

ISIS for IPv6



AfNOG 2011 AR-E Workshop

Topics Covered

- IS-IS standardisation
- IS-IS for IPv6
- Multi-Topology IS-IS

ISIS Standards History

- ❑ IETF ISIS for IP Internets Working Group
- ❑ ISO 10589 specifies OSI IS-IS routing protocol for CLNS traffic
 - Tag/Length/Value (TLV) options to enhance the protocol
 - A Link State protocol with a 2 level hierarchical architecture.
- ❑ RFC 1195 added IP support, also known as Integrated IS-IS (I/IS-IS)
 - I/IS-IS runs on top of the Data Link Layer
 - Requires CLNP to be configured

ISIS Standards History

- RFC5308 adds IPv6 address family support to IS-IS
- RFC5120 defines Multi-Topology concept for IS-IS
 - Permits IPv4 and IPv6 topologies which are not identical
 - Permits gradual roll out of IPv6 without impacting IPv4 operations

Integrated IS-IS for IPv6 Overview

- ❑ 2 Tag/Length/Values (TLV) added to support IPv6 routing
- ❑ IPv6 Reachability TLV (0xEC)
 - Describes network reachability such as IPv6 routing prefix, metric information and some option bits; the option bits indicates the advertisement of IPv6 prefix from a higher level, redistribution from other routing protocols.
 - Equivalent to IP Internal/External Reachability TLVs described in RFC1195

Integrated IS-IS for IPv6 Overview

- ❑ IPv6 Interface Address TLV (0xE8)
 - Contains 128 bit address
 - For Hello PDUs, must contain the link-local address (FE80::/10)
 - For LSP, must only contain the non link-local address
- ❑ A new Network Layer Protocol Identifier (NLPID) is defined
 - Allowing IS-IS routers with IPv6 support to advertise IPv6 prefix payload using 0x8E value (IPv4 and OSI uses different values)

ISIS for IPv6



IS-IS for IPv6

- ❑ IS-IS for IPv6 is available across all Cisco IOS releases
- ❑ A single SPF runs per level for OSI, IPv4 and IPv6
 - All routers in an area must run the same set of protocols [IPv4-only, IPv6-only, IPv4-IPv6]
 - L2 routers don't have to be configured similarly but no routing hole must exist

Simple SPF rules (1)

- If IS-IS is used for both IPv4 and IPv6 in an area, both protocols must support the same topology within this area.
 - Could set “no adjacency-check” between L2 routers, but must be used with caution
- All interfaces configured with IS-ISv6 must support IPv6
 - Can't be configured on DPT as it is not supported
 - Can't be configured on MPLS/TE since IS-ISv6 extensions for TE are not yet defined

