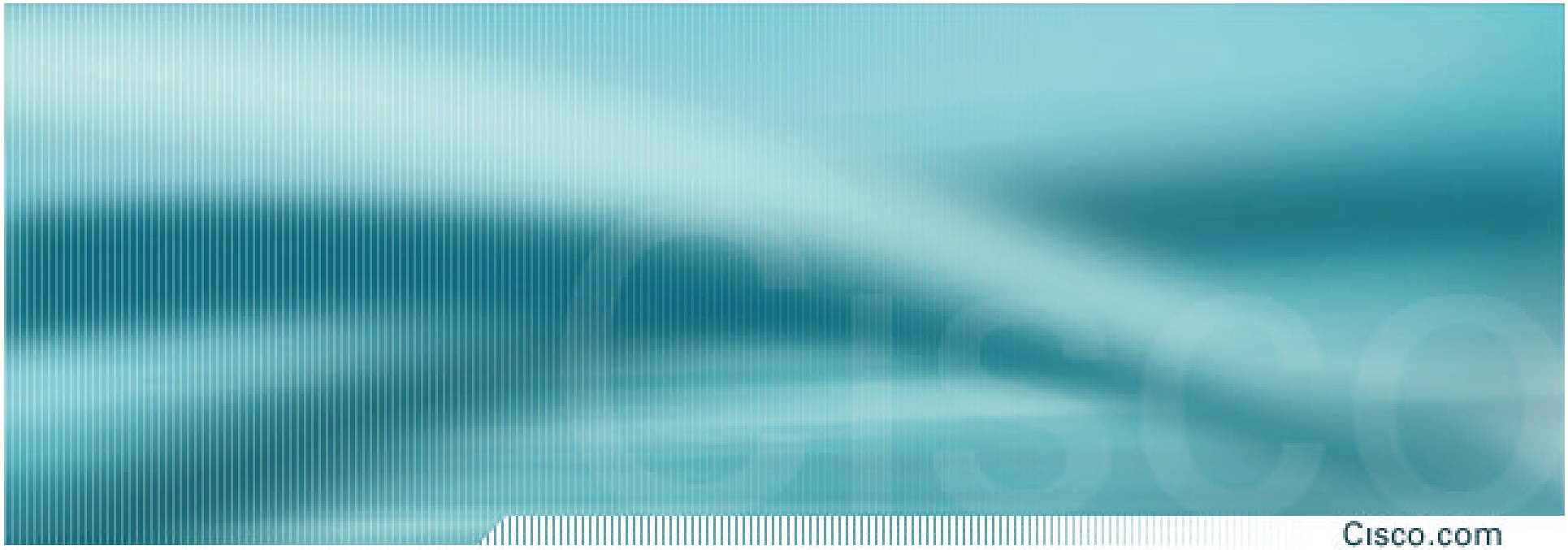

Cisco IOS IS-IS for IPv6

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Agenda

- IS-IS standardization
- Cisco IOS IS-IS for IPv6
- Cisco IOS Multi-Topology IS-IS

IPv6 Routing Protocols

- **Same “longest-prefix match” routing as IPv4 CIDR**
- **Two Different Classes**
  - **Link-State (i.e., OSPF, ISIS, etc.)**
  - **Distance-Vector (i.e., RIP, IGRP, etc.)**
- **Autonomous System / Routing Domain**
  - **Interior Gateway Protocols (IGPs)**
    - **i.e., OSPFv3, ISIS for IPv6, RIPng, EIGRP for IPv6**
  - **Exterior Gateway Protocols (EGPs)**
    - **Multi-Protocol Extensions for BGP4**

