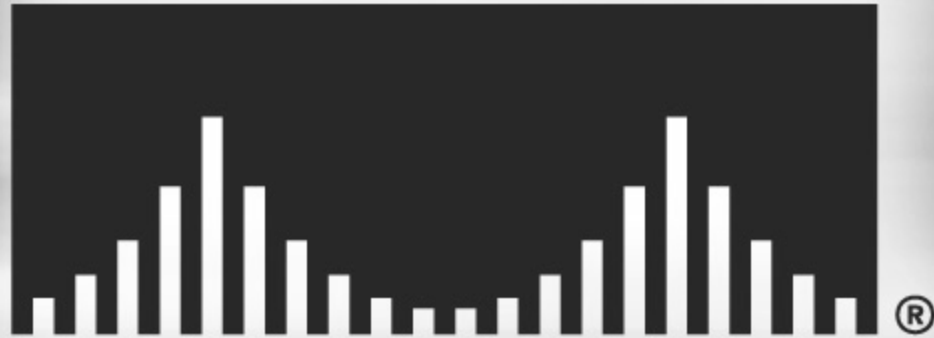
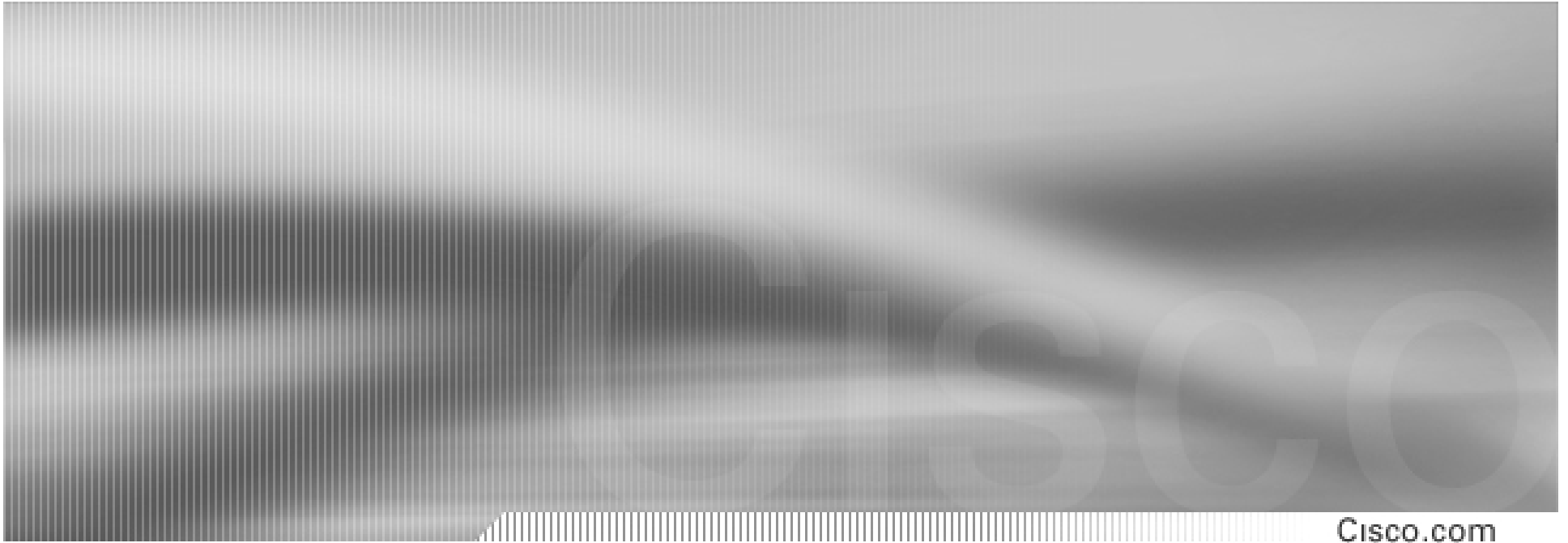


# CISCO SYSTEMS





# Open Shortest Path First v3

# Agenda

- **Starting from Open Shortest Path First version 2 (OSPFv2)**
- **Link State Advertisement (LSA) Details**
- **OSPFv3 Revisited Concepts**
- **Configuring OSPFv3**
- **Troubleshooting Commands**

# OSPFv2

- **April 1998 was the most recent revision (RFC 2328)**
- **OSPF uses a 2-level hierarchical model**
- **SPF calculation is performed independently for each area**
- **Typically faster convergence than DVRRPs**
- **Relatively low, steady state bandwidth requirements**

# Introduction to OSPFv2

- **Uses metrics—path cost**
- **Typically faster convergence than DVRRPs**
- **Support for CIDR, VLSM, authentication, multipath, and IP unnumbered**
- **Relatively low, steady state bandwidth requirements**

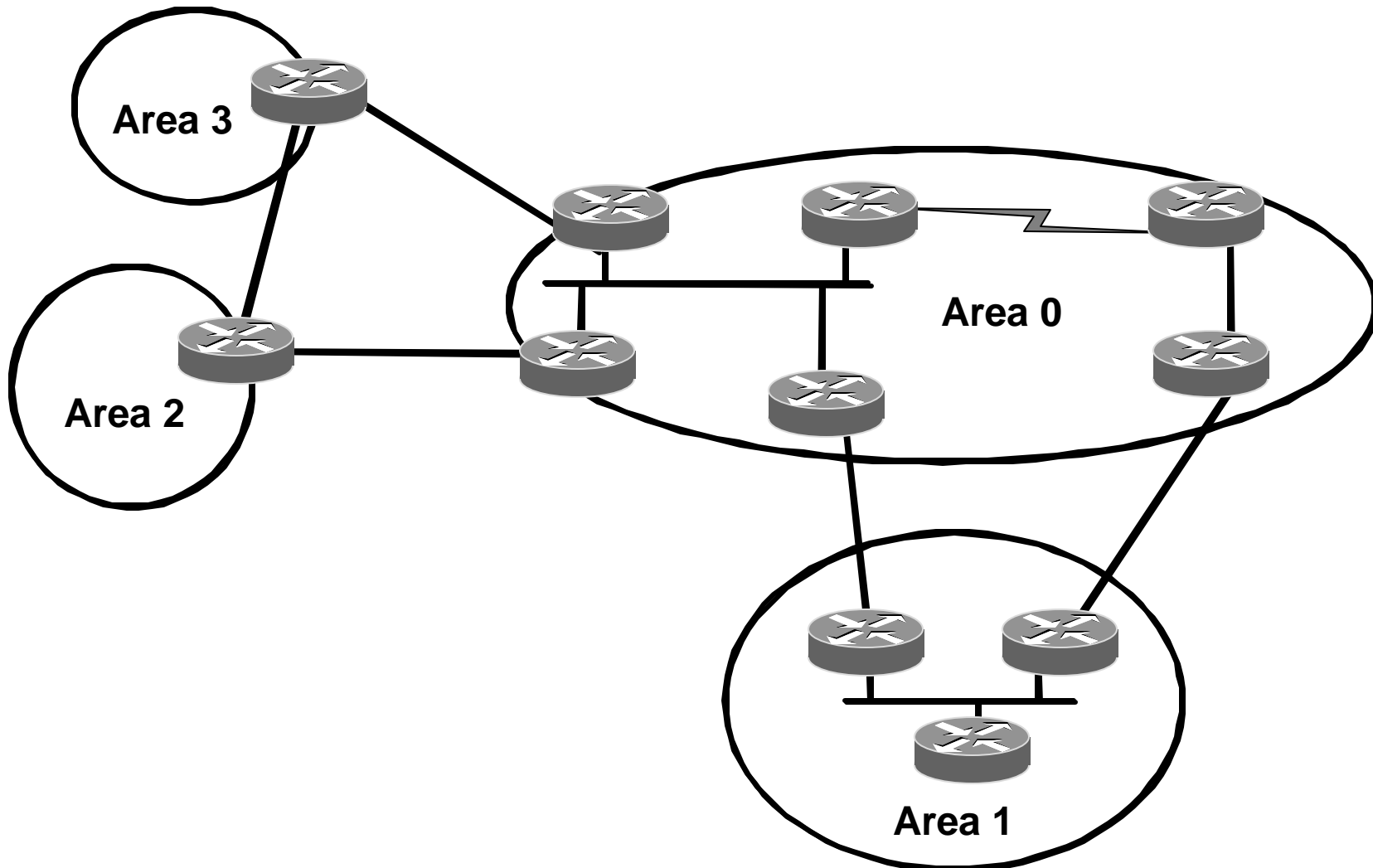
# Cost = Metric

- **Cost applied on all router link paths**
- **16-bit positive number 1–65,535**
- **The lower the more desirable**
- **Relevant going out an interface only**
- **Route decisions made on total cost of path**

# Areas

- **OSPF uses a 2 level hierarchical model**
- **Areas defined with 32 bit number**
  - Defined in IP address format**
  - Can also be defined using single decimal value (ie. Area 0.0.0.0, or Area 0)**
- **0.0.0.0 reserved for the backbone area**
- **All areas must connect to area 0.0.0.0**