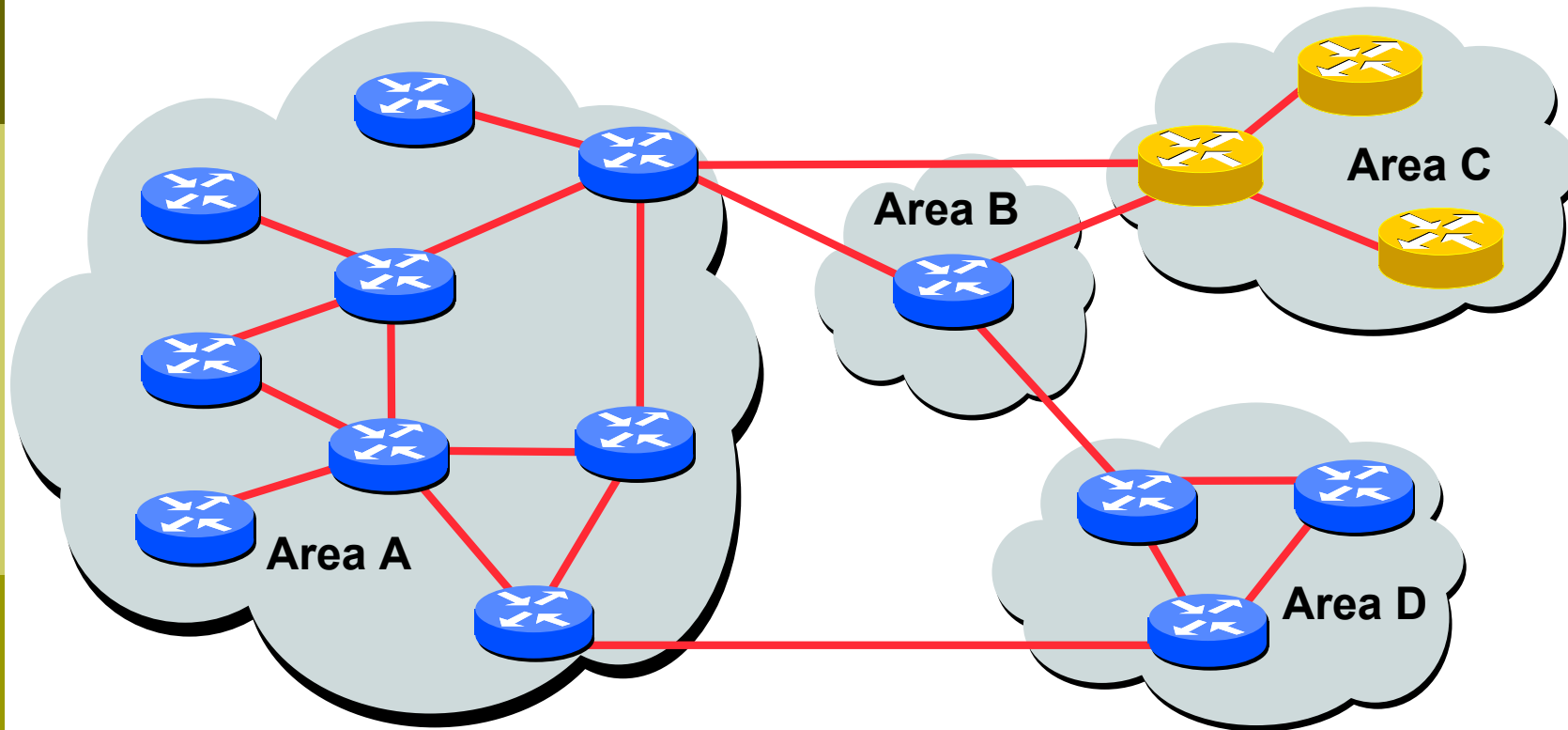
Simple SPF rules (2)

- All interfaces configured with IS-IS for both protocols must support both of them
 - IPv6 configured tunnel won't work, GRE should be used in this configuration
- Otherwise, consider Multi-Topology IS-IS (separate SPF)

Single SPF IS-IS for IPv6 restrictions

- ❑ IS-IS for IPv6 uses the same SPF for both IPv4 and IPv6.
- ❑ Therefore:
 - Not really suitable for an existing IPv4 IS-IS network where customer wants to turn on scattered IPv6 support.
 - If using IS-IS for both IPv4 and IPv6 then the IPv4 and IPv6 topologies MUST match exactly. Cannot run IS-IS IPv6 on some interfaces, IS-IS IPv4 on others.
 - Will only form adjacencies with similarly-configured routers. E.g. An IS-IS IPv6-only router will not form an adjacency with an IS-IS IPv4/IPv6 router. (Exception is over L2-only interface)
 - Cannot join two IPv6 areas via an IPv4-only area. L2 adjacencies will form OK but IPv6 traffic will black-hole in the IPv4 area.

IS-IS Hierarchy & IPv6 example



 IPv4-IPv6 enabled router

 IPv4-only enabled router

Configuring IS-IS for IPv6

- ❑ Configure generic IS-IS interface attributes
 - eg., circuit type, priority, etc
- ❑ Configure IS-IS for IPv6 on interfaces
 - Interface must be IPv6 enabled, eg. IPv6 address set
- ❑ Configure IS-IS router mode attributes
 - Some router-mode commands have no effect on IPv6, eg. Metric-style, mpls, traffic-share,...
- ❑ Configure IS-IS for IPv6 specific attributes
 - IPv6 attributes are configured via the IPv6 address-family sub-mode of router-mode.

IS-IS for IPv6

Specific Attributes (1)

- ❑ Entering address-family sub-mode

 - `[no] address-family ipv6`

- ❑ IPv6 address-family sub-mode.