IS-IS Standards

- IETF IS-IS for IP Internets WG

  http://www.ietf.org/html.charters/isis-charter.html

- 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

- Draft RFC defines how to add IPv6 address family support to IS-IS

  http://www.ietf.org/internet-drafts/draft-ietf-isis-ipv6-05.txt

- Draft RFC introduces Multi-Topology concept for IS-IS

  http://www.ietf.org/internet-drafts/draft-ietf-isis-wg-multi-topology-06.txt

IS-IS for IPv6

- 2 Tag/Length/Values added to introduce IPv6 routing
- IPv6 Reachability TLV (0xEC)
  - External bit
  - Equivalent to IP Internal/External Reachability TLV's
- IPv6 Interface Address TLV (0xE8)
  - For Hello PDUs, must contain the Link-Local address
  - For LSP, must only contain the non-Link Local address
- IPv6 NLPID (0x8E) is advertised by IPv6 enabled routers

Agenda

- IS-IS standardization
- Cisco IOS IS-IS for IPv6
- Cisco IOS Multi-Topology IS-IS

Cisco IOS IS-IS for IPv6

- IS-IS for IPv6 was introduced across Cisco IOS releases
  - 12.2(8)T and above as well as Cisco 12.3M on Cisco 2600 to Cisco 7500 series
  - 12.0(22)S and above on Cisco 12000
  - 12.2(14)S and above on Cisco 7x00 series and Cat.6K [12.2SX]
  - Images are –p and –js as CLNS is required for IS-IS
- 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 may not be configured similarly but no routing hole must exist

