
O IA 10.1.5.5/32 [110/66] via 10.1.23.2, 00:00:04, FastEthernet0/0
O IA 10.1.4.4/32 [110/66] via 10.1.23.2, 00:00:04, FastEthernet0/0
O 10.1.2.2/32 [110/2] via 10.1.23.2, 00:00:04, FastEthernet0/0
O IA 10.1.1.1/32 [110/67] via 10.1.23.2, 00:00:04, FastEthernet0/0
O IA 10.1.60.0/24 [110/67] via 10.1.23.2, 00:00:04, FastEthernet0/0
O IA 10.1.146.0/24 [110/66] via 10.1.23.2, 00:00:04, FastEthernet0/0
O IA 10.1.245.0/24 [110/65] via 10.1.23.2, 00:00:04, FastEthernet0/0
O*IA 0.0.0.0/0 [110/2] via 10.1.23.2, 00:00:04, FastEthernet0/0
```

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Stub Area Verification (cont.)

R2#show ip ospf database

OSPF Router with ID (10.1.2.2) (Process ID 1)

Router Link States (Area 0)					Router Link States (Area 1)				
Link ID	ADV Router	Age	Seq#	Checksum Link count	Link ID	ADV Router	Age	Seq#	Checksum Link count
10.1.2.2	10.1.2.2	307	0x80000003	0x06267 1	10.1.1.1	10.1.1.1	2326	0x80000002	0x00CF77 2
10.1.4.4	10.1.4.4	311	0x80000003	0x03A85 1	10.1.2.2	10.1.2.2	94	0x80000005	0x08523 2
10.1.5.5	10.1.5.5	322	0x80000003	0x06132 2	10.1.3.3	10.1.3.3	91	0x8000000A	0x0E0C5 6
Net Link States (Area 0)					Net Link States (Area 1)				
Link ID	ADV Router	Age	Seq#	Checksum	Link ID	ADV Router	Age	Seq#	Checksum
10.1.245.5	10.1.5.5	322	0x80000002	0x041A1	10.1.23.3	10.1.3.3	91	0x80000004	0x08B27
Summary Net Link States (Area 0)					Summary Net Link States (Area 1)				
Link ID	ADV Router	Age	Seq#	Checksum	Link ID	ADV Router	Age	Seq#	Checksum
10.1.1.1	10.1.4.4	311	0x80000002	0x061B8	0.0.0.0	10.1.2.2	102	0x80000001	0x035F9
10.1.2.2	10.1.2.2	307	0x80000002	0x05CC0	10.1.1.1	10.1.2.2	102	0x80000003	0x01AC4
10.1.3.3	10.1.2.2	85	0x80000001	0x053C7	10.1.4.4	10.1.2.2	102	0x80000003	0x0D009
10.1.4.4	10.1.4.4	311	0x80000002	0x018FC	10.1.5.5	10.1.2.2	102	0x80000003	0x08B1C
10.1.6.6	10.1.4.4	311	0x80000002	0x00F718	10.1.6.6	10.1.2.2	102	0x80000003	0x0B024
10.1.23.0	10.1.2.2	90	0x80000004	0x08483	10.1.60.0	10.1.2.2	103	0x80000003	0x0980C
10.1.32.0	10.1.2.2	86	0x80000001	0x022E1	10.1.146.0	10.1.2.2	103	0x80000003	0x0D876
10.1.60.0	10.1.4.4	312	0x80000002	0x0DFFF	10.1.245.0	10.1.2.2	103	0x80000003	0x08963
10.1.146.0	10.1.4.4	312	0x80000002	0x0206A	Type-5 AS External Link States				
Summary ASB Link States (Area 0)					Link ID	ADV Router	Age	Seq#	Checksum Tag
10.1.1.1	10.1.4.4	1139	0x80000001	0x04BCF	10.1.50.0	10.1.5.5	325	0x80000002	0x08BCL 0
					10.1.104.0	10.1.1.1	105	0x80000003	0x0046DE 0

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Stub Area Verification (cont.)

R3#show ip ospf database

OSPF Router with ID (10.1.3.3) (Process ID 1)

Router Link States (Area 1)				
Link ID	ADV Router	Age	Seq#	Checksum Link count
10.1.1.1	10.1.1.1	2333	0x80000002	0x00CF77 2
10.1.2.2	10.1.2.2	103	0x80000005	0x08523 2
10.1.3.3	10.1.3.3	97	0x8000000A	0x0E0C5 6
Net Link States (Area 1)				
Link ID	ADV Router	Age	Seq#	Checksum
10.1.23.3	10.1.3.3	97	0x80000004	0x08B27
Summary Net Link States (Area 1)				
Link ID	ADV Router	Age	Seq#	Checksum
0.0.0.0	10.1.2.2	110	0x80000001	0x035F9
10.1.1.1	10.1.2.2	110	0x80000003	0x01AC4
10.1.4.4	10.1.2.2	110	0x80000003	0x0D009
10.1.5.5	10.1.2.2	110	0x80000003	0x08B1C
10.1.6.6	10.1.2.2	110	0x80000003	0x0B024
10.1.60.0	10.1.2.2	110	0x80000003	0x0980C
10.1.146.0	10.1.2.2	110	0x80000003	0x0D876
10.1.245.0	10.1.2.2	110	0x80000003	0x08963

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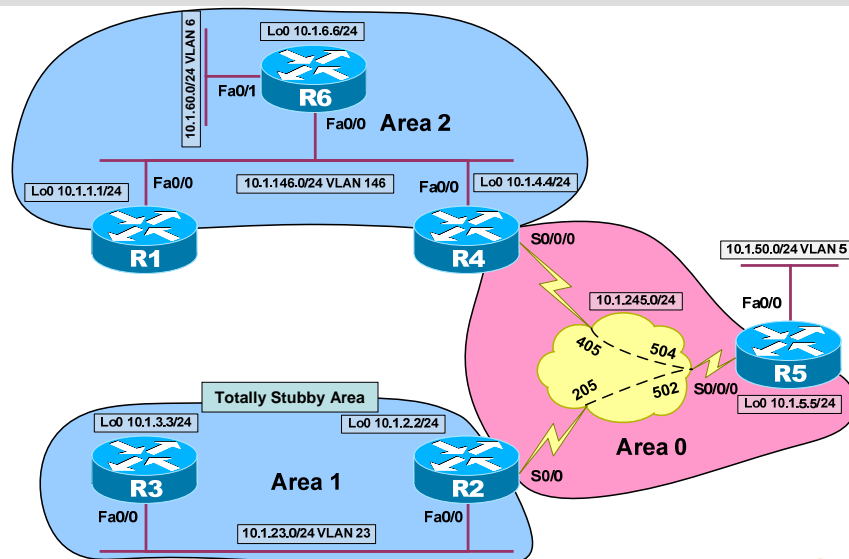
OSPF Totally Stubby Areas

- Totally Stub Area logic
 - I know how to get to my ABR
 - My ABR knows how to get to other areas and to the ASBRs
 - The ASBRs knows how to get to the external routes
 - If I default to the ABR, I don't need the specific inter-area or external routes
- `area [area-id] stub` on the internal routers in the area
- `area [area-id] stub no-summary` on the ABR(s) of the area
- Result
 - ABR removes LSAs 3 (Inter-Area), 4 (ASBR), & 5 (External)
 - ABR originates default route

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OSPF Totally Stubby Area Example



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Totally Stubby Area Config & Verification