# OSPF Areas—Example

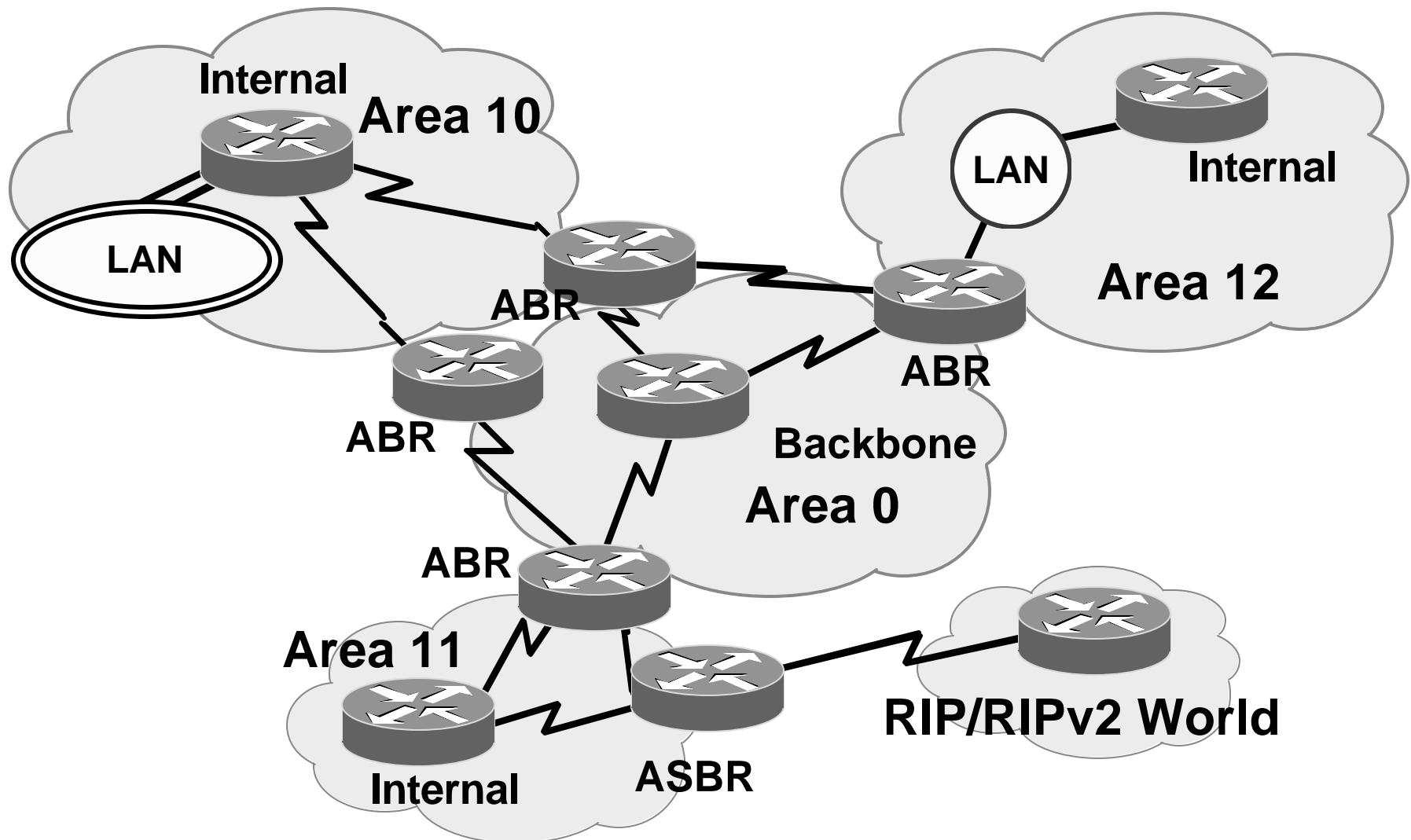




# Different Types of Routers

- **Internal routers (inside an area)**
- **Backbone routers (inside area 0)**
- **Area Border Routers (ABR)**
  - An ABR sits between two or more areas**
  - Must touch backbone area (area 0)**
- **Autonomous System Boundary Routers (ASBR)**
  - Redistribution makes a router an ASBR**

# Location of Different Routers



# OSPF Algorithm

- **Network changes generates LSAs**
- **All routers exchange LSAs to build and maintain a consistent database**
- **The protocol remains relatively quiet during steady-state conditions**

**Periodic refresh of LSAs every 30 minutes**

**Otherwise, updates only sent when there are changes**

# Routing Protocol Packets

- They share a common protocol header
- Routing protocol packets are sent with type of service (TOS) of 0
- Five types of OSPF routing protocol packets

**Hello**

**Database description**

**Link-state request**

**Link-state update**

**Link-state acknowledgment**

# OSPF Hello Packets

- **Multicast 224.0.0.5 on all router interfaces**
- **Unicast on virtual links**
- **Hello interval 10 sec. LAN, 30 sec. NBMA**
- **Used to form adjacencies between routers**
- **Describes the optional capabilities**

# Different Types of LSAs

- **Router link (LSA type 1)**
- **Network link (LSA type 2)**
- **Network summary (LSA type 3)**
- **ASBR (LSA type 4)**
- **External (LSA type 5)**
- **NSSA external (LSA type 7)**

# OSPFv3 overview

- **OSPF for IPv6**
- **Based on OSPFv2, with enhancements**
- **Distributes IPv6 prefixes**
- **Runs directly over IPv6**
- **Ships-in-the-night with OSPFv2**

# OSPFv3 / OSPFv2 Similarities

- **Basic packet types**  
Hello, DBD, LSR, LSU, LSA
- **Mechanisms for neighbor discovery and adjacency formation**
- **Interface types**  
P2P, P2MP, Broadcast, NBMA, Virtual
- **LSA flooding and aging**
- **Nearly identical LSA types**



# What IPv6 Attributes Affect OSPF?

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- **128 bit addresses**
- **Link-Local address**
- **Multiple addresses per interface**
- **Authentication**

# OSPFv3 / OSPFv2 Differences

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- **OSPFv3 runs over a link, rather than a subnet**
- **Multiple instances per link**
- **OSPFv2 topology not IPv6-specific**

**Router ID**

**Link ID**

- **Standard authentication mechanisms**
- **Uses link-local addresses**
- **Generalized flooding scope**

# Removal of Address Semantic

- **IPv6 address is not present in OSPFv3 packets**
  - Exception: LSA payload
- **Router-LSA and Network-LSA expressing topology**
- **Router ID, area ID, LSA link state ID remain a 32 bit number**
- **Neighbors are always identified by Router ID**

# New LSA Types

- **Link LSA**

  - Informs neighbors of link local address**

  - Informs neighbors of IPv6 prefixes on link**

- **Intra-Area Prefix LSA**

  - Associates IPv6 prefixes with a network or router**

# Agenda

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- **Starting from OSPFv2**
- **LSA Details**
- **OSPFv3 Revisited Concepts**
- **Configuring OSPFv3**
- **Troubleshooting Commands**

# OSPFv3 packet types

- **Share a common protocol header**
- **Routing protocol packets are sent with type of service (TOS) of 0**
- **Five types of OSPF routing protocol packets**

**Hello**

**Database description**

**Link-state request**

**Link-state update**

**Link-state acknowledgment**

# Addition of Flooding Scope

- **Flooding scope for LSAs has been generalized**  
Explicitly coded in the LS type field of the LSA
- **Three flooding scopes for LSAs**
  - Link-local
  - Area
  - AS
- **Coded in first three bits of LS Type field**
  - 0x0008 – link LSA has link-local flooding scope
  - 0x2001 – router LSA has area flooding scope
- **Supports flooding of LSAs with an unknown type**

# New LSA Type Field



- **U:** indicates how the LSA should be handled by a router that does not recognize the LSA's function code
- **S2,S1:** indicate the flooding scope of the LSA (link local, area, AS local)
- **Each LSA function code also implies a specific setting for the U, S2, and S1 bits**



# LSA Type Review

	LSA Function Code	LSA type
Router-LSA	1	0x2001
Network-LSA	2	0x2002
Inter-Area-Prefix-LSA	3	0x2003
Inter-Area-Router-LSA	4	0x2004
AS-External-LSA	5	0x4005
Group-membership-LSA	6	0x2006
Type-7-LSA	7	0x2007
Link-LSA	8	0x0008
Intra-Area-Prefix-LSA	9	0x2009

# LSA Format Change

- **New LSA added to distribute IPv6 address and data for next-hop resolution**
- **Change in LSA names for more consistency**

**Option field removed from header and increased in size**

**LSA type field expanded to 16 bits; contains flooding scope bits**

**Addresses expressed as prefix/length**

**Fragmented Router-LSA**

# LSA Header Comparison

## OSPFv2

- 20 bytes

LS Age	Options	LS Type
Link State ID		
Advertising Router		
LS Sequence Number		
LS Checksum	Length	

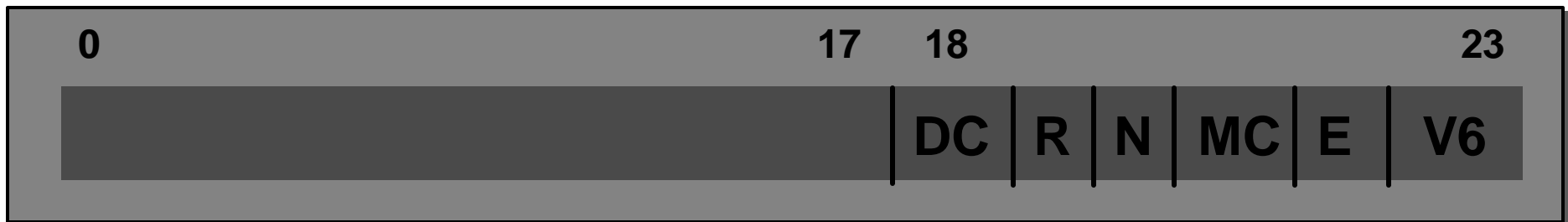
## OSPFv3

- 20 bytes

LS Age	LS Type
Link State ID	
Advertising Router	
LS Sequence Number	
LS Checksum	Length

# LSA Options

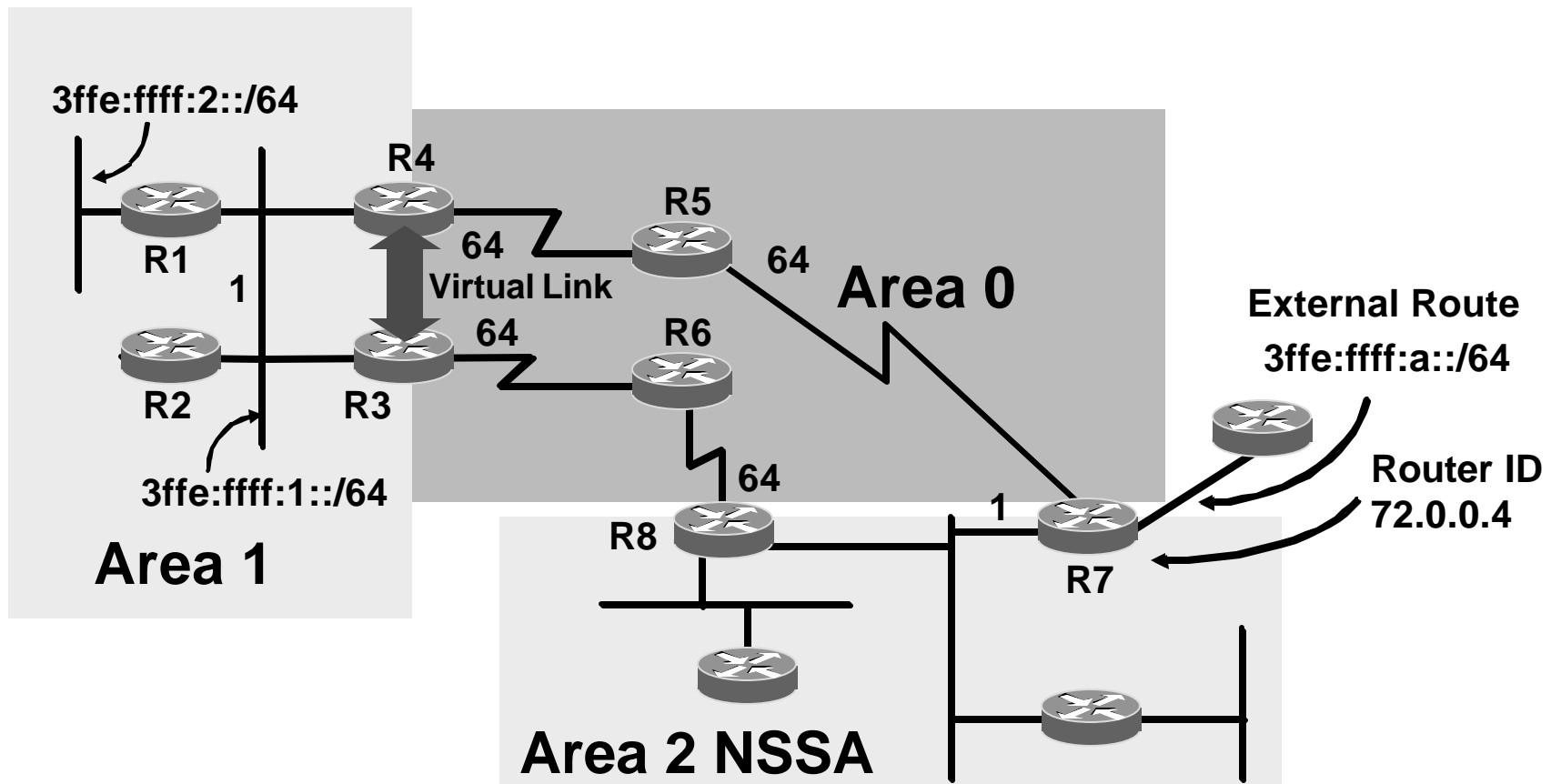
## Follow the LSA header when it makes sense