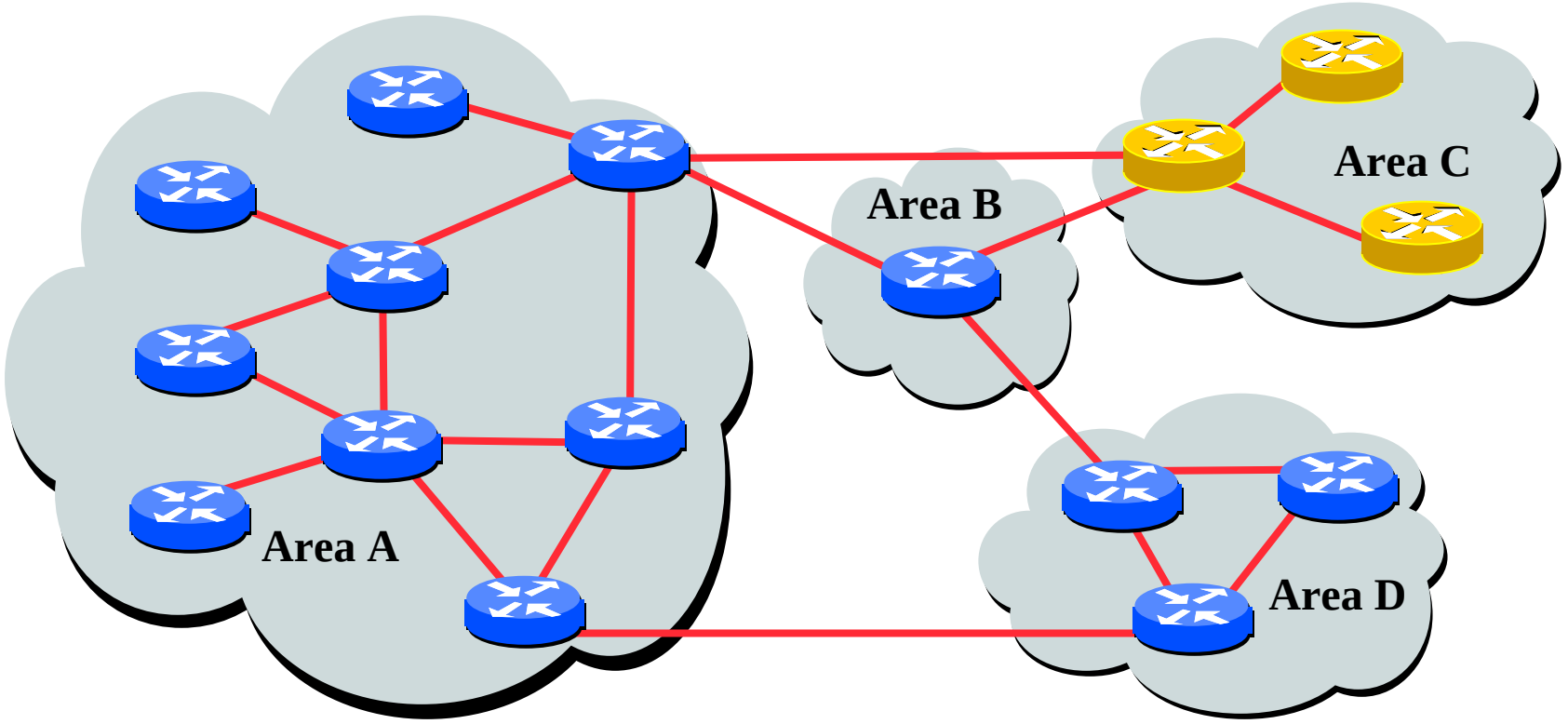
Single SPF rules

- 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 yet supported
  - Can’t be configured on MPLS/TE since IS-ISv6 extensions for TE are not yet defined
- 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 enable router

IPv4-only enable router

Configuring IS-IS for IPv6 on Cisco IOS

- **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.

Cisco IOS IS-IS for IPv6 Specific Attributes

- **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.

  [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.

Cisco IOS IS-IS for IPv6 Specific Attributes

[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.

[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.

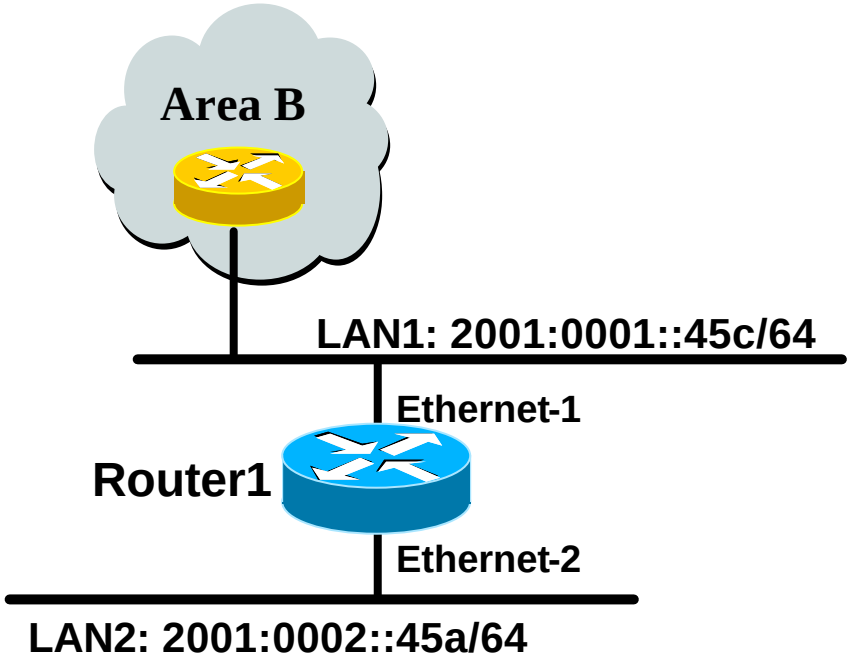
- **Leaving address-family sub-mode**

  exit-address-family

- **Showing the I/IS-ISv6 configuration**

  Show ipv6 protocols [summary]