```
R2#
router ospf 1
 area 1 stub no-summary

R3#
router ospf 1
 area 1 stub

R2#show ip route ospf
 10.0.0.0/8 is variably subnetted, 17 subnets, 4 masks
O IA 10.1.6.6/32 [110/66] via 10.1.245.4, 00:00:16, Serial0/0
O 10.1.5.5/32 [110/65] via 10.1.245.5, 00:00:16, Serial0/0
O IA 10.1.4.4/32 [110/65] via 10.1.245.4, 00:00:16, Serial0/0
O 10.1.3.3/32 [110/2] via 10.1.23.3, 00:00:16, FastEthernet0/0
O IA 10.1.1.1/32 [110/66] via 10.1.245.4, 00:00:16, Serial0/0
O 10.1.35.0/24 [110/2] via 10.1.23.3, 00:00:16, FastEthernet0/0
O 10.1.34.0/24 [110/2] via 10.1.23.3, 00:00:16, FastEthernet0/0
O 10.1.33.0/24 [110/2] via 10.1.23.3, 00:00:16, FastEthernet0/0
O 10.1.32.0/24 [110/2] via 10.1.23.3, 00:00:16, FastEthernet0/0
O 10.1.32.0/22 is a summary, 00:00:16, Null0
O IA 10.1.60.0/24 [110/66] via 10.1.245.4, 00:00:16, Serial0/0
O E2 10.1.50.0/24 [110/20] via 10.1.245.5, 00:00:16, Serial0/0
O E2 10.1.104.0/21 [110/20] via 10.1.245.4, 00:00:06, Serial0/0
O IA 10.1.146.0/24 [110/65] via 10.1.245.4, 00:00:16, Serial0/0

R3#show ip route ospf
 10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
O 10.1.2.2/32 [110/2] via 10.1.23.2, 00:06:05, FastEthernet0/0
O*IA 0.0.0.0/0 [110/2] via 10.1.23.2, 00:00:19, FastEthernet0/0
```

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Totally Stubby Area Verification (cont.)

```
R2#show ip ospf database

OSPF Router with ID (10.1.2.2) (Process ID 1)

Router Link States (Area 0)
Link ID      ADV Router  Age      Seq#       Checksum Link
count
10.1.2.2     10.1.2.2    650      0x80000003 0x06267 1
10.1.4.4     10.1.4.4    654      0x80000003 0x03A85 1
10.1.5.5     10.1.5.5    665      0x80000003 0x06132 2

Net Link States (Area 0)
Link ID      ADV Router  Age      Seq#       Checksum
10.1.245.5   10.1.5.5    665      0x80000002 0x041A1

Summary Net Link States (Area 0)
Link ID      ADV Router  Age      Seq#       Checksum
10.1.1.1     10.1.4.4    654      0x80000002 0x061B8
10.1.2.2     10.1.2.2    650      0x80000002 0x05CC0
10.1.3.3     10.1.2.2    428      0x80000001 0x053C7
10.1.4.4     10.1.4.4    654      0x80000002 0x0189C
10.1.6.6     10.1.4.4    654      0x80000002 0x0F718
10.1.23.0    10.1.2.2    433      0x80000004 0x08483
10.1.32.0    10.1.2.2    429      0x80000001 0x022E1
10.1.60.0    10.1.4.4    655      0x80000002 0x0DFFF
10.1.146.0   10.1.4.4    655      0x80000002 0x0206A

Summary ASB Link States (Area 0)
Link ID      ADV Router  Age      Seq#       Checksum
10.1.1.1     10.1.4.4    1483     0x80000001 0x04BCF

Router Link States (Area 1)
Link ID      count
10.1.1.1     2668
10.1.2.2     437
10.1.3.3     434

Net Link States (Area 1)
Link ID      ADV Router  Age      Seq#       Checksum
10.1.3.3     10.1.3.3    434      0x80000004 0x005E27

Summary Net Link States (Area 1)
Link ID      ADV Router  Age      Seq#       Checksum
10.1.2.2     82          0x80000002 0x0033FA

Type-5 AS External Link States
Link ID      ADV Router  Age      Seq#       Checksum Tag
10.1.50.0    10.1.5.5    667      0x80000002 0x089C1 0
10.1.104.0   10.1.1.1    84       0x80000004 0x004DF 0
```

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Totally Stubby Area Verification (cont.)

```
R3#show ip ospf database
```

```
OSPF Router with ID (10.1.3.3) (Process ID 1)
```

```
Router Link States (Area 1)
```

Link ID count	ADV Router	Age	Seq#	Checksum	Link
10.1.1.1	10.1.1.1	2674	0x80000002	0x00CF77	2
10.1.2.2	10.1.2.2	444	0x80000005	0x008523	2
10.1.3.3	10.1.3.3	439	0x8000000A	0x00E0C5	6

```
Net Link States (Area 1)
```

Link ID	ADV Router	Age	Seq#	Checksum
10.1.23.3	10.1.3.3	439	0x80000004	0x00BB27

```
Summary Net Link States (Area 1)
```

Link ID	ADV Router	Age	Seq#	Checksum
0.0.0.0	10.1.2.2	89	0x80000002	0x0033FA

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OSPF Not-So-Stubby Areas (NSSA)

- NSSA logic
 - Stub areas block external routes from coming from other areas
 - What if I want to redistribute directly into the stub area itself?
 - Filter like a stub area, but make an exception for local redistribution
- This exception requires the new Type 7 LSA (NSSA External)
- **area [area-id] nssa** on all routers in the area
- Result
 - Redistributing router in NSSA generates Type 7 external instead of Type 5
 - ABR changes Type 7 into Type 5 as it is sent into area 0
 - ABR removes LSAs 4 (ASBR) & 5 (External) from coming into the area
 - ABR **does not** originate default route

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Type 7 LSA In Detail

- Type 7 – NSSA External LSA
- Generated by ASBR inside NSSA
 - Flooded only within NSSA
 - Changed into Type 5 LSA as it leaves the area
- Describes routes ASBR is redistributing
 - Metric
 - Metric Type
 - Type 1 = N1
 - Type 2 = N2 (default)
 - Forward Address
 - Who should I route towards to reach the link?
 - Usually the ASBR itself, but could be someone else in some designs
 - Route Tag
- **show ip ospf database nssa-external [Link ID]**

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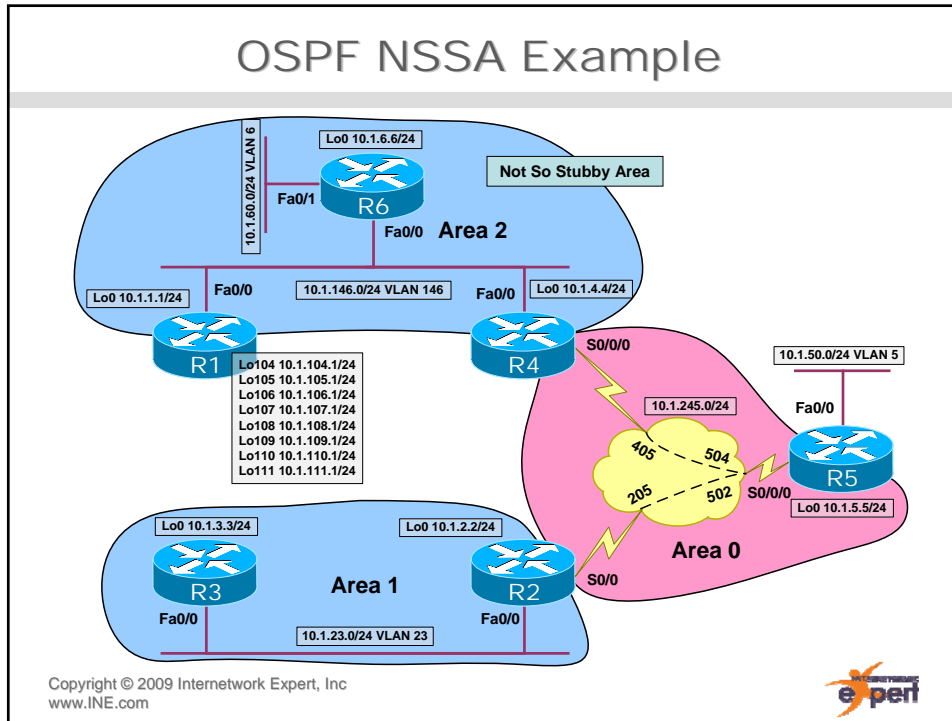


Type 7 LSA Translation

- N1/N2 routes exist only inside the NSSA
- Changed on ABR to E1/E2 routes as they enter area 0
 - ABR called “NSSA Translator”
- If multiple ABRs, hold an election
 - ABR with highest router-id becomes NSSA Translator
 - Traffic doesn’t necessarily transit the translator
- See RFC 3101 “The OSPF Not-So-Stubby Area (NSSA) Option” for details

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OSPF NSSA Config & Verification