- **V6:** router/link should be excluded from IPv6 routing calculations if this is clear
- **E:** AS-external-LSAs are not supported if this is clear
- **MC:** describes whether IP multicast datagrams are forwarded
- **N:** set if attached to a NSSA
- **R:** indicates whether the originator is an active router  
If the router bit is clear, then routes that transmit the advertising node cannot be computed
- **DC:** describes the router's handling of demand circuits

# Different Types of LSAs

## Sample network for each LSA



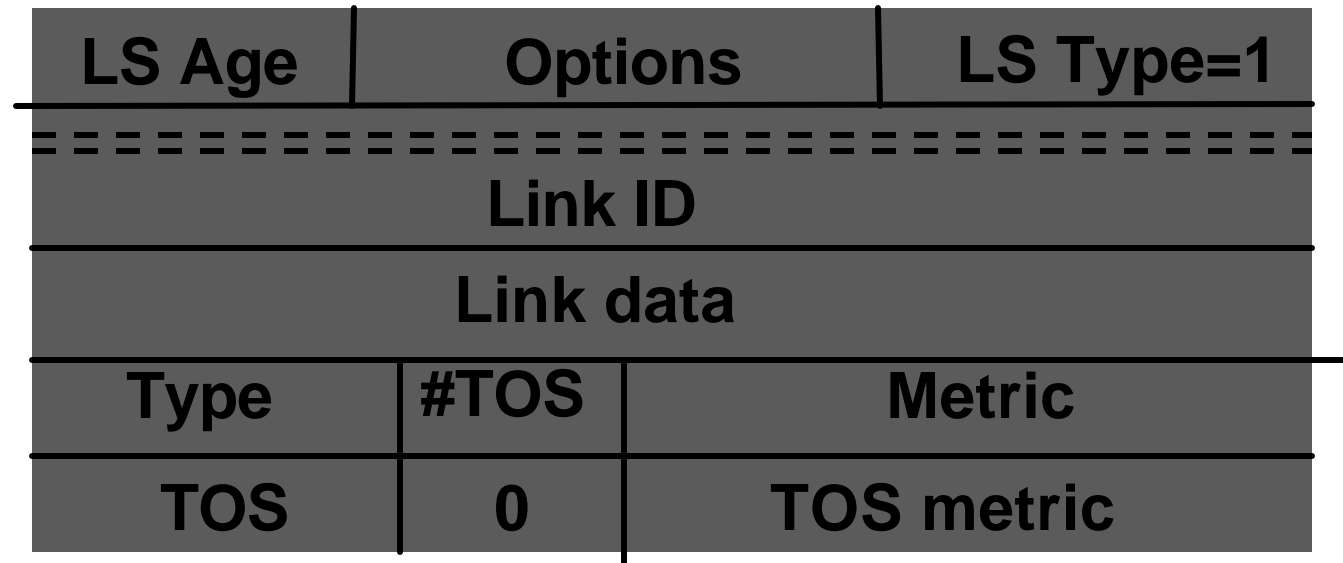
# Router LSA

- **Fragments possible, distinguished by their “Link State ID” field**
- **Taken together, the collection of router-LSAs originated by the router for an area describes the collected states of all the router's interfaces to that area**
- **Area flooding scope**

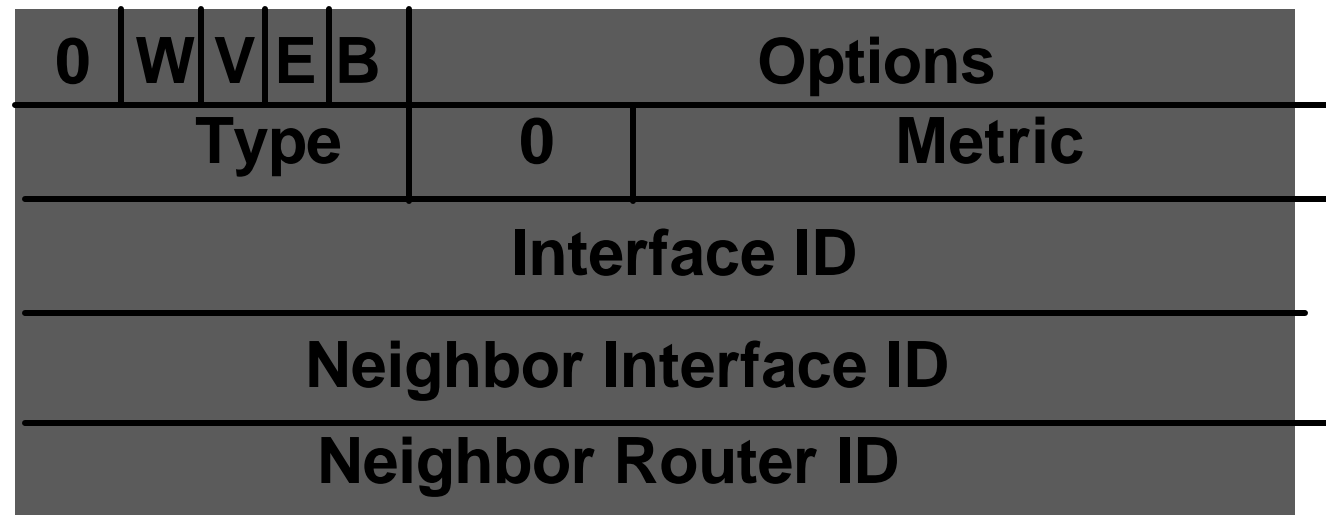
# Router LSA Structure Comparison

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## OSPFv2



## OSPFv3



W: wildcard multicast

V: virtual link endpoint

E: ASBR

B: ABR

# Router LSA of R3 for Area 1

```
R3#show ipv6 ospf database router
```

Router Link States (Area 1)

LS age: 0  
Options: (V6-Bit E-Bit R-bit DC-Bit)  
LS Type: Router Links  
Link State ID: 0  
Advertising Router: 26.50.0.2  
LS Seq Number: 80000020  
Checksum: 0xB587  
Length: 40  
Area Border Router  
Number of Links: 1

Link connected to: a Transit Network

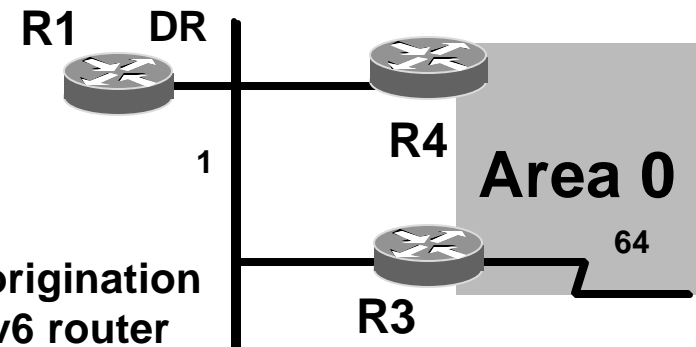
Link Metric: 1  
Local Interface ID: 3  
Neighbor (DR) Interface ID: 3  
Neighbor (DR) Router ID: 26.50.0.1

Always 0 at origination  
This is an IPv6 router  
This is a router LSA

Router ID of R3

bit B = 1

Cost to reach the interface  
IfIndex  
IfIndex  
Router ID of R1





# Router LSA of R3 for Area 0

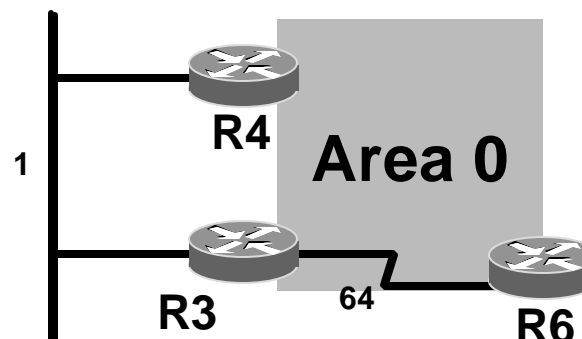
R3#show ipv6 ospf database router

Router Link States (Area 1)

LS age: 249  
Options: (V6-Bit E-Bit R-bit DC-Bit)  
LS Type: Router Links  
Link State ID: 0  
Advertising Router: 26.50.0.2  
LS Seq Number: 8000001F  
Checksum: 0xEA15  
Length: 40  
Area Border Router  
Number of Links: 1

Link connected to: another Router (point-to-point)

Link Metric: 64  
Local Interface ID: 5  
Neighbor Interface ID: 5  
Neighbor Router ID: 72.0.0.1



Router ID of R3

bit B = 1

Cost to reach the interface  
IfIndex  
IfIndex  
Router ID of R6

# Router LSA Types

Type	Description	Neighbor Router ID	Neighbor Interface ID
1	Point-to-Point	Neighbors RID	Neighbor's Link ID
2	Transit	DR's Router ID	DR's Interface ID
3	Reserved	N/A	N/A
4	Virtual Link	Neighbors RID	Neighbor's Link ID

# Network LSA Structure Comparison

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**OSPFv2**

LS Age	Options	2
Link ID		
Advertising router		
LS sequence number		
LS Checksum	Length	
Network mask		
Attached Router		

**OSPFv3**

0	Options	
Attached Router		
Attached Router		
Attached Router		

# Network LSA for LAN 1

R3#show ipv6 ospf database network

## Intra Area Prefix Link States (Area 1)

LS age: 992

Options: (V6-Bit E-Bit R-bit DC-Bit)

LS Type: Network Links

Link State ID: 3 (Interface ID of Designated Router)

Advertising Router: 26.50.0.1

LS Seq Number: 8000000E

Checksum: 0x3F29

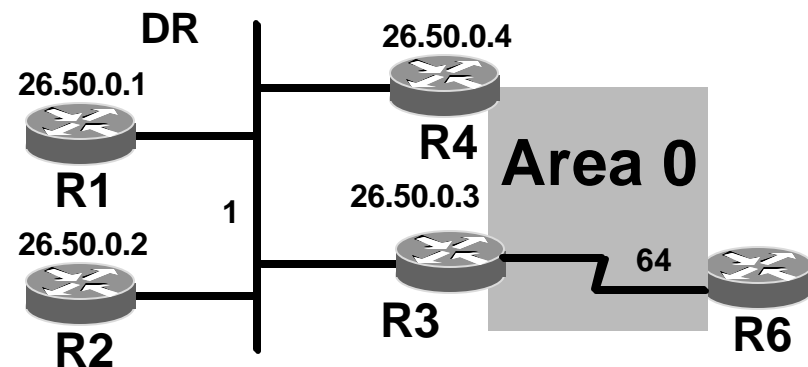
Length: 40

Attached Router: 26.50.0.1

Attached Router: 26.50.0.2

Attached Router: 26.50.0.4

Attached Router: 26.50.0.3



# Intra-Area LSA

- **Area flooding scope**
- **1- associate prefix when a transit network references a Network-LSA**
- **2-associate prefix when a router or stub references a Router-LSA**
- **Multiple instances for each router or transit network distinguished by their Link State ID**