 - `[no] adjacency-check`

 - Enables or disables adjacency IPv6 protocol-support checks. If checking is enabled (default condition when IS-IS IPv6 is configured) then the router will not form an adjacency with a neighbor not supporting IS-IS IPv6.

 - `[no] distance <1-254>`

 - Sets the administrative distance of IS-IS IPv6. Note that the administrative distance is applied to routes in the IPv6 routing table only.

IS-IS for IPv6

Specific Attributes (2)

[no] maximum-paths <1-4>

- Sets the maximum number of paths allowed for a route learnt via IS-IS IPv6. Note that this applies to the IPv6 routing table only.

[no] default-information originate [route-map <name>]

- Configures origination of the IPv6 default route (:::) by IS-IS. Used in the same manner as the existing IPv4 default-information command.

[no] summary-prefix <prefix> [level-1|level-2|level-1-2]

- Configures IPv6 summary prefixes. Command is used in same manner as the existing IPv4 summary-prefix command.

IS-IS for IPv6

Specific Attributes (3)

```
[no] redistribute <protocol> [metric <value>]  
    [metric-type {internal|external}] [level-  
    1|level-1-2|level-2] [route-map <name>]
```

- Configures redistribution of routes learnt from other IPv6 sources into IS-IS. Command is used in same manner as existing IPv4 redistribute command.

```
[no] redistribute isis {level-1|level-2} into  
    {level-1|level-2} distribute-list <prefix-list-  
    name>
```

- Configures IS-IS inter-area redistribution of IPv6 routes. Command is used in same manner as existing IPv4 redistribute isis command.

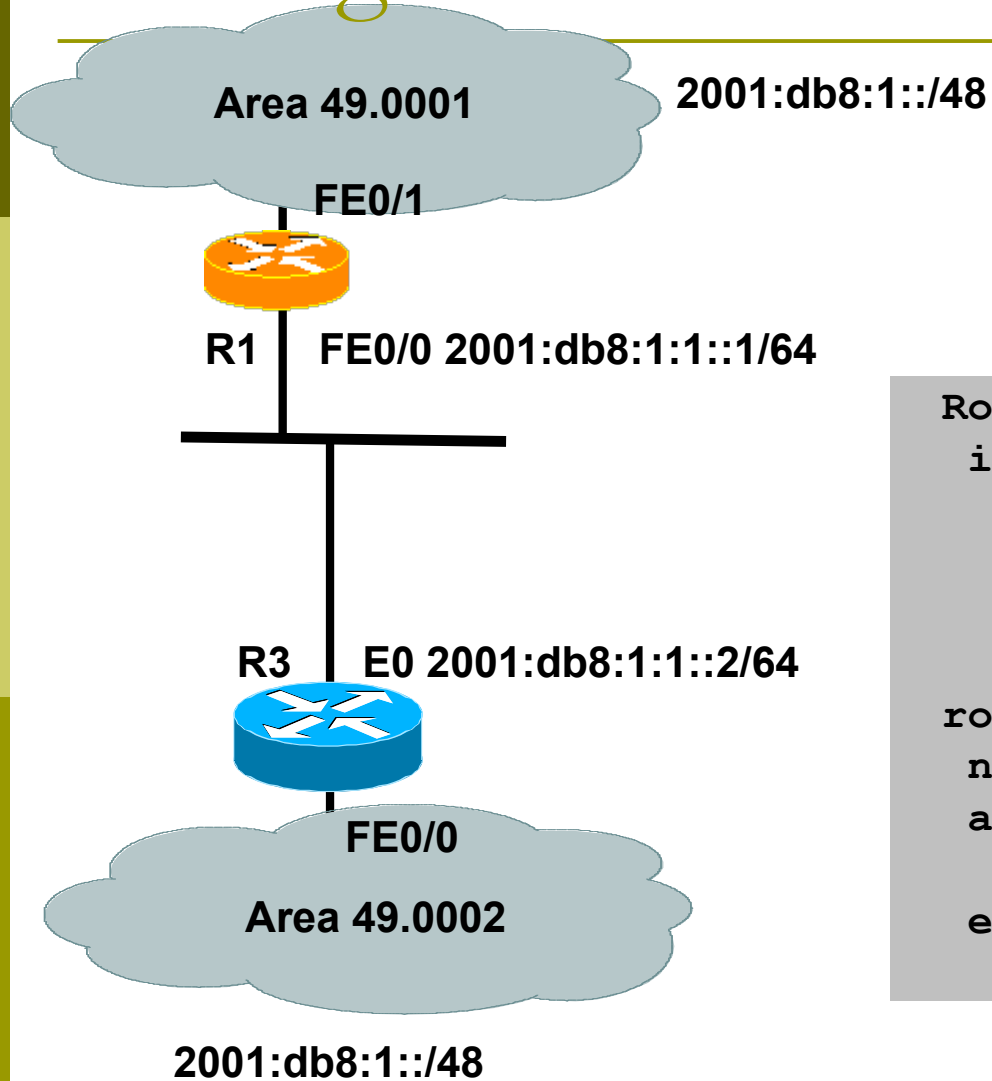
- Leaving address-family sub-mode

```
exit-address-family
```