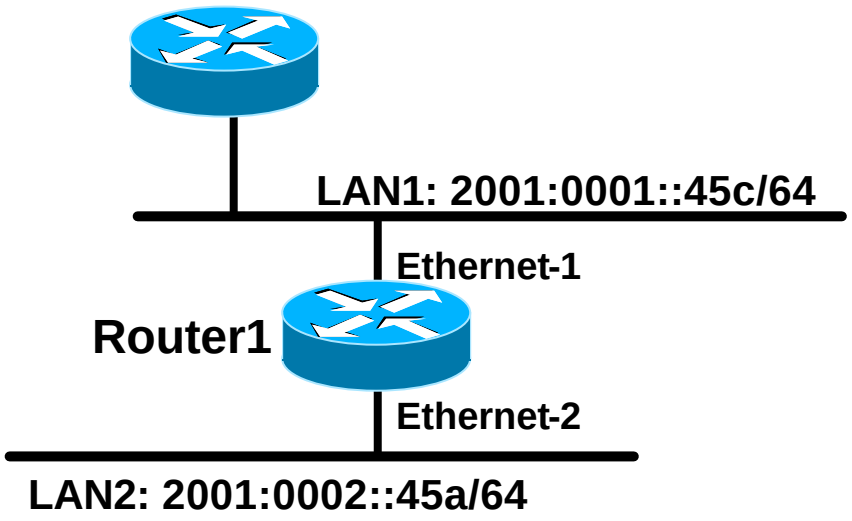
Cisco IOS IS-IS for IPv6-only configuration example



IPv6-only configuration.
Redistributing IPv6 static routes.

```
Router1#
 interface ethernet-1
     ipv6 address 2001:0001::45c/64
     ipv6 router isis
     isis circuit-type level-2-only

  interface ethernet-2
     ipv6 address 2001:0002::45a/64
     ipv6 router isis

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

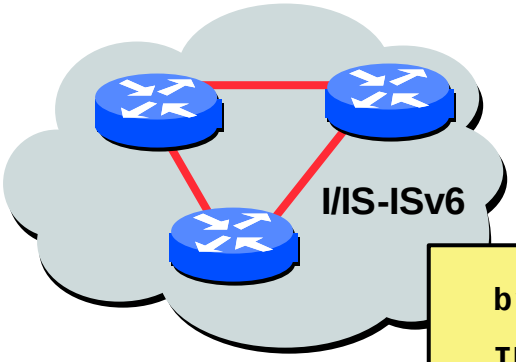
Cisco IOS IS-IS dual IP configuration



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 2001:0001::45c/64
     ip router isis
     ipv6 router isis

  interface ethernet-2
     ip address 10.2.1.1 255.255.255.0
     ipv6 address 2001:0002::45a/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
```

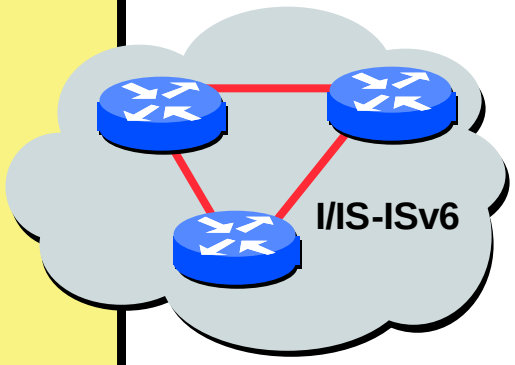
Cisco IOS IS-IS Display (1)




```
brum-45c#sho ipv6 rou 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  2001:45A:1000::/64 [115/20]
     via FE80::210:7BFF:FEC2:ACCC, Ethernet1, 00:10:12/never
I1  2001:72B: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
```

Cisco IOS IS-IS Display (2)