```

R1#
router ospf 1
 area 2 nssa
 redistribute connected subnets

R4#
router ospf 1
 area 2 nssa

R6#
router ospf 1
 area 2 nssa

R1#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       I - IS-IS, su - IS-IS summary, LI - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 19 subnets, 3 masks
C       10.1.1.0/24 is directly connected, Loopback0
O       10.1.6.6/32 [110/2] via 10.1.146.6, 00:01:37, FastEthernet0/0
O IA   10.1.5.5/32 [110/66] via 10.1.146.4, 00:01:37, FastEthernet0/0
O       10.1.4.4/32 [110/2] via 10.1.146.4, 00:01:37, FastEthernet0/0
O IA   10.1.3.3/32 [110/67] via 10.1.146.4, 00:01:37, FastEthernet0/0
O IA   10.1.2.2/32 [110/66] via 10.1.146.4, 00:01:37, FastEthernet0/0
O IA   10.1.23.0/24 [110/66] via 10.1.146.4, 00:01:38, FastEthernet0/0
O IA   10.1.32.0/22 [110/67] via 10.1.146.4, 00:01:38, FastEthernet0/0
O       10.1.60.0/24 [110/2] via 10.1.146.6, 00:01:38, FastEthernet0/0
C       10.1.107.0/24 is directly connected, Loopback107
C       10.1.106.0/24 is directly connected, Loopback106
C       10.1.105.0/24 is directly connected, Loopback105
C       10.1.104.0/24 is directly connected, Loopback104
C       10.1.111.0/24 is directly connected, Loopback111
C       10.1.110.0/24 is directly connected, Loopback110
C       10.1.109.0/24 is directly connected, Loopback109
C       10.1.108.0/24 is directly connected, Loopback108
C       10.1.146.0/24 is directly connected, FastEthernet0/0
O IA   10.1.245.0/24 [110/65] via 10.1.146.4, 00:01:38, FastEthernet0/0

```

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OSPF NSSA Verification (cont.)

```
R4#show ip route ospf
 10.0.0.0/8 is variably subnetted, 20 subnets, 3 masks
O   10.1.6.6/32 [110/2] via 10.1.146.6, 00:00:34, FastEthernet0/0
O   10.1.5.5/32 [110/65] via 10.1.245.5, 00:00:59, Serial0/0
O IA 10.1.3.3/32 [110/66] via 10.1.245.2, 00:00:34, Serial0/0
O IA 10.1.2.2/32 [110/65] via 10.1.245.2, 00:00:34, Serial0/0
O   10.1.1.1/32 [110/2] via 10.1.146.1, 00:00:34, FastEthernet0/0
O IA 10.1.23.0/24 [110/65] via 10.1.245.2, 00:00:34, Serial0/0
O IA 10.1.32.0/22 [110/66] via 10.1.245.2, 00:00:34, Serial0/0
O   10.1.60.0/24 [110/2] via 10.1.146.6, 00:00:34, FastEthernet0/0
O E2 10.1.50.0/24 [110/20] via 10.1.245.5, 00:00:34, Serial0/0
O N2 10.1.107.0/24 [110/20] via 10.1.146.1, 00:00:34, FastEthernet0/0
O N2 10.1.106.0/24 [110/20] via 10.1.146.1, 00:00:34, FastEthernet0/0
O N2 10.1.105.0/24 [110/20] via 10.1.146.1, 00:00:34, FastEthernet0/0
O N2 10.1.104.0/24 [110/20] via 10.1.146.1, 00:00:34, FastEthernet0/0
O N2 10.1.111.0/24 [110/20] via 10.1.146.1, 00:00:34, FastEthernet0/0
O N2 10.1.110.0/24 [110/20] via 10.1.146.1, 00:00:35, FastEthernet0/0
O N2 10.1.109.0/24 [110/20] via 10.1.146.1, 00:00:35, FastEthernet0/0
O N2 10.1.108.0/24 [110/20] via 10.1.146.1, 00:00:35, FastEthernet0/0

R6#show ip route ospf
 10.0.0.0/8 is variably subnetted, 19 subnets, 3 masks
O IA 10.1.5.5/32 [110/66] via 10.1.146.4, 00:00:50, FastEthernet0/0
O   10.1.4.4/32 [110/2] via 10.1.146.4, 00:00:50, FastEthernet0/0
O IA 10.1.3.3/32 [110/67] via 10.1.146.4, 00:00:50, FastEthernet0/0
O IA 10.1.2.2/32 [110/66] via 10.1.146.4, 00:00:50, FastEthernet0/0
O   10.1.1.1/32 [110/2] via 10.1.146.1, 00:00:50, FastEthernet0/0
O IA 10.1.23.0/24 [110/66] via 10.1.146.4, 00:00:50, FastEthernet0/0
O IA 10.1.32.0/22 [110/67] via 10.1.146.4, 00:00:50, FastEthernet0/0
O N2 10.1.107.0/24 [110/20] via 10.1.146.1, 00:00:50, FastEthernet0/0
O N2 10.1.106.0/24 [110/20] via 10.1.146.1, 00:00:50, FastEthernet0/0
O N2 10.1.105.0/24 [110/20] via 10.1.146.1, 00:00:50, FastEthernet0/0
O N2 10.1.104.0/24 [110/20] via 10.1.146.1, 00:00:50, FastEthernet0/0
O N2 10.1.111.0/24 [110/20] via 10.1.146.1, 00:00:50, FastEthernet0/0
O N2 10.1.110.0/24 [110/20] via 10.1.146.1, 00:00:50, FastEthernet0/0
O N2 10.1.109.0/24 [110/20] via 10.1.146.1, 00:00:51, FastEthernet0/0
O N2 10.1.108.0/24 [110/20] via 10.1.146.1, 00:00:51, FastEthernet0/0
O IA 10.1.245.0/24 [110/65] via 10.1.146.4, 00:00:51, FastEthernet0/0
```

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OSPF NSSA Verification (cont.)