# LSA Options

## Part of the (prefix, options, prefix length) triple



- **NU:** if set, the prefix should be excluded from IPv6 Unicast calculations
- **LA:** "local address" capability bit
  - If set, the /128 prefix is actually an IPv6 interface address of the advertising router
- **MC:** the "multicast" capability bit; if set, the prefix should be included in IPv6 multicast routing calculations
- **P:** The "propagate" bit; set on NSSA area prefixes that should be re-advertised at the NSSA area border

# Intra area LSA structure

## OSPFv3

# prefixes	Referenced LS type	
Referenced Link State ID		
Referenced Advertising Router		
Prefix length	PrefOptions	Metric
Address Prefix		
Prefix length	PrefOptions	Metric
Address Prefix		

# Intra-Area LSA Stub

R1#show ipv6 ospf database prefix

Intra Area Prefix Link States (Area 1)

Routing Bit Set on this LSA

LS age: 1431

LS Type: Intra-Area-Prefix-LSA

Link State ID: 0

Advertising Router: 26.50.0.1

LS Seq Number: 80000006

Checksum: 0x4005

Length: 56

Referenced LSA Type: 2001

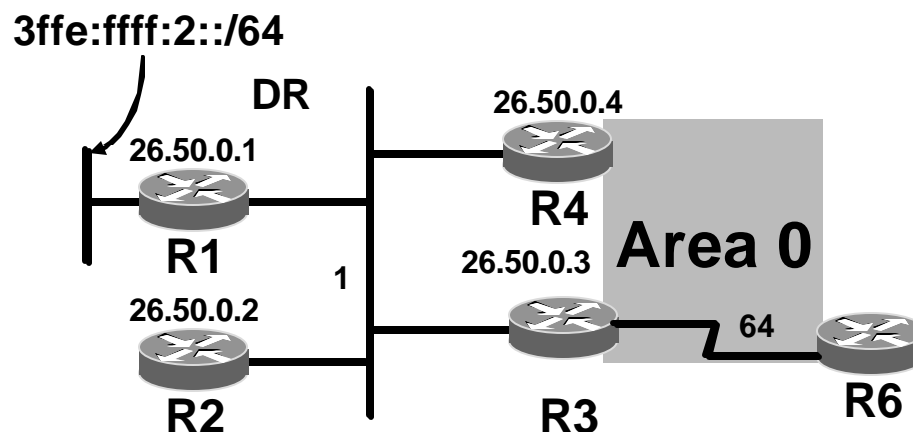
Referenced Link State ID: 0

Referenced Advertising Router: 26.50.0.1

Number of Prefixes: 1

Prefix Address: 3FFE:FFFF:2::

Prefix Length: 64, Options: None, Metric: 10





# Intra-Area LSA Transit

R3#show ipv6 ospf database prefix

Net Link States (Area 1)

Routing Bit Set on this LSA

LS age: 428

LS Type: Intra-Area-Prefix-LSA

Link State ID: 1003

Advertising Router: 26.50.0.1

LS Seq Number: 80000009

Checksum: 0x5899

Length: 44

Referenced LSA Type: 2002

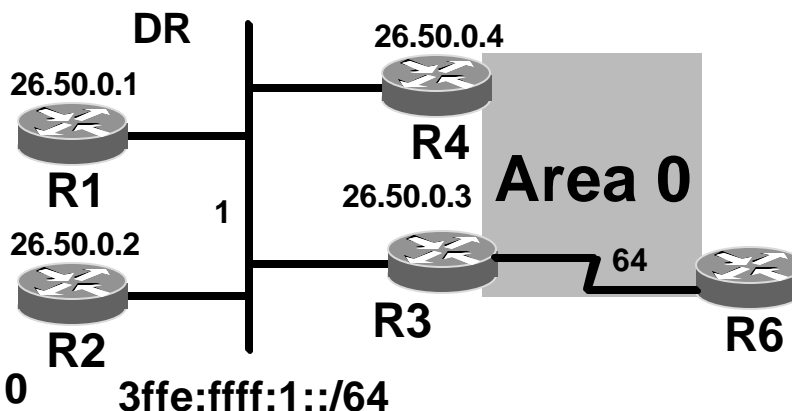
Referenced Link State ID: 3

Referenced Advertising Router: 26.50.0.1

Number of Prefixes: 1

Prefix Address: 3FFE:FFFF:1::

Prefix Length: 64, Options: None, Metric: 0



# Inter-Area Prefix LSA

- **Describes the destination outside the area but still in the AS**
- **Summary is created for one area, which is flooded out in all other areas**
- **Originated by an ABR**
- **Only intra-area routes are advertised into the backbone**
- **Link State ID simply serves to distinguish inter-area-prefix-LSAs originated by the same router**
- **Link-local addresses must never be advertised in inter-area prefix-LSAs**

# Inter-area Prefix LSA Structure Comparison

## OSPFv2

LS Age	Options	3
Link ID		
Advertising router		
LS sequence number		
LS Checksum	Length	
Network mask		
0	Metric	
TOS	TOS Metric	

## OSPFv3

0	Metric	
Prefix length	PrefOptions	0
Address Prefix		

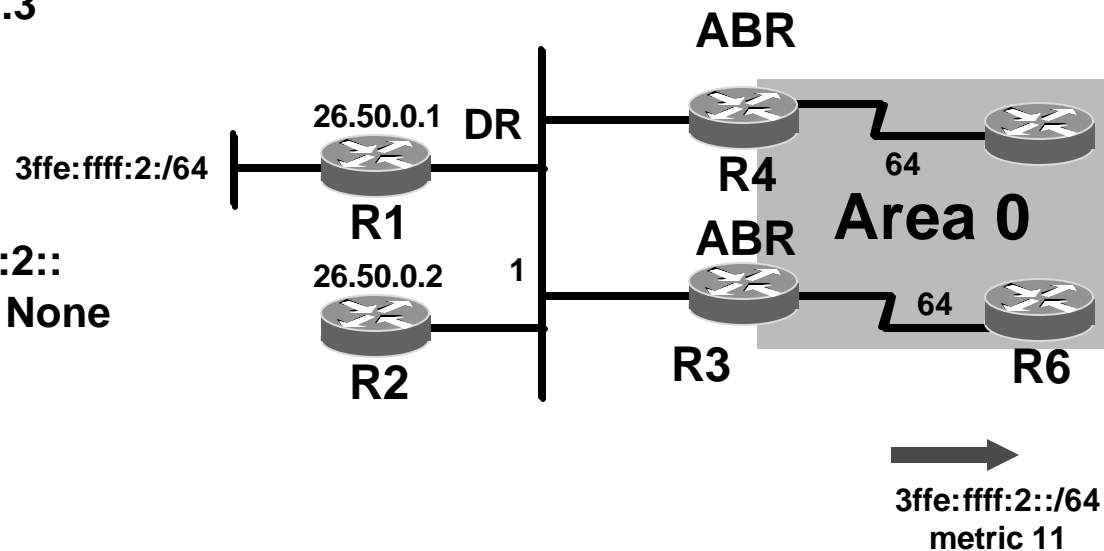
# Inter-area Prefix LSA

```
R6#show ipv6 ospf database inter-area prefix 3FFE:FFFF:2::/64
```

## Inter Area Prefix Link States (Area 0)

Routing Bit Set on this LSA

LS age: 81  
LS Type: Inter Area Prefix Links  
Link State ID: 5  
Advertising Router: 26.50.0.3  
LS Seq Number: 80000001  
Checksum: 0xCC8B  
Length: 36  
Metric: 65  
Prefix Address: 3FFE:FFFF:2::  
Prefix Length: 64, Options: None



# Inter-area Router LSA

- **Describes the path to a Router outside the area, but still in the AS**
- **The Options field in an inter-area-router-LSA should be set equal to the Options field contained in the destination router's own router-LSA**
- **Link State ID simply serves to distinguish inter-area-prefix-LSAs originated by the same router**

# Inter-area Router LSA

## OSPFv2

LS Age	Options	4
Link ID		
Advertising router		
LS sequence number		
LS Checksum	Length	
0		
0	Metric	
TOS	TOS Metric	

## OSPFv3

0	Options
0	Metric
Destination router ID	

# Inter-area Router LSA Details on R3

```
R3#show ipv6 ospf database inter-area router
```

## Inter Area Router Link States (Area 1)

LS age: 60

Options: (V6-Bit E-Bit R-bit DC-Bit)

LS Type: Inter Area Router Links

Link State ID: 1207959556

Advertising Router: 26.50.0.3

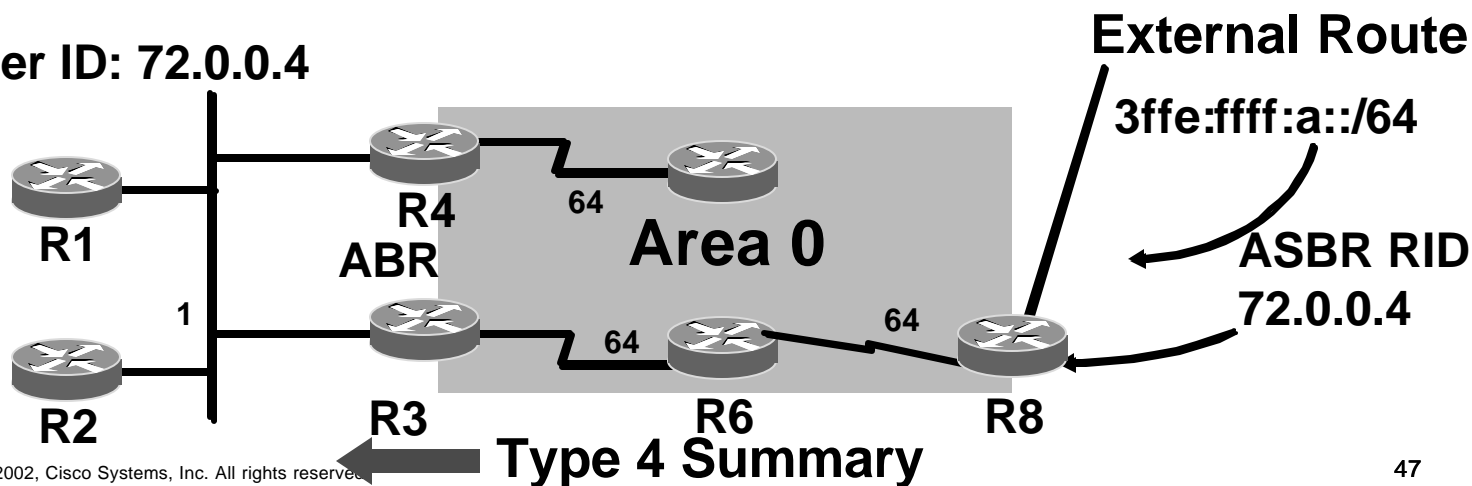
LS Seq Number: 80000001

Checksum: 0xD0CE

Length: 32

Metric: 128

Destination Router ID: 72.0.0.4



# External LSA

- **Defines routes to destination external to the AS**
- **Two types of external LSA:**
  - E1: consider the total cost up to the external destination**
  - E2: consider only the external cost advertised**
- **Default route can be injected as an external LSA**