- Showing the I/IS-ISv6 configuration

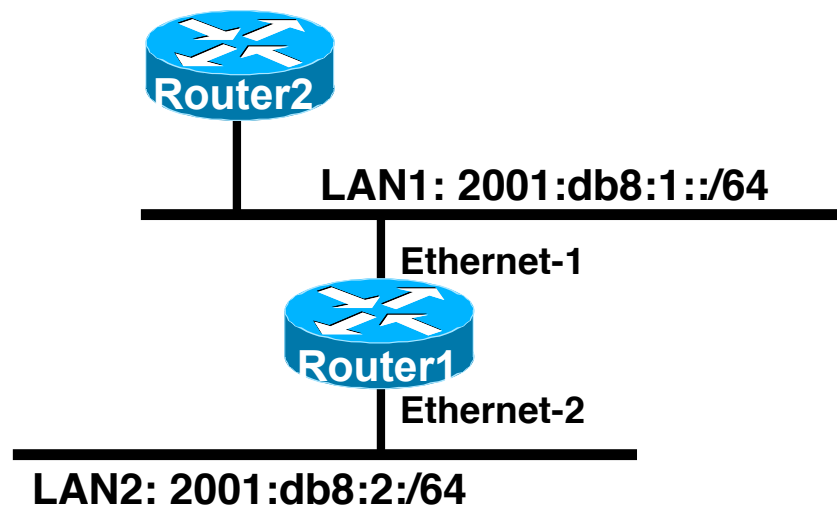
```
show ipv6 protocols [summary]
```


ISIS for IPv6 Configuration Example



```
Router1#  
interface fastethernet0/0  
  ipv6 address 2001:db8:1:1::1/64  
  ipv6 router isis  
  isis circuit-type level-2-only  
  
router isis  
  net 49.0001.1921.6801.0001.00  
  address-family ipv6  
  redistribute static  
  exit-address-family
```

IS-IS dual stack configuration



**Dual IPv4/IPv6 configuration.
Redistributing both IPv6 static routes
and IPv4 static routes.**

```
Router1#
interface ethernet-1
 ip address 10.1.1.1 255.255.255.0
 ipv6 address 2001:db8:1::1/64
 ip router isis
 ipv6 router isis

interface ethernet-2
 ip address 10.2.1.1 255.255.255.0
 ipv6 address 2001:db8:2::1/64
 ip router isis
 ipv6 router isis

router isis
 address-family ipv6
  redistribute static
 exit-address-family
 net 42.0001.0000.0000.072c.00
 redistribute static
```

ISIS Display (1)

```
Router1#show ipv6 route is-is
IPv6 Routing Table - 14 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
Timers: Uptime/Expires

I1  2001:DB8:1000::/64 [115/20]
     via FE80::210:7BFF:FEC2:ACCC, Ethernet1, 00:10:12/never
I1  2001:DB8:2000::/64 [115/10]
     via FE80::210:7BFF:FEC2:ACCC, Ethernet1, 00:05:19/never
I1  2002:49::/64 [115/10]
     via FE80::210:7BFF:FEC2:ACCC, Ethernet1, 00:05:19/never
```