```
R5#show ip route ospf
 10.0.0.0/8 is variably subnetted, 20 subnets, 3 masks
O IA 10.1.6.6/32 [110/66] via 10.1.245.4, 00:00:50, Serial0/0
O IA 10.1.4.4/32 [110/65] via 10.1.245.4, 00:01:00, Serial0/0
O IA 10.1.3.3/32 [110/66] via 10.1.245.2, 00:01:00, Serial0/0
O IA 10.1.2.2/32 [110/65] via 10.1.245.2, 00:01:00, Serial0/0
O IA 10.1.1.1/32 [110/66] via 10.1.245.4, 00:00:46, Serial0/0
O IA 10.1.23.0/24 [110/65] via 10.1.245.2, 00:01:00, Serial0/0
O IA 10.1.32.0/22 [110/66] via 10.1.245.2, 00:01:00, Serial0/0
O IA 10.1.60.0/24 [110/66] via 10.1.245.4, 00:00:50, Serial0/0
O E2 10.1.107.0/24 [110/20] via 10.1.245.4, 00:00:40, Serial0/0
O E2 10.1.106.0/24 [110/20] via 10.1.245.4, 00:00:40, Serial0/0
O E2 10.1.105.0/24 [110/20] via 10.1.245.4, 00:00:40, Serial0/0
O E2 10.1.104.0/24 [110/20] via 10.1.245.4, 00:00:40, Serial0/0
O E2 10.1.111.0/24 [110/20] via 10.1.245.4, 00:00:40, Serial0/0
O E2 10.1.110.0/24 [110/20] via 10.1.245.4, 00:00:40, Serial0/0
O E2 10.1.109.0/24 [110/20] via 10.1.245.4, 00:00:41, Serial0/0
O E2 10.1.108.0/24 [110/20] via 10.1.245.4, 00:00:41, Serial0/0
O IA 10.1.146.0/24 [110/65] via 10.1.245.4, 00:01:01, Serial0/0
```

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OSPF NSSA Verification (cont.)

```
R1#show ip ospf database

OSPF Router with ID (10.1.1.1) (Process ID 1)

Router Link States (Area 2)

Link ID      ADV Router  Age      Seq#       Checksum Link count
10.1.1.1    10.1.1.1    4        0x80000001 0x00BFF4 2
10.1.4.4    10.1.4.4    158      0x80000007 0x00F79C 2
10.1.6.6    10.1.6.6    340      0x80000005 0x00B77B 3

Net Link States (Area 2)

Link ID      ADV Router  Age      Seq#       Checksum
10.1.146.6   10.1.6.6    335      0x80000005 0x000733

Summary Net Link States (Area 2)

Link ID      ADV Router  Age      Seq#       Checksum
10.1.2.2    10.1.4.4    355      0x80000003 0x006869
10.1.3.3    10.1.4.4    355      0x80000002 0x005F70
10.1.5.5    10.1.4.4    355      0x80000003 0x0029A2
10.1.23.0   10.1.4.4    355      0x80000002 0x009629
10.1.32.0   10.1.4.4    355      0x80000002 0x002E8A
10.1.245.0  10.1.4.4    355      0x80000003 0x00F6E9

Type-7 AS External Link States (Area 2)

Link ID      ADV Router  Age      Seq#       Checksum Tag
10.1.104.0   10.1.1.1    0        0x80000005 0x00669E 0
10.1.105.0   10.1.1.1    0        0x80000003 0x005FA6 0
10.1.106.0   10.1.1.1    0        0x80000003 0x0054B0 0
10.1.107.0   10.1.1.1    0        0x80000003 0x0049BA 0
10.1.108.0   10.1.1.1    0        0x80000003 0x003EC4 0
10.1.109.0   10.1.1.1    0        0x80000003 0x0033CE 0
10.1.110.0   10.1.1.1    0        0x80000003 0x0028D8 0
10.1.111.0   10.1.1.1    0        0x80000003 0x001DE2 0
```

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OSPF NSSA Verification (cont.)

```
R6#show ip ospf database

OSPF Router with ID (10.1.6.6) (Process ID 1)

Router Link States (Area 2)

Link ID      ADV Router  Age      Seq#       Checksum Link count
10.1.1.1    10.1.1.1    20       0x8000000B 0x00A7FE 2
10.1.4.4    10.1.4.4    181      0x80000007 0x00F79C 2
10.1.6.6    10.1.6.6    363      0x80000005 0x00B77B 3

Net Link States (Area 2)

Link ID      ADV Router  Age      Seq#       Checksum
10.1.146.6   10.1.6.6    358      0x80000005 0x000733

Summary Net Link States (Area 2)

Link ID      ADV Router  Age      Seq#       Checksum
10.1.2.2    10.1.4.4    378      0x80000003 0x006869
10.1.3.3    10.1.4.4    378      0x80000002 0x005F70
10.1.5.5    10.1.4.4    378      0x80000003 0x0029A2
10.1.23.0   10.1.4.4    378      0x80000002 0x009629
10.1.32.0   10.1.4.4    378      0x80000002 0x002E8A
10.1.245.0  10.1.4.4    378      0x80000003 0x00F6E9

Type-7 AS External Link States (Area 2)

Link ID      ADV Router  Age      Seq#       Checksum Tag
10.1.104.0   10.1.1.1    25       0x80000005 0x00669E 0
10.1.105.0   10.1.1.1    25       0x80000003 0x005FA6 0
10.1.106.0   10.1.1.1    25       0x80000003 0x0054B0 0
10.1.107.0   10.1.1.1    25       0x80000003 0x0049BA 0
10.1.108.0   10.1.1.1    25       0x80000003 0x003EC4 0
10.1.109.0   10.1.1.1    25       0x80000003 0x0033CE 0
10.1.110.0   10.1.1.1    25       0x80000003 0x0028D8 0
10.1.111.0   10.1.1.1    25       0x80000003 0x001DE2 0
```

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OSPF NSSA Verification (cont.)

```
R4#show ip ospf database

OSPF Router with ID (10.1.4.4) (Process ID 1)

Router Link States (Area 0)

Link ID      ADV Router   Age         Seq#         Checksum Link
count
10.1.2.2     10.1.2.2     1514       0x80000003  0x06267 1
10.1.4.4     10.1.4.4     401        0x80000004  0x03E7E 1
10.1.5.5     10.1.5.5     1527       0x80000003  0x06132 2

Net Link States (Area 0)

Link ID      ADV Router   Age         Seq#         Checksum
10.1.245.5   10.1.5.5     1527       0x80000002  0x041A1

Summary Net Link States (Area 0)

Link ID      ADV Router   Age         Seq#         Checksum
10.1.1.1     10.1.4.4     27         0x80000008  0x055BE
10.1.2.2     10.1.2.2     1514       0x80000002  0x05CC0
10.1.3.3     10.1.2.2     1293       0x80000001  0x053C7
10.1.4.4     10.1.4.4     1515       0x80000002  0x018FC
10.1.6.6     10.1.4.4     385        0x80000001  0x0F917
10.1.23.0    10.1.2.2     1298       0x80000004  0x084E3
10.1.32.0    10.1.2.2     1294       0x80000001  0x022E1
10.1.60.0    10.1.4.4     387        0x80000001  0x0E1FE
10.1.146.0   10.1.4.4     1517       0x80000002  0x0206A