# External LSA (Cont.)

- **Link State ID simply serves to distinguish inter-area-prefix-LSAs originated by the same router**
- **Link-local addresses not advertised in AS-external-LSAs**
- **Optionally reference another LSA**
- **Forwarding address and tag now optional**

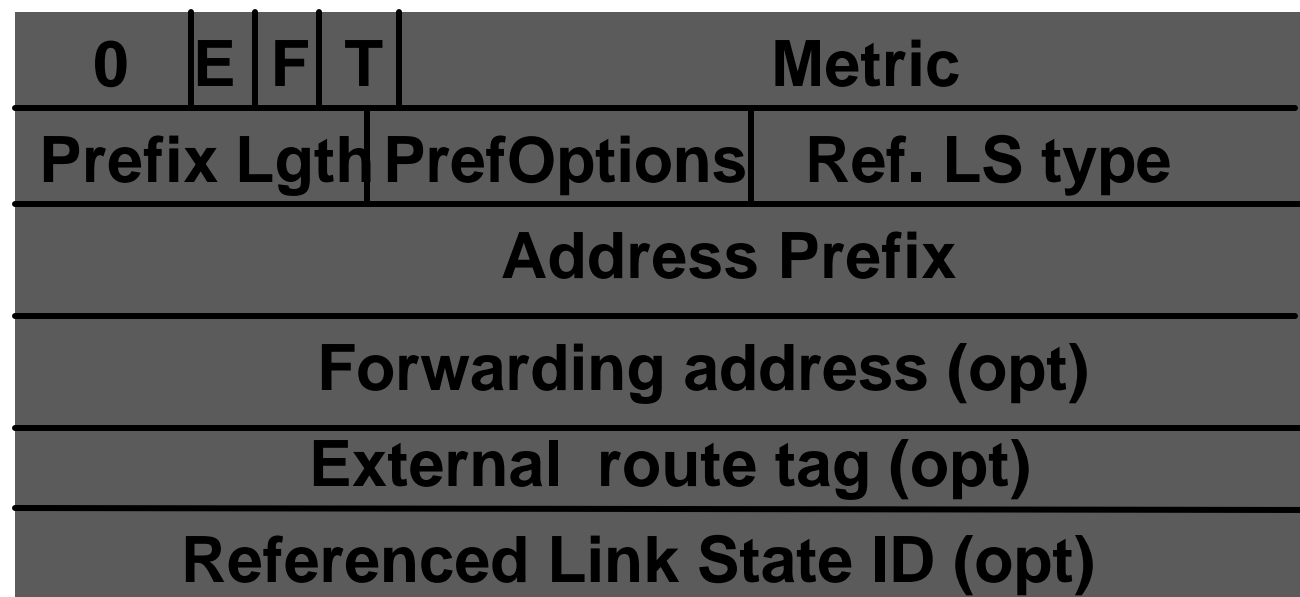
# External LSA Structure

## OSPFv3

E: 1/2

F: frwd Addr

T: Tag



# External LSA Details

```
R3#show ipv6 ospf database external
```

## Type-5 AS External Link States

**Routing Bit Set on this LSA**

**LS age: 473**

**LS Type: AS External Link**

**Link State ID: 5**

**Advertising Router: 72.0.0.4**

**LS Seq Number: 80000001**

**Checksum: 0x77AB**

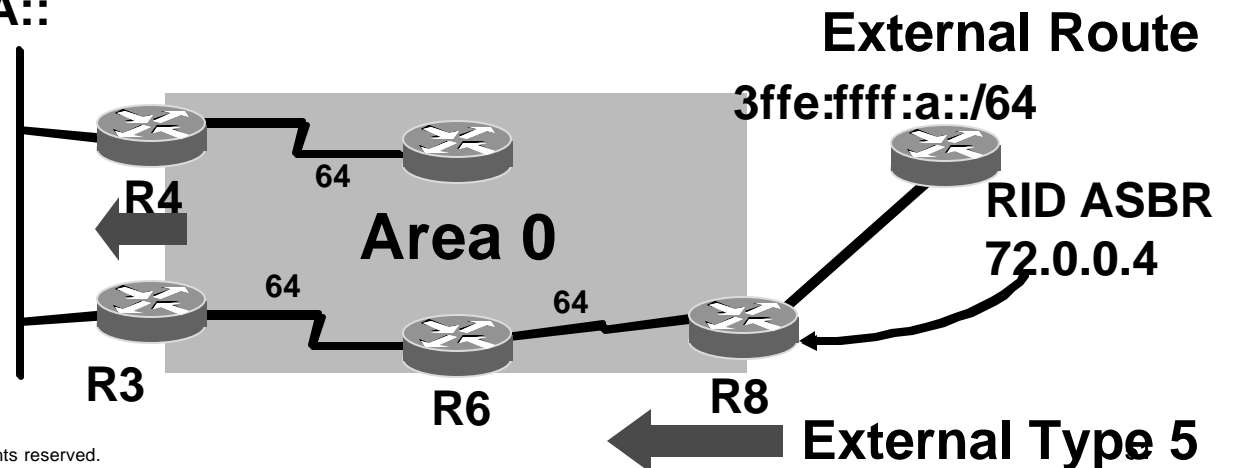
**Length: 36**

**Prefix Address: 3FFE:FFFF:A::**

**Prefix Length: 64,**

**Metric Type: 2/1**

**Metric: 20 type2 /148 type1**



# NSSA External LSA

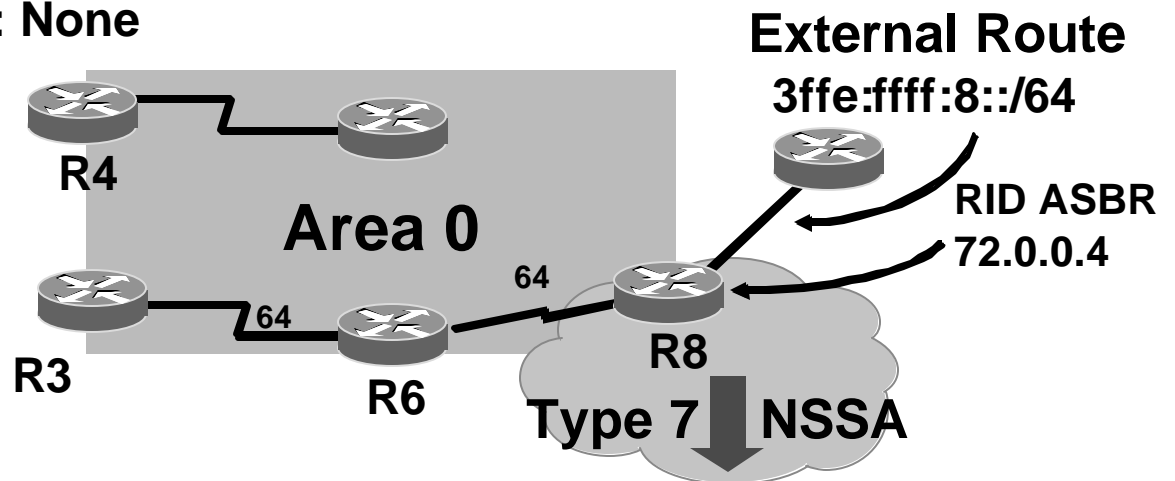
## NSSA External LSA (Type 7) RFC1587

- **NSSA was created to inject external routes from stub area into OSPF domain**
- **Redistribution in NSSA creates Type 7 LSA**
- **Generated by the NSSA ASBR**
- **Type 7 can only exist in NSSA area**
- **NSSA ABR does the translation from 7–5**

# NSSA External LSA Details

```
R8#show ipv6 ospf database nssa-external 3ffe:ffff:8::/64  
Type-7 AS External Link States (Area 2)
```

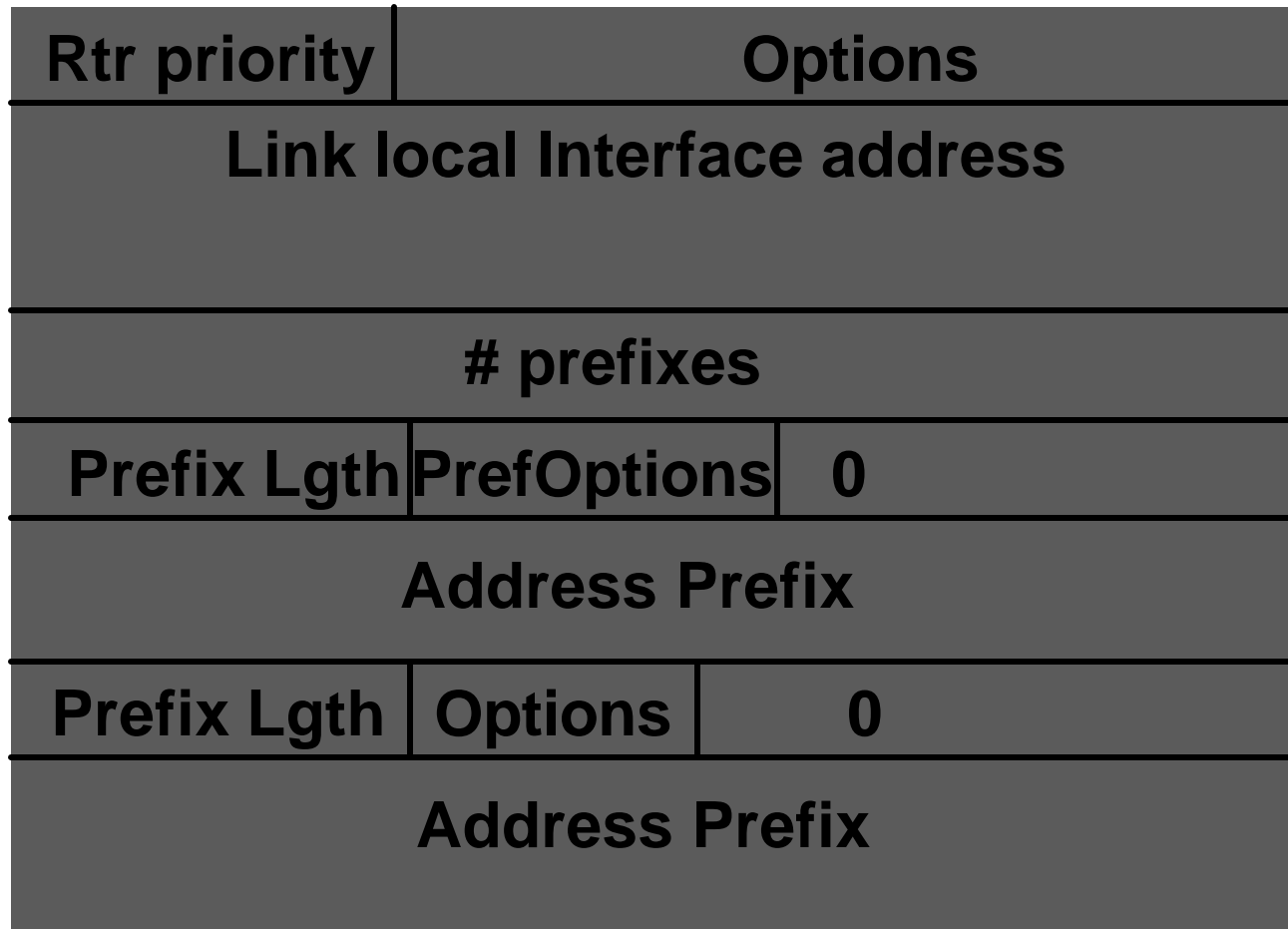
LS age: 163  
LS Type: AS External Link  
Link State ID: 1  
Advertising Router: 72.0.0.4  
LS Seq Number: 80000001  
Checksum: 0xB35  
Length: 36  
Prefix Address: 3FFE:FFFF:8::  
Prefix Length: 64, Options: None  
Metric Type: 2  
Metric: 20