ISIS Display (2)

```
Router3#sho clns is-neigh detail
```

```
System Id      Interface  State  Type Priority  Circuit Id      Format
brum-45a      Et1       Up     L1    64        router3.01     Phase V
Area Address(es): 47.0023.0001.0000.0001.0002.0001
IPv6 Address(es): FE80::210:7BFF:FEC2:ACCC
Uptime: 00:06:56
```

```
IS-IS Level-1 Link State Database:
```

```
LSPID          LSP Seq Num  LSP Checksum  LSP Holdtime  ATT/P/OL
router3.00-00  * 0x00000003  0xA745        732           0/0/0
Area Address: 47.0023.0001.0000.0001.0002.0001
NLPID:         0x8E
Hostname: Router3
IPv6 Address: 3F02::45C
IPv6 Address: 2001:db8:2000::45C
Metric: 10     IPv6 2001:db8:1000::/64
Metric: 10     IPv6 3F02::/64
Metric: 10     IPv6 2001:db8:2000::/64
Metric: 10     IS router3.02
Metric: 10     IS router3.01
router3.01-00  * 0x00000001  0x96DB        733           0/0/0
Metric: 0      IS router3.00
Metric: 0      IS router1.00
router1.00-00  0x00000005  0xDDBA        1027          0/0/0
Area Address: 47.0023.0001.0000.0001.0002.0001
NLPID:         0x8E
Hostname: Router1
IPv6 Address: 2001:db8:1000::45A
Metric: 10     IPv6 2001:db8:1000::/64
Metric: 10     IS router3.01
Metric: 0      IPv6-Ext 2001:db8:2000::/64
Metric: 0      IPv6-Ext 2002:49::/64
```

Multi-topology ISIS



Multi-Topology IS-IS extensions

- ❑ IS-IS for IPv6 assumes that the IPv6 topology is the same as the IPv4 topology
 - Single SPF running, multiple address families
 - Some networks may be like this, but many others are not
- ❑ Multi-Topology IS-IS solves this problem
 - New TLV attributes introduced
 - New Multi-Topology ID #2 for IPv6 Routing Topology
 - Cisco IOS now maintains two topologies:
 - ❑ ISO/IPv4 Routing Topology
 - ❑ IPv6 Routing Topology

Multi-Topology IS-IS extensions

- New TLVs attributes for Multi-Topology extensions.
 - Multi-topology TLV: contains one or more multi-topology ID in which the router participates. It is theoretically possible to advertise an infinite number of topologies. This TLV is included in IIH and the first fragment of a LSP.
 - MT Intermediate Systems TLV: this TLV appears as many times as the number of topologies a node supports. A MT ID is added to the extended IS reachability TLV type 22.
 - Multi-Topology Reachable IPv4 Prefixes TLV: this TLV appears as many times as the number of IPv4 announced by an IS for a given MT ID. Its structure is aligned with the extended IS Reachability TLV Type 236 and add a MT ID.
 - Multi-Topology Reachable IPv6 Prefixes TLV: this TLV appears as many times as the number of IPv6 announced by an IS for a given MT ID. Its structure is aligned with the extended IS Reachability TLV Type 236 and add a MT ID.
- Multi-Topology ID Values
 - Multi-Topology ID (MT ID) standardized and in use in Cisco IOS:
 - MT ID #0 – “standard” topology for IPv4/CLNS
 - MT ID #2 – IPv6 Routing Topology.