Router Link States (Area 2)

Link ID      ADV Router   Age         Seq#         Checksum Link
count
10.1.1.1     10.1.1.1     44         0x8000000B  0x0A7FE 2
10.1.4.4     10.1.4.4     204        0x80000007  0x0F79C 2
10.1.6.6     10.1.6.6     389        0x80000005  0x0B77B 3

Net Link States (Area 2)

Link ID      ADV Router   Age         Seq#         Checksum
10.1.146.6   10.1.6.6     384        0x80000005  0x00733

Summary Net Link States (Area 2)

Link ID      ADV Router   Age         Seq#         Checksum
10.1.1.2.2   10.1.4.4     402        0x80000003  0x06869
10.1.1.3.3   10.1.4.4     402        0x80000002  0x05F70
10.1.1.5.5   10.1.4.4     402        0x80000003  0x029A2
10.1.23.0    10.1.4.4     402        0x80000002  0x09629
10.1.32.0    10.1.4.4     403        0x80000002  0x0288A
10.1.245.0   10.1.4.4     403        0x80000003  0x09FEE

Type-7 AS External Link States (Area 2)

Link ID      ADV Router   Age         Seq#         Checksum Tag
10.1.104.0   10.1.1.1     49         0x80000005  0x0669E 0
10.1.105.0   10.1.1.1     49         0x80000003  0x05FA6 0
10.1.106.0   10.1.1.1     49         0x80000003  0x054B0 0
10.1.107.0   10.1.1.1     49         0x80000003  0x049BA 0
10.1.108.0   10.1.1.1     49         0x80000003  0x038C4 0
10.1.109.0   10.1.1.1     49         0x80000003  0x033CE 0
10.1.110.0   10.1.1.1     49         0x80000003  0x028D8 0
10.1.111.0   10.1.1.1     49         0x80000003  0x01DE2 0

Type-5 AS External Link States

Link ID      ADV Router   Age         Seq#         Checksum Tag
10.1.50.0    10.1.5.5     1529       0x80000002  0x08BC1 0
10.1.104.0   10.1.4.4     39         0x80000001  0x0DB31 0
10.1.105.0   10.1.4.4     39         0x80000001  0x0D338 0
10.1.106.0   10.1.4.4     39         0x80000001  0x0C545 0
10.1.107.0   10.1.4.4     39         0x80000001  0x0BA4F 0
10.1.108.0   10.1.4.4     39         0x80000001  0x0AF59 0
10.1.109.0   10.1.4.4     39         0x80000001  0x0A463 0
10.1.110.0   10.1.4.4     39         0x80000001  0x0996D 0
10.1.111.0   10.1.4.4     39         0x80000001  0x08E77 0
```

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OSPF NSSA Verification (cont.)

```
R5#show ip ospf database

OSPF Router with ID (10.1.5.5) (Process ID 1)

Router Link States (Area 0)

Link ID      ADV Router   Age         Seq#         Checksum Link
count
10.1.2.2     10.1.2.2     1550       0x80000003  0x06267 1
10.1.4.4     10.1.4.4     438        0x80000004  0x03E7E 1
10.1.5.5     10.1.5.5     1563       0x80000003  0x06132 2

Net Link States (Area 0)

Link ID      ADV Router   Age         Seq#         Checksum
10.1.245.5   10.1.5.5     1563       0x80000002  0x041A1

Summary Net Link States (Area 0)

Link ID      ADV Router   Age         Seq#         Checksum
10.1.1.1     10.1.4.4     69         0x80000008  0x055BE
10.1.2.2     10.1.2.2     1550       0x80000002  0x05CC0
10.1.3.3     10.1.2.2     1328       0x80000001  0x053C7
10.1.4.4     10.1.4.4     1553       0x80000002  0x018FC
10.1.6.6     10.1.4.4     423        0x80000001  0x0F917
10.1.23.0    10.1.2.2     1333       0x80000004  0x084E3
10.1.32.0    10.1.2.2     1329       0x80000001  0x022E1
10.1.60.0    10.1.4.4     424        0x80000001  0x0E1FE
10.1.146.0   10.1.4.4     1554       0x80000002  0x0206A

Type-5 AS External Link States

Link ID      ADV Router   Age         Seq#         Checksum Tag
10.1.50.0    10.1.5.5     1564       0x80000002  0x08BC1 0
10.1.104.0   10.1.4.4     75         0x80000001  0x0DB31 0
10.1.105.0   10.1.4.4     75         0x80000001  0x0D338 0
10.1.106.0   10.1.4.4     75         0x80000001  0x0C545 0
10.1.107.0   10.1.4.4     75         0x80000001  0x0BA4F 0
10.1.108.0   10.1.4.4     75         0x80000001  0x0AF59 0
10.1.109.0   10.1.4.4     75         0x80000001  0x0A463 0
10.1.110.0   10.1.4.4     75         0x80000001  0x0996D 0
10.1.111.0   10.1.4.4     75         0x80000001  0x08E77 0
```

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OSPF NSSA Verification (cont.)

```
R4#show ip ospf database nssa-external 10.1.104.0
      OSPF Router with ID (10.1.4.4) (Process ID 1)
        Type-7 AS External Link States (Area 2)

Routing Bit Set on this LSA
LS age: 118
Options: (No TOS-capability, Type 7/5 translation, DC)
LS Type: AS External Link
Link State ID: 10.1.104.0 (External Network Number )
Advertising Router: 10.1.1.1
LS Seq Number: 80000005
Checksum: 0x669E
Length: 36
Network Mask: /24
  Metric Type: 2 (Larger than any link state path)
  TOS: 0
  Metric: 20
  Forward Address: 10.1.1.1
  External Route Tag: 0

R4#show ip ospf database external 10.1.104.0
      OSPF Router with ID (10.1.4.4) (Process ID 1)
        Type-5 AS External Link States

LS age: 116
Options: (No TOS-capability, DC)
LS Type: AS External Link
Link State ID: 10.1.104.0 (External Network Number )
Advertising Router: 10.1.4.4
LS Seq Number: 80000001
Checksum: 0xDB31
Length: 36
Network Mask: /24
  Metric Type: 2 (Larger than any link state path)
  TOS: 0
  Metric: 20
  Forward Address: 10.1.1.1
  External Route Tag: 0
```

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OSPF Not-So-Totally Stubby Areas

- Not-So-Totally Stubby Area logic
 - Totally Stubby areas block inter-area and external routes from coming from other areas
 - What if I want to redistribute directly into the totally stubby area itself?
 - Combine totally stubby and NSSA behaviors
- **area [area-id] nssa** on all routers in the area
- **area [area-id] nssa no-summary** on ABR(s) in the area
- Result
 - Redistributing router in NSSA generates Type 7 external instead of Type 5
 - ABR changes Type 7 into Type 5 as it is sent into area 0
 - ABR removes LSAs 3 (Inter-Area), 4 (ASBR), & 5 (External) from coming into the area
 - ABR originates default route

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Not-So-Totally Stubby Verification (cont.)