# Link LSA

- **A link LSA per link**
- **Link local scope flooding on the link with which they are associated**
- **Provide router link local address**
- **List all IPv6 prefixes attached to the link**
- **Assert a collection of option bit for the Router-LSA**

# Link LSA structure



# Link LSA of R3 For LAN1

```
R3#show ipv6 ospf database link
```

Link (Type-8) Link States (Area 0)

LS age: 1936

Options: (V6-Bit E-Bit R-bit DC-Bit)

LS Type: Link-LSA (Interface: FastEthernet0/0)

Link State ID: 3 (Interface ID)

Advertising Router: 26.50.0.3

LS Seq Number: 8000002E

Checksum: 0xD7B3

Length: 68

Router Priority: 1

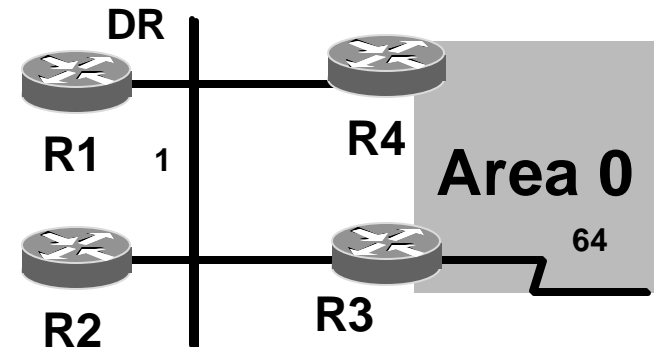
Link Local Address: FE80::204:C1FF:FEDB:2FA0

Number of Prefixes: 2

Prefix Address: 3FFE:FFFF:1::           Your interface

Prefix Length: 64, Options: None

Prefix Address: 3FFE:FFFF:1::           Remote interface





# Agenda

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- **Starting from OSPFv2**
- **LSA Details**
- **OSPFv3 Revisited Concepts**
- **Configuring OSPFv3**
- **Troubleshooting Commands**

# OSPFv3 vs. OSPFv2 differences

- **Interface ID is now a 32 bit ID**
- **Hello Packet no longer contains an IP network mask**
- **DR and BDR indicated by Router ID and Interface ID**

**E-bit: the interface attaches to a non-stub area**

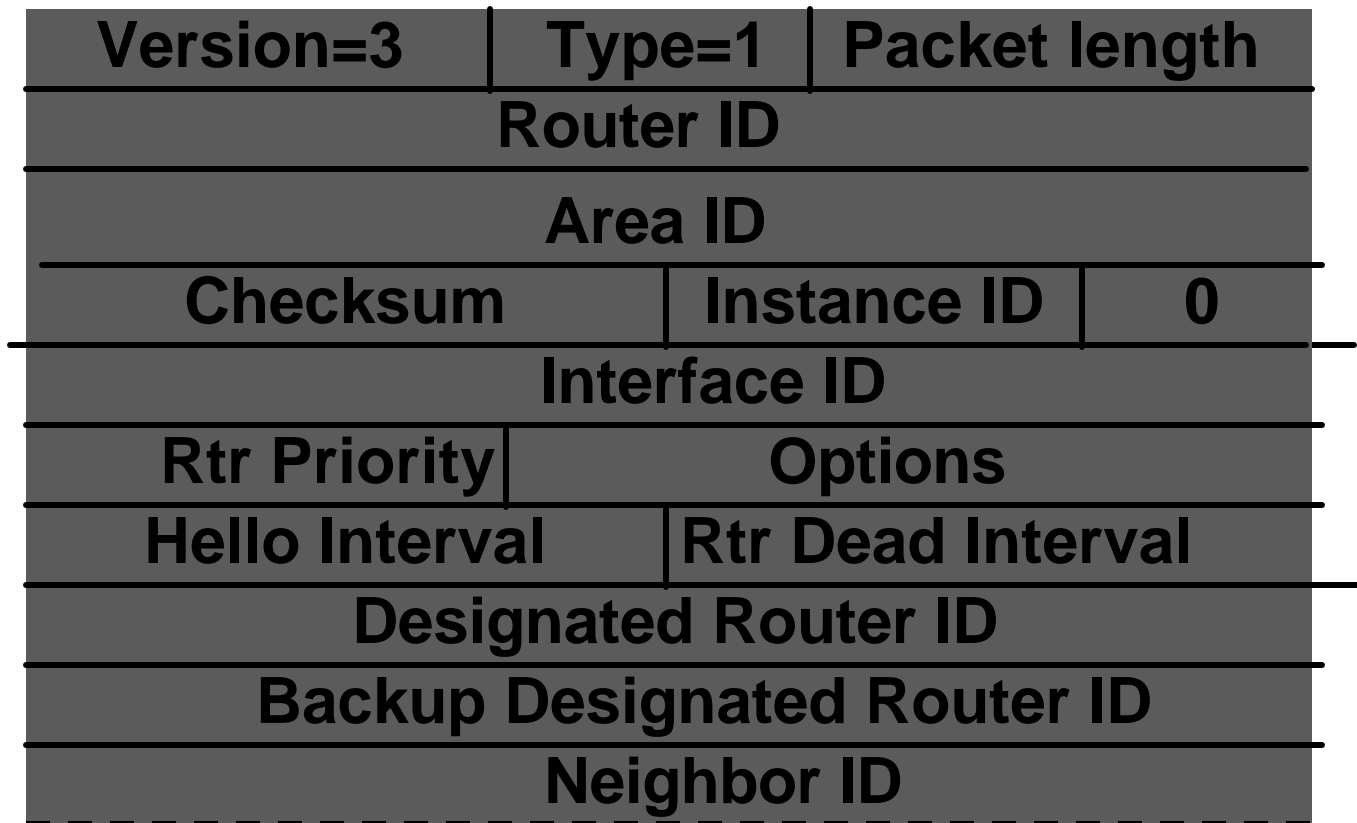
**N-bit: the interface attaches to an NSSA area**

**DC- bit: the router wishes to suppress the sending of future Hellos over the interface**

# Hello Packet

- **OSPF packet type 1**
- **Sent periodically on all interfaces in order to establish and maintain neighbor relationships**
- **Hello Packets are multicast on links that have a multicast or broadcast capability, enabling dynamic discovery of neighboring routers**
- **All routers connected to a common link must agree on certain parameters (HelloInterval and RouterDeadInterval)**

# Hello Structure



# Handling Unknown LSA

- More flexible handling of unknown LSA types
- Unknown LSA types are either treated as having link-local flooding scope (U=0), or are stored and flooded as if they were understood (U=1)

This distinction is based on LS type



- IPv4 OSPF behavior of simply discarding unknown types is unsupported, because of the desire to mix router capabilities on a single link

Discarding unknown types causes problems when the Designate Router supports fewer options than the other routers on the link

# Stub Area Support

- **Stub areas carry only router-LSAs, network-LSAs, Inter-Area-Prefix-LSAs, Link-LSAs, and Intra-Area-Prefix-LSAs**
- **IPv6 allows LSAs with unrecognized LS types to be labeled "Store and flood the LSA, as if type understood"**
- **Uncontrolled introduction of such LSAs could cause a stub area's link-state database to grow larger than its component routers' capacities**
- **LSA whose LS type is unrecognized may only be flooded into/throughout a stub area if**
  - LSA has area or Link-local flooding scope, AND**
  - LSA has U-bit set to 0**

# OSPFv3 Virtual Link Handling

- **LSA with AS flooding scope are not flooded over a virtual adjacency**
- **Site local or global scope address**
  - Used as IPv6 source for packets sent over the virtual link
- **Virtual link interface IPv6 address advertises in Intra-area-prefix-LSA to enable its discovery**
- **Virtual links are assigned with an unique interface ID**

# Unchanged Mechanisms

- **Designated router election**
- **Database description exchange**
- **Area support**
- **SPF calculations**
- **LSA aging**



# Agenda

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- **Starting from OSPFv2**
- **LSA Details**
- **OSPFv3 Revisited Concepts**
- **Configuring OSPFv3**
- **Troubleshooting Commands**

# Configuring OSPFv3 in Cisco IOS® Software

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- **Similar to OSPFv2**

- Prefixing existing Interface and Exec mode commands with “ipv6”

- **Interfaces configured directly**

- Replaces `network` command

- **“Native” IPv6 router mode**

- Not a sub-mode of `router ospf`

# Configuration Modes in OSPFv3

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- **Entering router mode**

[no] ipv6 router ospf <process ID>

- **Entering interface mode**

[no] ipv6 ospf <process ID> area <area ID>

- **Exec mode**

[no] show ipv6 ospf [<process ID>]

clear ipv6 ospf [<process ID>]

# Cisco IOS OSPFv3 Specific Attributes

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- **Configuring area range**

`[no] area <area ID> range <prefix>/<prefix length>`

- **Showing new LSA**

`show ipv6 ospf [<process ID>] database link`

`show ipv6 ospf [<process ID>] database prefix`

# Enable OSPFv3 globally

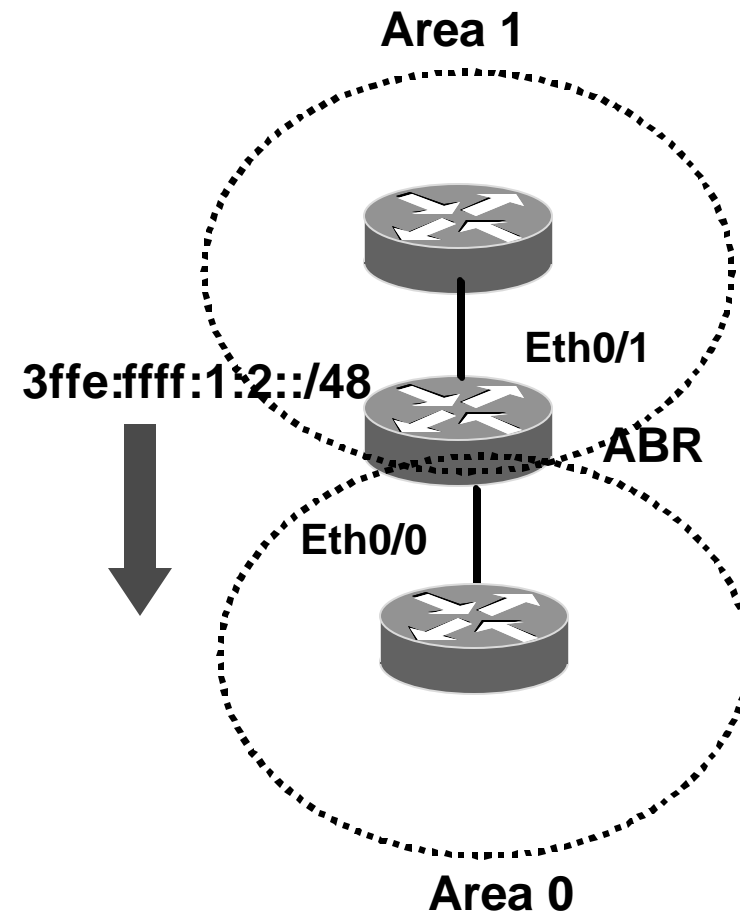
```
ipv6 unicast-routing
!
ipv6 router ospf 1
router-id 2.2.2.2
```