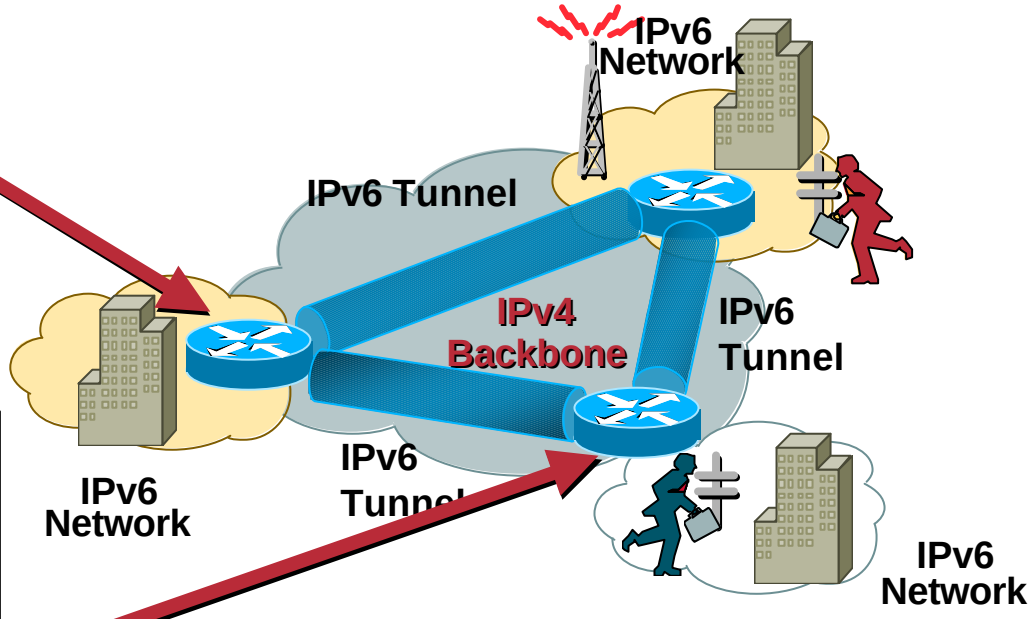

```
brum-45c#sho clns is-neigh detail

System Id      Interface   State  Type Priority  Circuit Id         Format
brum-45a       Et1         Up     L1   64        brum-45c.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
brum-45c.00-00      * 0x00000003   0xA745        732               0/0/0
  Area Address: 47.0023.0001.0000.0001.0002.0001
  NLPID:        0x8E
  Hostname: brum-45c
  IPv6 Address: 3F02::45C
  IPv6 Address: 2001:45C:2000::45C
  Metric: 10         IPv6 2001:45C:1000::/64
  Metric: 10         IPv6 3F02::/64
  Metric: 10         IPv6 2001:45C:2000::/64
  Metric: 10         IS brum-45c.02
  Metric: 10         IS brum-45c.01
brum-45c.01-00      * 0x00000001   0x96DB        733               0/0/0
  Metric: 0          IS brum-45c.00
  Metric: 0          IS brum-45a.00
brum-45a.00-00        0x00000005   0xDDBA        1027              0/0/0
  Area Address: 47.0023.0001.0000.0001.0002.0001
  NLPID:        0x8E
  Hostname: brum-45a
  IPv6 Address: 2001:45A:1000::45A
  Metric: 10         IPv6 2001:45A:1000::/64
  Metric: 10         IS brum-45c.01
  Metric: 0          IPv6-Ext 2001:72B:2000::/64
  Metric: 0          IPv6-Ext 2002:49::/64
```



IS-IS for IPv6 on IPv6 Tunnels over IPv4


```
interface Tunnel0
 no ip address
 ipv6 address 2001:0001::45A/64
 ipv6 address FE80::10:7BC2:ACC9:10 link-local
 ipv6 router isis
 tunnel source Ethernet1
 tunnel destination 10.42.2.1
!
router isis
 passive-interface Ethernet2
 net 42.0001.0000.0000.045a.00
```

```
interface Tunnel0
 no ip address
 ipv6 address 2001:0001::45C/64
 ipv6 address FE80::10:7BC2:B280:11 link-local
 ipv6 router isis
tunnel source Ethernet2
 tunnel destination 10.42.1.1
!
router isis
 net 42.0001.0000.0000.045c.00
```



IS-IS for IPv6 on an IPv6 Tunnel requires GRE Tunnel, it can't work with IPv6 configured tunnel as IS-IS runs directly over the data link layer