```
R6#show ip route ospf
 10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks
O   10.1.4.4/32 [110/2] via 10.1.146.4, 00:04:41, FastEthernet0/0
O   10.1.1.1/32 [110/2] via 10.1.146.1, 00:04:41, FastEthernet0/0
O N2 10.1.107.0/24 [110/20] via 10.1.146.1, 00:00:11, FastEthernet0/0
O N2 10.1.106.0/24 [110/20] via 10.1.146.1, 00:00:11, FastEthernet0/0
O N2 10.1.105.0/24 [110/20] via 10.1.146.1, 00:00:11, FastEthernet0/0
O N2 10.1.104.0/24 [110/20] via 10.1.146.1, 00:00:11, FastEthernet0/0
O N2 10.1.111.0/24 [110/20] via 10.1.146.1, 00:00:11, FastEthernet0/0
O N2 10.1.110.0/24 [110/20] via 10.1.146.1, 00:00:11, FastEthernet0/0
O N2 10.1.109.0/24 [110/20] via 10.1.146.1, 00:00:11, FastEthernet0/0
O N2 10.1.108.0/24 [110/20] via 10.1.146.1, 00:00:11, FastEthernet0/0
O*IA 0.0.0.0/0 [110/2] via 10.1.146.4, 00:00:16, FastEthernet0/0

R4#show ip route ospf
 10.0.0.0/8 is variably subnetted, 20 subnets, 3 masks
O   10.1.6.6/32 [110/2] via 10.1.146.6, 00:00:20, FastEthernet0/0
O   10.1.5.5/32 [110/65] via 10.1.245.5, 00:00:20, Serial0/0
O IA 10.1.3.3/32 [110/66] via 10.1.245.2, 00:00:20, Serial0/0
O IA 10.1.2.2/32 [110/65] via 10.1.245.2, 00:00:20, Serial0/0
O   10.1.1.1/32 [110/2] via 10.1.146.1, 00:00:20, FastEthernet0/0
O IA 10.1.23.0/24 [110/65] via 10.1.245.2, 00:00:20, Serial0/0
O IA 10.1.32.0/22 [110/66] via 10.1.245.2, 00:00:20, Serial0/0
O   10.1.60.0/24 [110/2] via 10.1.146.6, 00:00:20, FastEthernet0/0
O E2 10.1.50.0/24 [110/20] via 10.1.245.5, 00:00:20, Serial0/0
O N2 10.1.107.0/24 [110/20] via 10.1.146.1, 00:00:20, FastEthernet0/0
O N2 10.1.106.0/24 [110/20] via 10.1.146.1, 00:00:20, FastEthernet0/0
O N2 10.1.105.0/24 [110/20] via 10.1.146.1, 00:00:20, FastEthernet0/0
O N2 10.1.104.0/24 [110/20] via 10.1.146.1, 00:00:20, FastEthernet0/0
O N2 10.1.111.0/24 [110/20] via 10.1.146.1, 00:00:20, FastEthernet0/0
O N2 10.1.110.0/24 [110/20] via 10.1.146.1, 00:00:22, FastEthernet0/0
O N2 10.1.109.0/24 [110/20] via 10.1.146.1, 00:00:22, FastEthernet0/0
O N2 10.1.108.0/24 [110/20] via 10.1.146.1, 00:00:22, FastEthernet0/0
```

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Not-So-Totally Stubby Verification (cont.)

```
R5#show ip route ospf
 10.0.0.0/8 is variably subnetted, 20 subnets, 3 masks
O IA 10.1.6.6/32 [110/66] via 10.1.245.4, 00:12:35, Serial0/0
O IA 10.1.4.4/32 [110/65] via 10.1.245.4, 00:12:45, Serial0/0
O IA 10.1.3.3/32 [110/66] via 10.1.245.2, 00:12:45, Serial0/0
O IA 10.1.2.2/32 [110/65] via 10.1.245.2, 00:12:45, Serial0/0
O IA 10.1.1.1/32 [110/66] via 10.1.245.4, 00:06:37, Serial0/0
O IA 10.1.23.0/24 [110/65] via 10.1.245.2, 00:12:45, Serial0/0
O IA 10.1.32.0/22 [110/66] via 10.1.245.2, 00:12:45, Serial0/0
O IA 10.1.60.0/24 [110/66] via 10.1.245.4, 00:12:35, Serial0/0
O E2 10.1.107.0/24 [110/20] via 10.1.245.4, 00:06:32, Serial0/0
O E2 10.1.106.0/24 [110/20] via 10.1.245.4, 00:06:32, Serial0/0
O E2 10.1.105.0/24 [110/20] via 10.1.245.4, 00:06:32, Serial0/0
O E2 10.1.104.0/24 [110/20] via 10.1.245.4, 00:06:32, Serial0/0
O E2 10.1.111.0/24 [110/20] via 10.1.245.4, 00:06:32, Serial0/0
O E2 10.1.110.0/24 [110/20] via 10.1.245.4, 00:06:32, Serial0/0
O E2 10.1.109.0/24 [110/20] via 10.1.245.4, 00:06:33, Serial0/0
O E2 10.1.108.0/24 [110/20] via 10.1.245.4, 00:06:33, Serial0/0
O IA 10.1.146.0/24 [110/65] via 10.1.245.4, 00:12:46, Serial0/0
```

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Not-So-Totally Stubby Verification (cont.)

```
R1#show ip ospf database

OSPF Router with ID (10.1.1.1) (Process ID 1)

Router Link States (Area 2)

Link ID      ADV Router   Age         Seq#         Checksum Link count
10.1.1.1     10.1.1.1     428        0x8000000B  0x00A7FE 2
10.1.4.4     10.1.4.4     591        0x80000007  0x00F79C 2
10.1.6.6     10.1.6.6     773        0x80000005  0x00B77B 3

Net Link States (Area 2)

Link ID      ADV Router   Age         Seq#         Checksum
10.1.146.6   10.1.6.6     768        0x80000005  0x000733

Summary Net Link States (Area 2)

Link ID      ADV Router   Age         Seq#         Checksum
0.0.0.0     10.1.4.4     160        0x80000001  0x00A280

Type-7 AS External Link States (Area 2)

Link ID      ADV Router   Age         Seq#         Checksum Tag
10.1.104.0   10.1.1.1     432        0x80000005  0x00669E 0
10.1.105.0   10.1.1.1     432        0x80000003  0x005FA6 0
10.1.106.0   10.1.1.1     432        0x80000003  0x0054B0 0
10.1.107.0   10.1.1.1     433        0x80000003  0x0049BA 0
10.1.108.0   10.1.1.1     433        0x80000003  0x003EC4 0
10.1.109.0   10.1.1.1     433        0x80000003  0x0033CE 0
10.1.110.0   10.1.1.1     433        0x80000003  0x0028D8 0
10.1.111.0   10.1.1.1     433        0x80000003  0x001DE2 0
```

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Not-So-Totally Stubby Verification (cont.)