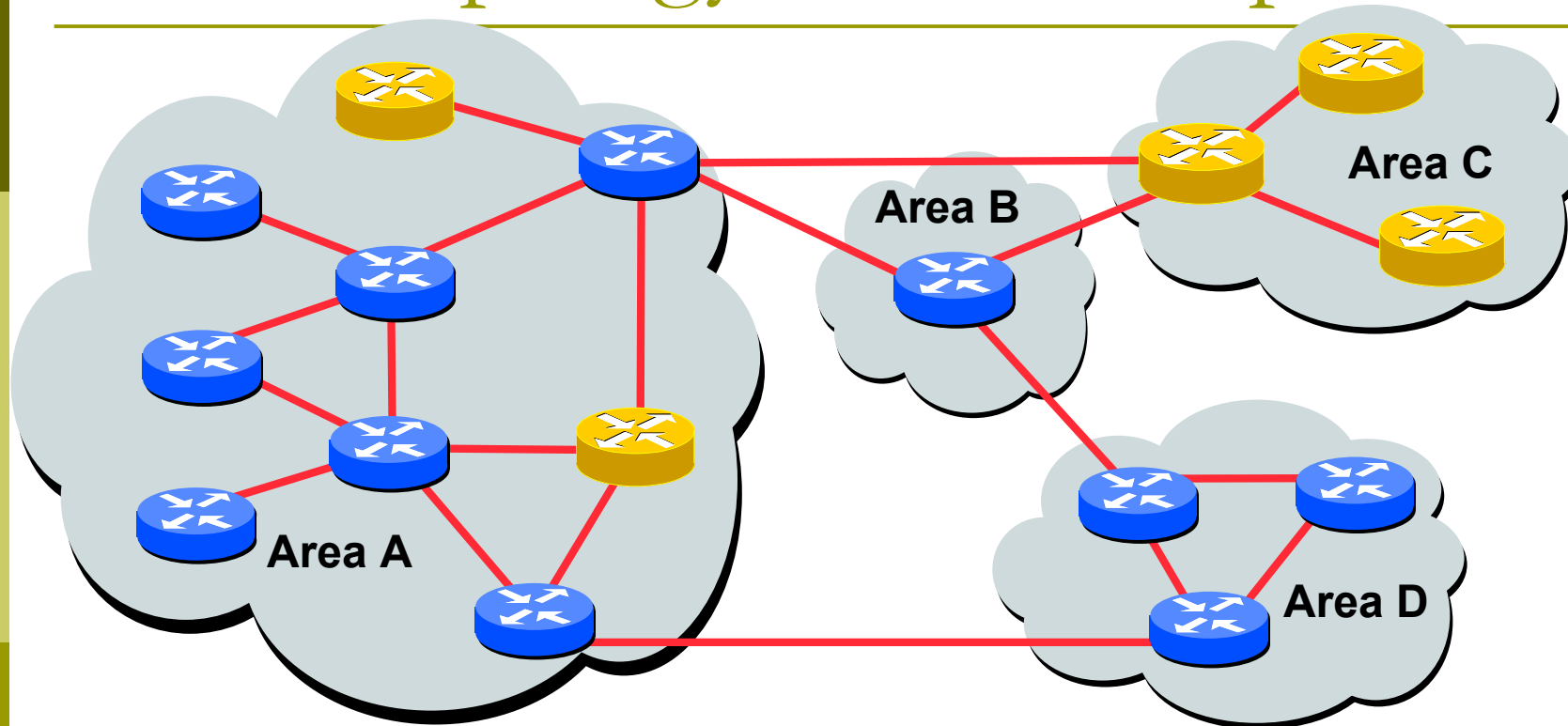
Multi-Topology IS-IS Restrictions



- ❑ This feature is not compatible with the previous single SPF model, as new TLV are used to transmit and advertise IPv6 capabilities.
 - All routers that run IS-IS for IPv6 need to enable multi-topology within the network.
 - A transition mode (refer to documentation) is provided for existing IS-IS IPv6 network to migrate to Multi-Topology IS-IS IPv6.
- ❑ IPv4, IPv6, or IPv4/IPv6 may be configured on the interface for either level-1 level-2 or level-1-2. But if IPv4 and IPv6 are configured on the same interface, they must be running the same IS-IS level
 - IPv4 cannot be configured to run on ISIS level-1 only on an interface while IPv6 is configured to run ISIS level-2₂₄ only on the same interface.

Multi-Topology IS-IS Restrictions

- ❑ All routers on a LAN or point to point link must have at least one common supported topology (IPv4 or IPv6) when operating in Multi-Topology IS-IS mode
 - N.B. a router that is not operating in Multi-Topology IS-IS IPv6 mode cannot form adjacency with Multi-Topology IS-IS IPv6 router, even though IPv6 is the common supported topology. However, if IPv4 is the common supported topology between those two routers, adjacency should be formed.
- ❑ Wide metrics are required to be enabled globally on the Autonomous System to run