Agenda

- IS-IS standardization
- Cisco IOS IS-IS for IPv6
- Cisco IOS Multi-Topology IS-IS

Cisco IOS Multi-Topology IS-IS

- **Multi-Topology IS-IS was added to Cisco IOS Software to fix the limitations of a single SPF process on networks where both IPv4 and IPv6 topologies cannot be aligned, while maintaining the current IS-IS IPv6 functionalities.**

  IS-IS has been extended by additions of new Type Length Value (TLVs).This IS-IS extension impacts adjacency forming, prefix advertisement and Intermediate Systems reachability.

- **Cisco IOS Software maintains 2 topologies, one for IPv6 and one common topology for IPv4 and ISO.**

12.2(15)T and above as well as Cisco 12.3M on Cisco 2600 to Cisco 7500 series

12.0(26)S and above on Cisco 12000

12.2S RLS3 and above on Cisco 7x00 series and Cat.6K [12.2SX]

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 give n 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

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- **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 are expected 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.

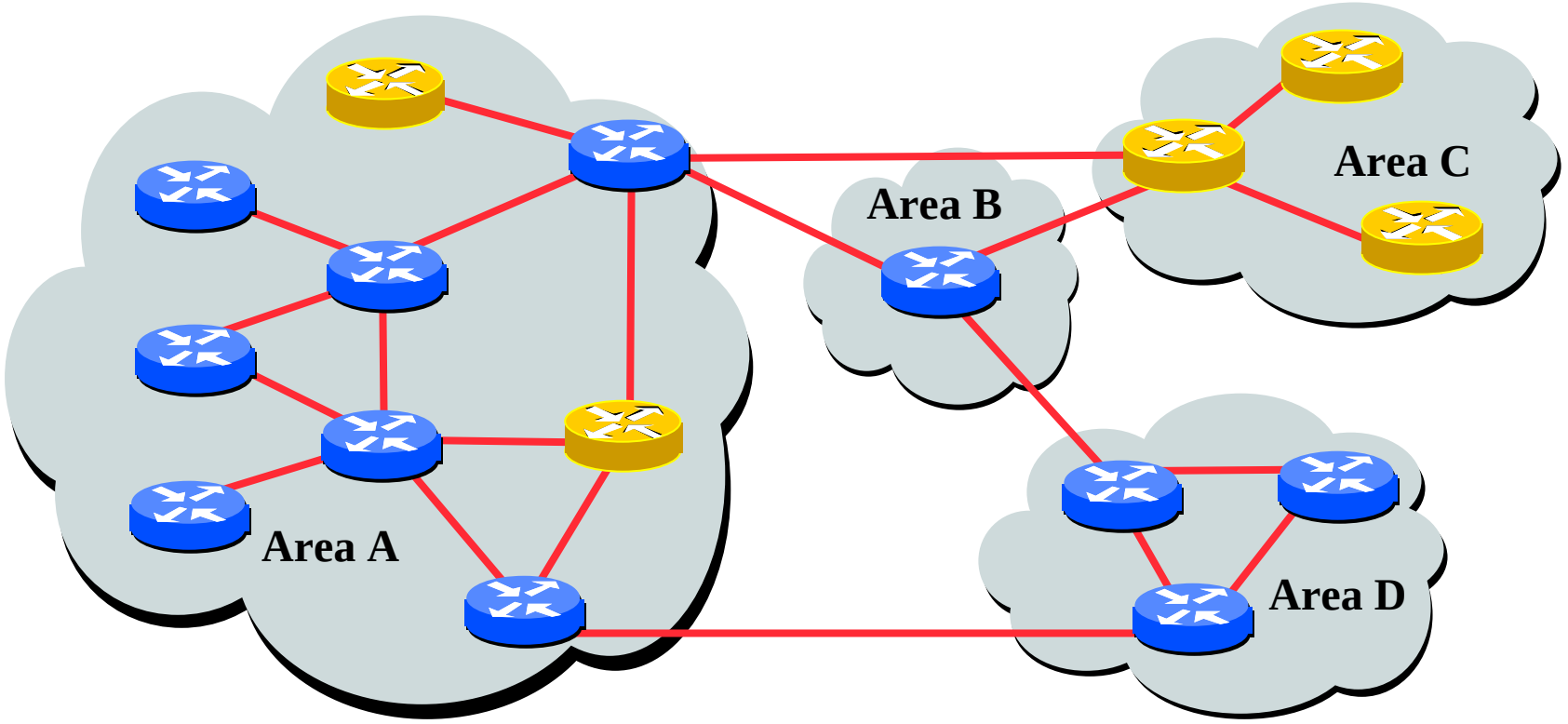
- **· IPv4, IPv6, or IPv4/IPv6 may be configured on the interface for either level-1 level-2 or level-1-2. But if IPv4 and IPv6 are configured on the same interface, they must be running the same IS-IS level**