```
R6#show ip ospf database

OSPF Router with ID (10.1.6.6) (Process ID 1)

Router Link States (Area 2)

Link ID      ADV Router   Age         Seq#         Checksum Link count
10.1.1.1     10.1.1.1     436        0x8000000B  0x00A7FE 2
10.1.4.4     10.1.4.4     597        0x80000007  0x00F79C 2
10.1.6.6     10.1.6.6     779        0x80000005  0x00B77B 3

Net Link States (Area 2)

Link ID      ADV Router   Age         Seq#         Checksum
10.1.146.6   10.1.6.6     774        0x80000005  0x000733

Summary Net Link States (Area 2)

Link ID      ADV Router   Age         Seq#         Checksum
0.0.0.0     10.1.4.4     167        0x80000001  0x00A280

Type-7 AS External Link States (Area 2)

Link ID      ADV Router   Age         Seq#         Checksum Tag
10.1.104.0   10.1.1.1     440        0x80000005  0x00669E 0
10.1.105.0   10.1.1.1     440        0x80000003  0x005FA6 0
10.1.106.0   10.1.1.1     440        0x80000003  0x0054B0 0
10.1.107.0   10.1.1.1     441        0x80000003  0x0049BA 0
10.1.108.0   10.1.1.1     441        0x80000003  0x003EC4 0
10.1.109.0   10.1.1.1     441        0x80000003  0x0033CE 0
10.1.110.0   10.1.1.1     441        0x80000003  0x0028D8 0
10.1.111.0   10.1.1.1     441        0x80000003  0x001DE2 0
```

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Not-So-Totally Stubby Verification (cont.)

```
R4#show ip ospf database

OSPF Router with ID (10.1.4.4) (Process ID 1)

Router Link States (Area 0)

Link ID      ADV Router   Age         Seq#         Checksum Link
count
10.1.2.2     10.1.2.2     1915        0x80000003  0x06267 1
10.1.4.4     10.1.4.4     801         0x80000004  0x03E7E 1
10.1.5.5     10.1.5.5     1928        0x80000003  0x06132 2

Net Link States (Area 0)

Link ID      ADV Router   Age         Seq#         Checksum
10.1.245.5   10.1.5.5     1928        0x80000002  0x041A1

Summary Net Link States (Area 0)

Link ID      ADV Router   Age         Seq#         Checksum
10.1.1.1     10.1.4.4     428         0x80000008  0x055BE
10.1.2.2     10.1.2.2     1915        0x80000002  0x05CC0
10.1.3.3     10.1.2.2     1693        0x80000001  0x053C7
10.1.4.4     10.1.4.4     1916        0x80000002  0x018FC
10.1.6.6     10.1.4.4     786         0x80000001  0x0F917
10.1.23.0    10.1.2.2     1698        0x80000004  0x08463
10.1.32.0    10.1.2.2     1695        0x80000001  0x022E1
10.1.60.0    10.1.4.4     786         0x80000001  0x0E1FE
10.1.146.0   10.1.4.4     1918        0x80000002  0x0206A

Router Link States (Area 2)

Link ID      ADV Router   Age         Seq#         Checksum Link
count
10.1.1.1     10.1.1.1     445         0x8000000B  0x0A7FE 2
10.1.4.4     10.1.4.4     605         0x80000007  0x0F79C 2
10.1.6.6     10.1.6.6     789         0x80000005  0x0B77B 3

Net Link States (Area 2)

Link ID      ADV Router   Age         Seq#         Checksum
10.1.146.6   10.1.6.6     784         0x80000005  0x00733

Summary Net Link States (Area 2)

Link ID      ADV Router   Age         Seq#         Checksum
0.0.0.0      10.1.4.4     175         0x80000001  0x0A280

Type-7 AS External Link States (Area 2)

Link ID      ADV Router   Age         Seq#         Checksum Tag
10.1.104.0   10.1.1.1     449         0x80000005  0x0669E 0
10.1.105.0   10.1.1.1     450         0x80000003  0x05FA6 0
10.1.106.0   10.1.1.1     450         0x80000003  0x054B0 0
10.1.107.0   10.1.1.1     450         0x80000003  0x049BA 0
10.1.108.0   10.1.1.1     450         0x80000003  0x038C4 0
10.1.109.0   10.1.1.1     450         0x80000003  0x033CE 0
10.1.110.0   10.1.1.1     450         0x80000003  0x028D8 0
10.1.111.0   10.1.1.1     450         0x80000003  0x01DE2 0

Type-5 AS External Link States

Link ID      ADV Router   Age         Seq#         Checksum Tag
10.1.50.0    10.1.5.5     1930        0x80000002  0x08BCL 0
10.1.104.0   10.1.4.4     439         0x80000001  0x0DB31 0
10.1.105.0   10.1.4.4     439         0x80000001  0x0D3B 0
10.1.106.0   10.1.4.4     439         0x80000001  0x0C545 0
10.1.107.0   10.1.4.4     439         0x80000001  0x0BA4F 0
10.1.108.0   10.1.4.4     439         0x80000001  0x0AF59 0
10.1.109.0   10.1.4.4     439         0x80000001  0x0A463 0
10.1.110.0   10.1.4.4     440         0x80000001  0x0996D 0
10.1.111.0   10.1.4.4     440         0x80000001  0x08E77 0
```

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Not-So-Totally Stubby Verification (cont.)

```
R5#show ip ospf database

OSPF Router with ID (10.1.5.5) (Process ID 1)

Router Link States (Area 0)

Link ID      ADV Router   Age         Seq#         Checksum Link count
10.1.2.2     10.1.2.2     1949        0x80000003  0x06267 1
10.1.4.4     10.1.4.4     837         0x80000004  0x03E7E 1
10.1.5.5     10.1.5.5     1962        0x80000003  0x06132 2

Net Link States (Area 0)

Link ID      ADV Router   Age         Seq#         Checksum
10.1.245.5   10.1.5.5     1962        0x80000002  0x041A1

Summary Net Link States (Area 0)

Link ID      ADV Router   Age         Seq#         Checksum
10.1.1.1     10.1.4.4     464         0x80000008  0x055BE
10.1.2.2     10.1.2.2     1949        0x80000002  0x05CC0
10.1.3.3     10.1.2.2     1727        0x80000001  0x053C7
10.1.4.4     10.1.4.4     1952        0x80000002  0x018FC
10.1.6.6     10.1.4.4     822         0x80000001  0x0F917
10.1.23.0    10.1.2.2     1732        0x80000004  0x08463
10.1.32.0    10.1.2.2     1728        0x80000001  0x022E1
10.1.60.0    10.1.4.4     823         0x80000001  0x0E1FE
10.1.146.0   10.1.4.4     1953        0x80000002  0x0206A

Type-5 AS External Link States

Link ID      ADV Router   Age         Seq#         Checksum Tag
10.1.50.0    10.1.5.5     1963        0x80000002  0x08BCL 0
10.1.104.0   10.1.4.4     474         0x80000001  0x0DB31 0
10.1.105.0   10.1.4.4     474         0x80000001  0x0D3B 0
10.1.106.0   10.1.4.4     474         0x80000001  0x0C545 0
10.1.107.0   10.1.4.4     474         0x80000001  0x0BA4F 0
10.1.108.0   10.1.4.4     474         0x80000001  0x0AF59 0
10.1.109.0   10.1.4.4     474         0x80000001  0x0A463 0
10.1.110.0   10.1.4.4     474         0x80000001  0x0996D 0
10.1.111.0   10.1.4.4     474         0x80000001  0x08E77 0
```

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Controlling NSSA Redistribution

- What if I redistribute on the ABR of the NSSA itself?
 - ABR is now also an ASBR
- Type 5 sent into area 0
- Type 7 sent into NSSA
- Type 7 generation can be suppressed with **area [area-id] nssa no-redistribution [no-summary]** on ABR/ASBR

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OSPF Default Routing

- OSPF stub areas' ABR(s) automatically generate a default route into the stub area
 - NSSA exception
- Normal routers can generate a default route with...
 - Redistribution
 - **default-information originate [always] [route-map name]**
- If **always** keyword is omitted, default must exist in local routing table before being generated
 - Used in designs where with multiple default exit points
- Route-map used for condition checking
 - e.g. if link to ISP is down, do not originate default

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OSPF Default Routing Example