# Enable OSPFv3 On An Interface

```
interface Ethernet0/0
ipv6 address 3ffe:ffff:1::1/64
ipv6 ospf 1 area 0
ipv6 ospf priority 20
ipv6 ospf cost 20
```

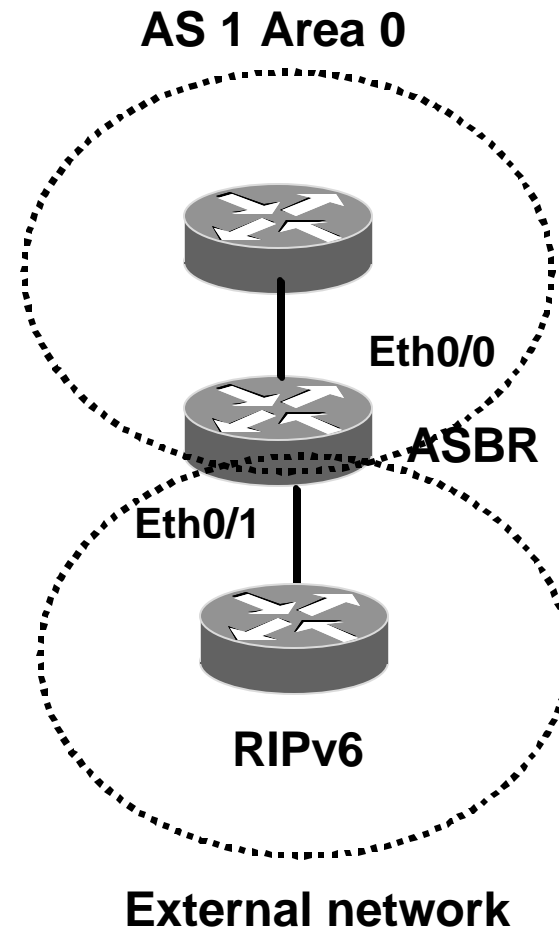
# ABR Configuration

```
ipv6 unicast-routing
!
interface Ethernet0/0
ipv6 address 3ffe:ffff:1:1::1/64
ipv6 ospf 1 area 0
!
interface Ethernet0/1
ipv6 address 3ffe:ffff:1:2::2/64
ipv6 ospf 1 area 1
!
ipv6 router ospf 1
router-id 2.2.2.2
area 1 range 3ffe:ffff:1:2::/48
```



# ASBR Configuration

```
ipv6 unicast-routing
!
interface Ethernet0/0
ipv6 address 3ffe:ffff:1:1::1/64
ipv6 ospf 1 area 0
!
interface Ethernet0/1
ipv6 address 3ffe:ffff:1:2::2/64
ipv6 rip trial1 enable
!
ipv6 router ospf 1
router-id 2.2.2.2
redistribute rip trial1 metric 20
!
ipv6 router rip trial1
```





# Agenda

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- **Starting from OSPFv2**
- **LSA Details**
- **OSPFv3 Revisited Concepts**
- **Configuring OSPFv3**
- **Troubleshooting Commands**

# Show ipv6 ospf

**R7#show ipv6 ospf**

**Routing Process "ospfv3 1" with ID 75.0.7.1**

**It is an area border and autonomous system boundary router**

**Redistributing External Routes from, connected**

**SPF schedule delay 5 secs, Hold time between two SPFs 10 secs**

**Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs**

**LSA group pacing timer 240 secs**

**Interface flood pacing timer 33 msec**

**Retransmission pacing timer 66 msec**

**Number of external LSA 3. Checksum Sum 0x12B75**

# Show ipv6 ospf (Cont.)

Number of areas in this router is 2. 1 normal 0 stub 1 nssa

## Area BACKBONE(0)

Number of interfaces in this area is 1

SPF algorithm executed 23 times

Number of LSA 14. Checksum Sum 0x760AA

Number of DCbitless LSA 0

Number of indication LSA 0

Number of DoNotAge LSA 0

Flood list length 0

## Area 2

Number of interfaces in this area is 1

It is a NSSA area

Perform type-7/type-5 LSA translation

SPF algorithm executed 17 times

Number of LSA 25. Checksum Sum 0xE3BF0

Number of DCbitless LSA 0

Number of indication LSA 0

Number of DoNotAge LSA 0

Flood list length 0

# Show ipv6 ospf interface

```
R7#show ipv6 ospf interface
```

```
Serial1/1/0 is up, line protocol is up  
Link Local Address FE80::205:DCFF:FE26:4800, Interface ID 10  
Area 0, Process ID 1, Instance ID 0, Router ID 75.0.7.1  
Network Type POINT_TO_POINT, Cost: 64  
Transmit Delay is 1 sec, State POINT_TO_POINT,  
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5  
Hello due in 00:00:00  
Index 1/1/1, flood queue length 0  
Next 0x0(0)/0x0(0)/0x0(0)  
Last flood scan length is 1, maximum is 4  
Last flood scan time is 0 msec, maximum is 0 msec  
Neighbor Count is 1, Adjacent neighbor count is 1  
Adjacent with neighbor 72.0.0.3  
Suppress hello for 0 neighbor(s)
```

# Show ipv6 ospf neighbor

```
R3#show ipv6 ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Interface ID	Interface
72.0.0.1	1	FULL/ -	00:00:35	5	Serial0/0
26.50.0.4	1	2WAY/DROTHER	00:00:30	3	FastEthernet0/0
26.50.0.3	1	FULL/BDR	00:00:30	3	FastEthernet0/0
26.50.0.1	1	FULL/DR	00:00:37	3	FastEthernet0/0

```
R3#show ipv6 ospf neighbor 26.50.0.1
```

```
Neighbor 26.50.0.1
```

```
In the area 1 via interface FastEthernet0/0
```

```
Neighbor: interface-id 3, link-local address FE80::204:C1FF:FEDA:E580
```

```
Neighbor priority is 1, State is FULL, 6 state changes
```

```
DR is 26.50.0.1 BDR is 26.50.0.3
```

```
Options is 0x822E8D91
```

```
Dead timer due in 00:00:30
```

```
Neighbor is up for 01:00:30
```

```
Index 1/1/2, retransmission queue length 0, number of retransmission 3
```

```
First 0x0(0)/0x0(0)/0x0(0) Next 0x0(0)/0x0(0)/0x0(0)
```

```
Last retransmission scan length is 1, maximum is 2
```

```
Last retransmission scan time is 0 msec, maximum is 0 msec
```

# Show ipv6 ospf database

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## Router Link States (Area 1)

ADV Router	Age	Seq#	Fragment ID	Link count	Bits
26.50.0.1	1812	0x80000048	0 1	None	
26.50.0.2	1901	0x80000006	0 1	B	

## Net Link States (Area 1)

ADV Router	Age	Seq#	Link ID	Rtr count
26.50.0.1	57	0x8000003B	3 3	4

## Inter Area Prefix Link States (Area 1)

ADV Router	Age	Seq#	Prefix
26.50.0.2	139	0x80000003	3FFE:FFFF:26::/64
26.50.0.2	719	0x80000001	3FFE:FFF:26::/64

## Inter Area Router Link States (Area 1)

ADV Router	Age	Seq#	Link ID	Dest RtrID
26.50.0.2	772	0x80000001	1207959556	72.0.0.4
26.50.0.4	5	0x80000003	1258292993	75.0.7.1

# Show ipv6 ospf database

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## Link (Type-8) Link States (Area 1)

ADV Router	Age	Seq#	Link ID	Interface
26.50.0.1	1412	0x80000031	3	Fa0/0
26.50.0.2	238	0x80000003	3	Fa0/0

## Intra Area Prefix Link States (Area 1)

ADV Router	Age	Seq#	Link ID	Ref-Istype	Ref-LSID
26.50.0.1	1691	0x8000002E	0	0x2001	0
26.50.0.1	702	0x80000031	1003	0x2002	3
26.50.0.2	1797	0x80000002	0	0x2001	0

## Type-5 AS External Link States

ADV Router	Age	Seq#	Prefix
72.0.0.4	287	0x80000028	3FFE:FFFF:A::/64
72.0.0.4	38	0x80000027	3FFE:FFFF:78::/64
75.0.7.1	162	0x80000007	3FFE:FFFF:8::/64

# Show ipv6 ospf database database-summary

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```
R3#show ipv6 ospf database database-summary
```

```
Area 0 database summary
```

LSA Type	Count	Delete	Maxage
Router	3	0	0
Network	0	0	0
Link	3	0	0
Prefix	3	0	0
Inter-area Prefix	6	0	0
Inter-area Router	0	0	0
Type-7 External	0	0	0
Subtotal	15	0	0

```
Process 1 database summary
```

LSA Type	Count	Delete	Maxage
Router	7	0	0
Network	1	0	0
Link	7	0	0
Prefix	8	0	0
Inter-area Prefix	14	0	0
Inter-area Router	2	0	0
Type-7 External	0	0	0
Type-5 Ext	3	0	0
Total	42	0	0