  IPv4 cannot be configured to run on ISIS level-1 only on an interface while IPv6 is configured to run ISIS level-2 only on the same interface.

- **· All routers on a LAN or point to point must have at least one common supported topology (IPv4 or IPv6) when operating in Multi-Topology IS-IS mode. However, 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 metric is required to be enabled globally on the Autonomous System to run**

Multi-Topology IS-IS example

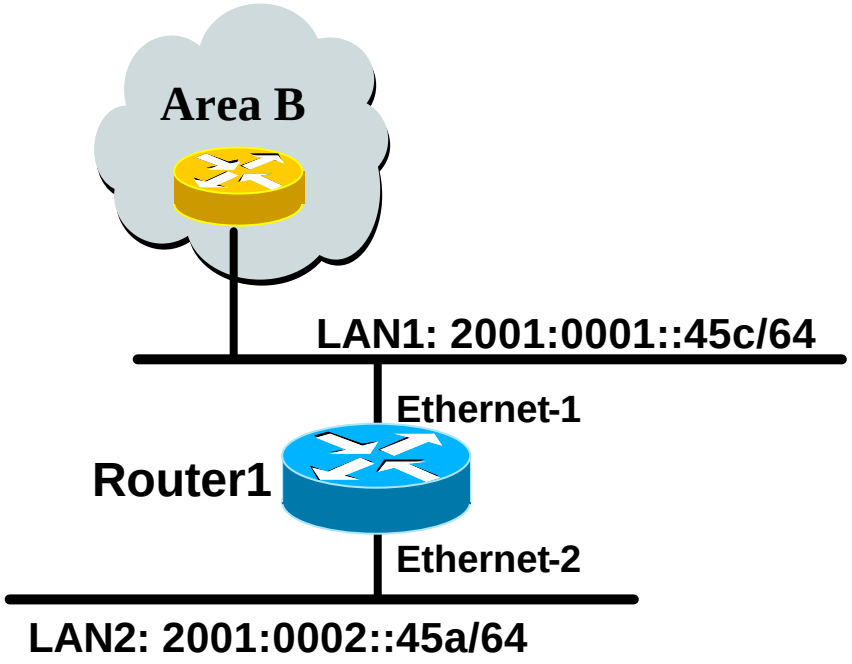


IPv4-IPv6 enable router

IPv4-only enable router

The Multi-Topology software will create two topologies inside Area
IPv4 and IPv6.
IPv4-only routers will be excluded from the IPv6 topology

Cisco IOS Multi-Topology IS-IS 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 2001:0001::45c/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 2001:0002::45a/64
    ip router isis
    ipv6 router isis
    isis ipv6 metric 20


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

Cisco IOS 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

2652# 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: 3FFF:FFFF: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) 3FFF:FFFF:1::/64
               Metric: 10 IPv6 (MT-IPv6) 3FFF:FFFF:2::/64
```