```
R5#sh run | s router ospf
default-information originate always metric 50

R2#show ip route ospf
10.0.0.0/8 is variably subnetted, 24 subnets, 3 masks
O IA 10.1.6.6/32 [110/66] via 10.1.245.4, 00:16:26, Serial0/0
O    10.1.5.5/32 [110/65] via 10.1.245.5, 00:16:36, Serial0/0
O IA 10.1.4.4/32 [110/65] via 10.1.245.4, 00:16:36, Serial0/0
O    10.1.3.3/32 [110/2] via 10.1.23.3, 00:25:49, FastEthernet0/0
O IA 10.1.1.1/32 [110/66] via 10.1.245.4, 00:10:27, Serial0/0
O    10.1.35.0/24 [110/2] via 10.1.23.3, 00:25:49, FastEthernet0/0
O    10.1.34.0/24 [110/2] via 10.1.23.3, 00:25:49, FastEthernet0/0
O    10.1.33.0/24 [110/2] via 10.1.23.3, 00:25:49, FastEthernet0/0
O    10.1.32.0/24 [110/2] via 10.1.23.3, 00:25:49, FastEthernet0/0
O    10.1.32.0/22 is a summary, 00:25:49, Null0
O IA 10.1.60.0/24 [110/66] via 10.1.245.4, 00:16:26, Serial0/0
O E2 10.1.50.0/24 [110/20] via 10.1.245.5, 00:10:22, Serial0/0
O E2 10.1.107.0/24 [110/20] via 10.1.245.4, 00:10:22, Serial0/0
O E2 10.1.106.0/24 [110/20] via 10.1.245.4, 00:10:22, Serial0/0
O E2 10.1.105.0/24 [110/20] via 10.1.245.4, 00:10:24, Serial0/0
O E2 10.1.104.0/24 [110/20] via 10.1.245.4, 00:10:24, Serial0/0
O E2 10.1.111.0/24 [110/20] via 10.1.245.4, 00:10:24, Serial0/0
O E2 10.1.110.0/24 [110/20] via 10.1.245.4, 00:10:24, Serial0/0
O E2 10.1.109.0/24 [110/20] via 10.1.245.4, 00:10:24, Serial0/0
O E2 10.1.108.0/24 [110/20] via 10.1.245.4, 00:10:24, Serial0/0
O IA 10.1.146.0/24 [110/65] via 10.1.245.4, 00:16:37, Serial0/0
O*E2 0.0.0.0/0 [110/50] via 10.1.245.5, 00:00:04, Serial0/0
```

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OSPF Authentication

- Like EIGRP, OSPF supports adjacency authentication to protect control plane
- Every packet header includes authentication information
 - e.g. Hello, LSU, LSR
- Three types of authentication
 - Type 0 – Null
 - Type 1 – Simple Password
 - Type 2 – Cryptographic (MD5)

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Implementing OSPF Authentication

- OSPF authentication can be enabled on...
 - All local links in the area
 - `area [area-id] authentication [message-digest]`
 - Per link basis
 - `ip ospf authentication [null|message-digest]`
- Password always configured on the link
 - `ip ospf authentication-key [password]`
 - `ip ospf message-digest-key [key-id] md5 [password]`
- Key ID's must match for MD5 authentication

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OSPF Simple Authentication Example

```
R2#
interface FastEthernet0/0
 ip ospf authentication-key CISCO
!
router ospf 1
 area 1 authentication

R3#
interface FastEthernet0/0
 ip ospf authentication
 ip ospf authentication-key CISCO

R3#show ip ospf neighbor

Neighbor ID      Pri  State           Dead Time   Address        Interface
10.1.2.2         1    FULL/BDR        00:00:35   10.1.23.2     FastEthernet0/0

R3#show ip ospf interface Fa0/0
FastEthernet0/0 is up, line protocol is up
 Internet Address 10.1.23.3/24, Area 1
 Process ID 1, Router ID 10.1.3.3, Network Type BROADCAST, Cost: 1
 Transmit Delay is 1 sec, State DR, Priority 1
 Designated Router (ID) 10.1.3.3, Interface address 10.1.23.3
 Backup Designated router (ID) 10.1.2.2, Interface address 10.1.23.2
 Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
   oob-resync timeout 40
 Hello due in 00:00:07
 Supports Link-local Signaling (LLS)
 Index 3/3, flood queue length 0
 Next 0x0(0)/0x0(0)
 Last flood scan length is 0, maximum is 8
 Last flood scan time is 0 msec, maximum is 4 msec
 Neighbor Count is 1, Adjacent neighbor count is 1
   Adjacent with neighbor 10.1.2.2 (Backup Designated Router)
 Suppress hello for 0 neighbor(s)
 Simple password authentication enabled
```

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OSPF MD5 Authentication Example

```

R1#
interface FastEthernet0/0
ip ospf message-digest-key 1 md5 CISCO
!
router ospf 1
area 1 authentication message-digest

R4#
interface FastEthernet0/0
ip ospf authentication message-digest
ip ospf message-digest-key 1 md5 CISCO

R6#
interface FastEthernet0/0
ip ospf authentication message-digest
ip ospf message-digest-key 1 md5 CISCO

R6#show ip ospf neighbor

Neighbor ID      Pri   State           Dead Time   Address      Interface
10.1.1.1         1    FULL/DROTHER    00:00:17   10.1.146.1   FastEthernet0/0
10.1.4.4         1    FULL/DR        00:00:39   10.1.146.4   FastEthernet0/0

R6#show ip ospf interface Fa0/0
FastEthernet0/0 is up, line protocol is up
Internet Address 10.1.146.6/24, Area 2
Process ID 1, Router ID 10.1.6.6, Network Type BROADCAST, Cost: 1
Transmit Delay is 1 sec, State DR, Priority 1
Designated Router (ID) 10.1.6.6, Interface address 10.1.146.6
Backup Designated router (ID) 10.1.4.4, Interface address 10.1.146.4
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
oob-resync timeout 40
Hello due in 00:00:09
Supports link-local signaling (LLS)
Index 3/3, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 0, maximum is 14
Last flood scan time is 0 msec, maximum is 4 msec
Neighbor Count is 2, Adjacent neighbor count is 2
  Adjacent with neighbor 10.1.1.1
  Adjacent with neighbor 10.1.4.4 (Backup Designated Router)
Suppress hello for 0 neighbor(s)
Message digest authentication enabled
Youngest key id is 1

```

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OSPF Tuning

- OSPF database calculation & lookup times a function of hardware
 - e.g. faster CPU, more memory, faster lookups
- Resource needs can be lowered through
 - Areas for flooding domain segmentation
 - Summarization
 - Stub areas
- Further optimization through timers
 - Hello & dead timers
 - Faster neighbor down detection
 - Pacing timers
 - How long do I wait between updates, retransmits, etc.
 - Throttling timers
 - How often do I generate LSAs, run SPF, etc.

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OSPF Q&A

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