# Show ipv6 ospf virtual-links

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```
R3#show ipv6 ospf virtual-links
```

Virtual Link OSPF\_VL1 to router 26.50.0.4 is up

Interface ID 12, IPv6 address 3FFE:FFFF:45::

Run as demand circuit

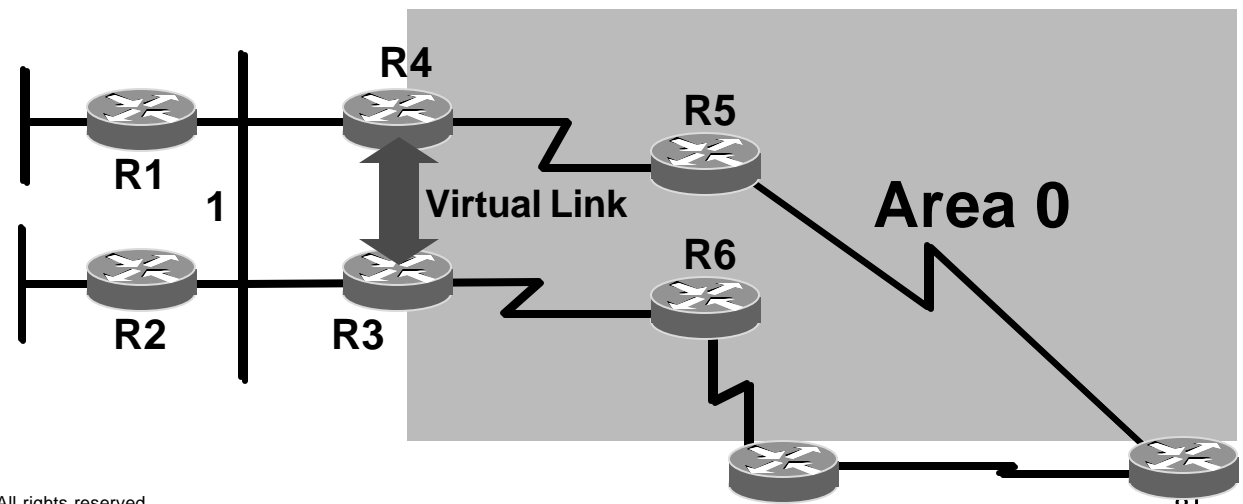
DoNotAge LSA allowed.

Transit area 1, via interface FastEthernet0/0, Cost of using 1

Transmit Delay is 1 sec, State POINT\_TO\_POINT,

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

Hello due in 00:00:04



# Show ipv6 ospf stat

## Requires Enable mode

R3#show ipv6 ospf 1 stat

Area 0: SPF algorithm executed 30 times

Area 1: SPF algorithm executed 23 times

### SPF calculation time

Delta T	SPT	Prefix	D-Int	Sum	D-Sum	Ext	D-Ext	Total	Reason
00:09:46	0	0	0	0	0	0	0	0	R N P
00:09:36	0	0	4	0	0	0	4	4	N SN
00:09:26	0	0	0	0	0	0	0	0	L
00:04:03	0	0	0	0	0	0	0	0	R SN L
00:03:53	0	0	0	0	0	0	0	0	L
00:03:49	0	0	4	0	0	0	4	4	R N SN SA X
00:03:46	0	0	4	0	0	0	4	4	R N SN SA X
00:03:36	0	0	0	0	0	0	0	0	P L
00:03:26	0	0	0	0	0	0	0	0	R SN
00:03:16	0	0	0	0	0	0	0	0	L

...

R=Router LSA; N=NetworkLSA; SN=Summary Network LSA; SA=Summary ASBR LSA; X=External LSA

# Show ipv6 ospf borders-routers

```
R3#show ipv6 ospf borders-routers
```

```
OSPFv3 Process 1 internal Routing Table
```

```
Codes: i - Intra-area route, I - Inter-area route
```

```
i 72.0.0.4 [128] via FE80::202:FCFF:FE3C:A408, Serial0/0, ABR/ASBR,  
Area 0, SPF 30
```

```
i 26.50.0.4 [1] via FE80::204:C1FF:FEDB:2B60, FastEthernet0/0, ABR, Area  
1, SPF 23
```

# Other Show Commands

```
R3#show ipv6 ospf database self-originate
```

```
OSPFv3 Router with ID (26.50.0.2) (Process ID 1)
```

```
Router Link States (Area 0)
```

ADV Router	Age	Seq#	Fragment ID	Link count	Bits
26.50.0.2	446	0x80000020	0	1	B

```
Inter Area Prefix Link States (Area 0)
```

ADV Router	Age	Seq#	Prefix
26.50.0.2	462	0x80000002	3FFE:FFFF:26::/128
26.50.0.2	446	0x80000001	3FFE:FFFF:45::/128

```
Link (Type-8) Link States (Area 0)
```

ADV Router	Age	Seq#	Link ID	Interface
26.50.0.2	446	0x80000001	12	Se0/1
26.50.0.2	1107	0x80000004	5	Se0/0

# Other Show Commands (Cont.)

```
R3#show ipv6 ospf database adv-router 72.0.0.1
```

```
OSPFv3 Router with ID (26.50.0.2) (Process ID 1)
```

```
Router Link States (Area 0)
```

ADV Router	Age	Seq#	Fragment ID	Link count	Bits
72.0.0.1	1058	0x800000FE	0	2	None

```
Link (Type-8) Link States (Area 0)
```

ADV Router	Age	Seq#	Link ID	Interface
72.0.0.1	1279	0x8000002D	5	Se0/0

```
Intra Area Prefix Link States (Area 0)
```

ADV Router	Age	Seq#	Link ID	Ref-Istype	Ref-LSID
72.0.0.1	1284	0x80000032	0	0x2001	0

# OSPFv3 Debug Commands

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- **Adjacency is not appearing**

[no] debug ipv6 ospf adj

[no] debug ipv6 ospf hello

- **SPF is running constantly**

[no] debug ipv6 ospf spf

[no] debug ipv6 ospf flooding

[no] debug ipv6 ospf events

[no] debug ipv6 ospf lsa-generation

[no] debug ipv6 ospf database-timer

- **General purpose**

[no] debug ipv6 ospf packets

[no] debug ipv6 ospf retransmission

[no] debug ipv6 ospf tree

# Debug ipv6 ospf adj (PtoP)

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```
01:29:34: OSPFv3: 2 Way Communication to 72.0.0.1 on Serial0/0, state 2WAY
01:29:34: OSPFv3: Send DBD to 72.0.0.1 on Serial0/0 seq 0x8C0 opt 0x0013 flag 0x7 len 28
01:29:34: OSPFv3: Rcv DBD from 72.0.0.1 on Serial0/0 seq 0x1589 opt 0x0013 flag 0x7 len 28 mtu 1500 state
EXSTART
01:29:34: OSPFv3: NBR Negotiation Done. We are the SLAVE
01:29:34: OSPFv3: Send DBD to 72.0.0.1 on Serial0/0 seq 0x1589 opt 0x0013 flag 0x2 len 368
01:29:34: OSPFv3: Rcv DBD from 72.0.0.1 on Serial0/0 seq 0x158A opt 0x0013 flag 0x3 len 388 mtu 1500 state
EXCHANGE
01:29:34: OSPFv3: Send DBD to 72.0.0.1 on Serial0/0 seq 0x158A opt 0x0013 flag 0x0 len 28
01:29:34: OSPFv3: Database request to 72.0.0.1
01:29:34: OSPFv3: sent LS REQ packet to FE80::202:FCFF:FE3C:A408, length 48
01:29:34: OSPFv3: Rcv DBD from 72.0.0.1 on Serial0/0 seq 0x158B opt 0x0013 flag 0x1 len 28 mtu 1500 state
EXCHANGE
01:29:34: OSPFv3: Exchange Done with 72.0.0.1 on Serial0/0
01:29:34: OSPFv3: Send DBD to 72.0.0.1 on Serial0/0 seq 0x158B opt 0x0013 flag 0x0 len 28
01:29:34: OSPFv3: Synchronized with 72.0.0.1 on Serial0/0, state FULL
01:29:34: %OSPFv3-5-ADJCHG: Process 1, Nbr 72.0.0.1 on Serial0/0 from LOADING to FULL, Loading Done
```

# Debug ipv6 ospf (LAN)

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```
01:34:08: OSPFv3: Rcv DBD from 26.50.0.3 on FastEthernet0/0 state INIT
01:34:08: OSPFv3: 2 Way Communication to 26.50.0.3 on FastEthernet0/0, state
2WAY
01:34:14: OSPFv3: DR/BDR election on FastEthernet0/0
01:34:14: OSPFv3: Elect BDR 26.50.0.3
01:34:14: OSPFv3: Elect DR 26.50.0.1
01:34:14:    DR: 26.50.0.1 (Id)  BDR: 26.50.0.3 (Id)
01:34:14: OSPFv3: Send DBD to 26.50.0.3 on FastEthernet0/0
01:34:14: OSPFv3: Rcv DBD from 26.50.0.1 on FastEthernet0/0 state EXSTART
01:34:14: OSPFv3: sent LS REQ packet to FE80::204:C1FF:FEDA:E580, length 72
01:34:14: OSPFv3: Rcv DBD from 26.50.0.1 on FastEthernet0/0 state EXCHANGE
01:34:14: OSPFv3: Exchange Done with 26.50.0.1 on FastEthernet0/0
01:34:14: OSPFv3: Synchronized with 26.50.0.1 on FastEthernet0/0, state FULL
01:34:14: %OSPFv3-5-ADJCHG: Process 1, Nbr 26.50.0.1 on FastEthernet0/0 from
LOADING to FULL, Loading Done
01:34:28: OSPFv3: Interface OSPF_VL1 going Up
```



# OSPF Log-Adjacency-Changes

```
R3#config terminal
R3(config)#ipv6 router ospf 1
R3(config-router)#log-adjacency-changes
```

```
01:39:55: %OSPFv3-5-ADJCHG: Process 1, Nbr 26.50.0.4 on FastEthernet0/0 from
2WAY to DOWN, Neighbor Down: Interface down or detached
```

```
01:39:55: %OSPFv3-5-ADJCHG: Process 1, Nbr 26.50.0.3 on FastEthernet0/0 from
FULL to DOWN, Neighbor Down: Interface down or detached
```

```
01:39:55: %OSPFv3-5-ADJCHG: Process 1, Nbr 26.50.0.1 on FastEthernet0/0 from
FULL to DOWN, Neighbor Down: Interface down or detached
```

```
01:40:24: %OSPFv3-5-ADJCHG: Process 1, Nbr 26.50.0.3 on FastEthernet0/0 from
LOADING to FULL, Loading Done
```

```
01:40:29: %OSPFv3-5-ADJCHG: Process 1, Nbr 26.50.0.1 on FastEthernet0/0 from
LOADING to FULL, Loading Done
```

# Summary: What Have We Learned?

- **Key differences between OSPFv2 and OSPFv3**
- **How to look at the specific LSAs in the database in detail**
- **OSPFv3 specificities**
- **Different troubleshooting commands and what to look for in those commands**

# Cisco IOS Software Availability

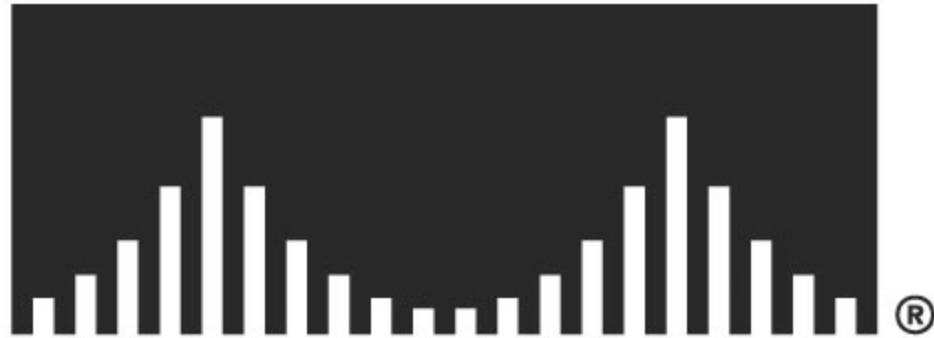
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- **Release 12.2(15)T**
- **Release 12.2(RLS3)S for Cisco 7x00 Series Routers and Cisco Catalyst 6000 Series Switches**
- **Release 12.0(24)S the Cisco 12000 Series Internet Routers**

# References

- **RFC 2740 “OSPF for IPv6”**
- **RFC 2328 “OSPF version 2”**
- **RFC 1587 “NSSA”**
- **RFC 2373 “IP Version 6 Addressing Architecture”**
- **RFC 2460 “Internet Protocol, Version 6 (IPv6) Spec”**
- **RFC 3041 “Extensions to IPv6 Address Autoconfiguration”**

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