Multi-Topology IS-IS example



-  IPv4-IPv6 enabled router
-  IPv4-only enabled router

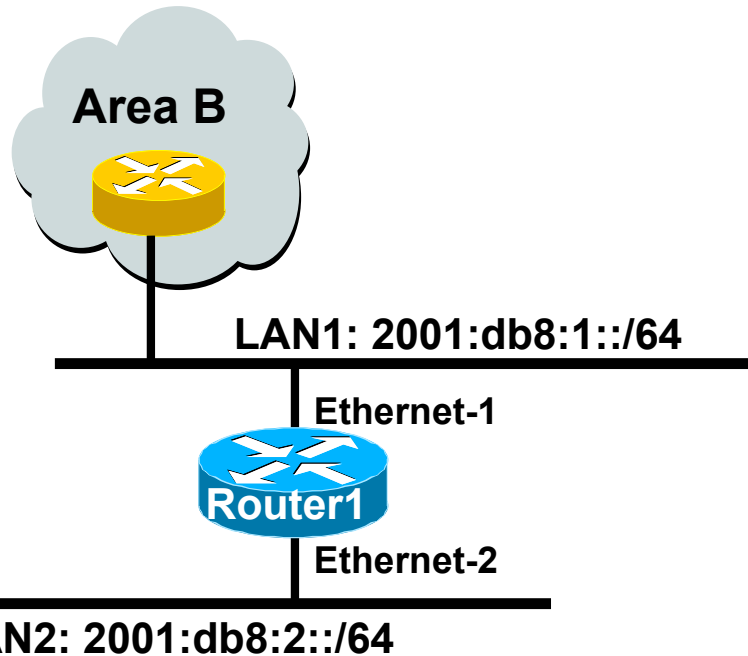
The Multi-Topology software will create two topologies inside Area:

IPv4 and IPv6.

IPv4-only routers will be excluded from the IPv6 topology

Multi-Topology ISIS

Configuration example



- ❑ The optional keyword **transition** may be used for transitioning existing IS-IS IPv6 single SPF mode to MT IS-IS
- ❑ Wide metric is mandated for Multi-Topology to work

```
Router1#
interface Ethernet 1
 ip address 10.1.1.1 255.255.255.0
 ipv6 address 2001:db8:1::1/64
 ip router isis
 ipv6 router isis
 isis ipv6 metric 20

interface Ethernet 2
 ip address 10.2.1.1 255.255.255.0
 ipv6 address 2001:db8:2::1/64
 ip router isis
 ipv6 router isis
 isis ipv6 metric 20

router isis isp
 net 49.0000.0100.0000.0000.0500
 metric-style wide
 !
 address-family ipv6
 multi-topology
 exit-address-family
```

Narrow to Wide Metrics Transition

- ❑ When migrating from narrow to wide metrics, care is required
 - Narrow and wide metrics are NOT compatible with each other
 - Migration is a two stage process, using the “transition” keyword
- ❑ Networks using narrow metrics should first configure across all routers:

```
router isis isp  
metric-style transition
```

- ❑ Once the whole network is changed to transition support, the metric style can be changed to wide:

```
router isis isp  
metric-style wide
```

Multi-Topology IS-IS Display

```
Router# show clns neighbors detail
```

System Id	Interface	SNPA	State	Holdtime	Type	Protocol
2653	Se0/1	*HDLC*	Up	25	L1L2	M-ISIS

Area Address(es): 49.0000.01
IP Address(es): 192.168.0.6*
IPv6 Address(es): FE80::204:C1FF:FEDB:2FA0
Uptime: 00:01:22
Topology: IPv4, IPv6

```
Router# show isis database detail
```

```
IS-IS Level-2 Link State Database:
```

LSPID	LSP Seq Num	LSP Checksum	LSP Holdtime	ATT/P/OL
2651.00-00	0x0000000F	0x0161	1066	0/0/0

Area Address: 49.0000.01
Topology: IPv4 (0x0) IPv6 (0x2)
NLPID: 0xCC 0x8E
Hostname: 2651
IP Address: 192.168.0.2
IPv6 Address: 2001:db8:2::1
Metric: 10 IS-Extended 2652.00
Metric: 10 IS-Extended 2653.01
Metric: 10 IS (MT-IPv6) 2653.01
Metric: 10 IP 192.168.0.0/30
Metric: 20 IP 192.168.0.4/30
Metric: 10 IP 192.168.1.0/24
Metric: 20 IPv6 (MT-IPv6) 2001:db8:1::/64
Metric: 10 IPv6 (MT-IPv6) 2001:db8:2::/64

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