IS-IS Up to date

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Agenda

- IS-IS for High Availability Enhancements
  - **Check-Pointing method**
  - **ietf Restart TLV**
- IS-IS for IPv6
- Multi-Topology Support
- MD5 Authentication Support
- Other Topics
  - Default-Metric Change
  - IS-IS Protocol Shutdown
  - Limit the number of Redistributed Routes
  - Update on IETF Drafts

Scope of the Presentation

- Is to present the recent IS-IS enhancements
- Some of these enhancements have been proposed through the Standards Organization like IETF
- And some of them will help the Network Operator to improve the operating efficiency of their network

IS-IS for HA

IS-IS for HA – Terminology

- Starting Router
  - A Router whose control function has been started/restarted, but the forwarding functions have not been maintained in prior state.
- Restarting Router
  - A Router which is experiencing RP Switchover
- Neighbor Router
  - Router which is Adjacent to the Restarting Router
- NSF Capable-Router
  - Router which has implemented NSF, and will continue to forward packets after a RP failure.
- NSF Aware-Router
  - Router is only Capable of understanding the new Capabilities to assist the NSF-Capable Neighbors
- NSF-Unaware-Router
  - A Router that is not NSF-Aware

IS-IS for HA – Problem

- Primarily 2 issues in Existing IS-IS Deployments

- When a RP/LC gets reset, we tear-down the whole adjacency.

- Then Restarting-Router/Neighbors compute their routes before database Synchronization

IS-IS for HA - Problem

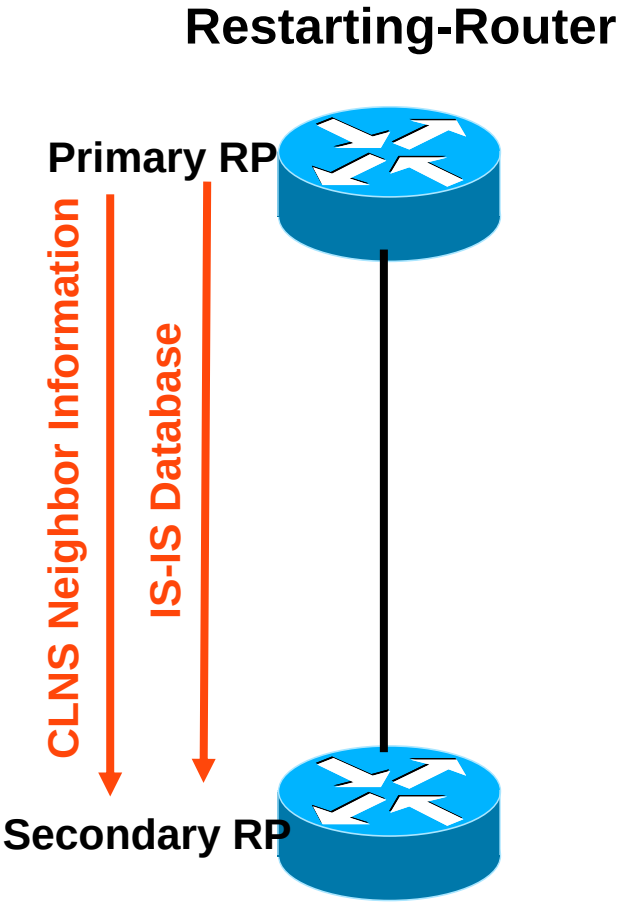
- Issues [in Detail]
  - On Restarting Router:
    - Causes it to compute its own routes before achieving database synchronization with its neighbors.
    - These results likely to be non-convergent with the routes computed by other routers in the area/domain.
  - On the Neighbor Router(s):
    - Adjacency is reinitialized is to the Restarting Router
    - Causes its own LSP(s) to be generated, thus triggering the SPF runs throughout the area
    - Sets the SRM Flags on its own LSP Database on the Adj. concerned
    - On p2p link, transmit a set of CSNP(s) over the Adjacency.

IS-IS for HA – Methods

- Issues Addressed via:
  - Check pointing method
  - ietf TLV method

IS-IS for HA – Check pointing Method

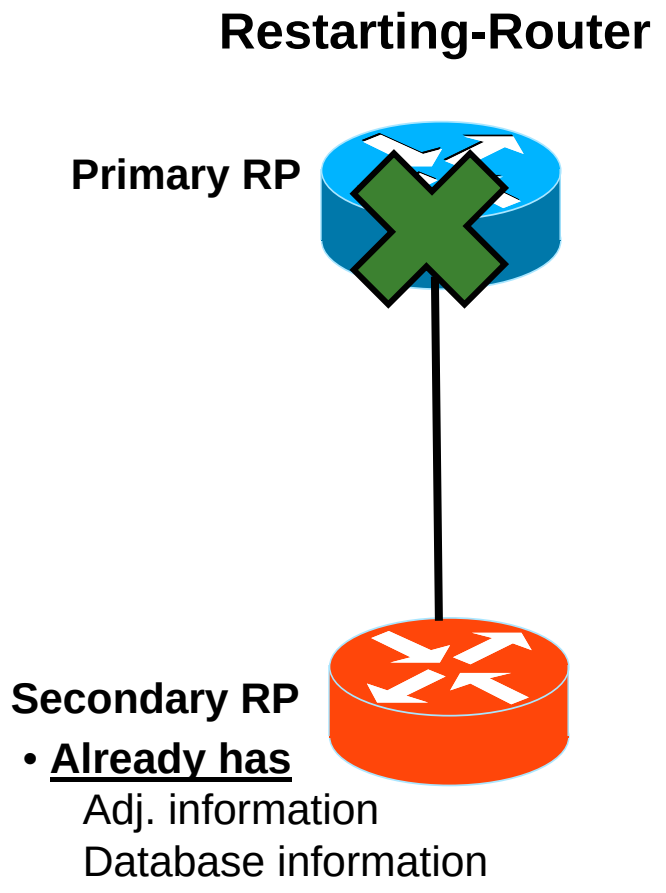
- The Primary RP on the Restarting Router will check point or save the full Neighbor Adjacency information to the Secondary RP.
- Restarting Router will also save or Check point the IS-IS LSP Database information to the Secondary RP from the Primary RP.



IS-IS for HA – Check pointing Method

- **In case of a failure on the Primary RP, after the switch-over, the Secondary RP has all the necessary information to maintain its adjacencies using the checkpointed data & quickly rebuild its routing tables.**

- **Any missing information will be learned by the new-RP from its neighbors via the normal LSP Flooding mechanism.**



IS-IS for HA – Check pointing Method

- If any of the interface(s) doesn't come up with the allocated interface wait-time, the routes learned from the neighbor routers are not considered in the routing table calculation.

IS-IS for HA – Check pointing Method

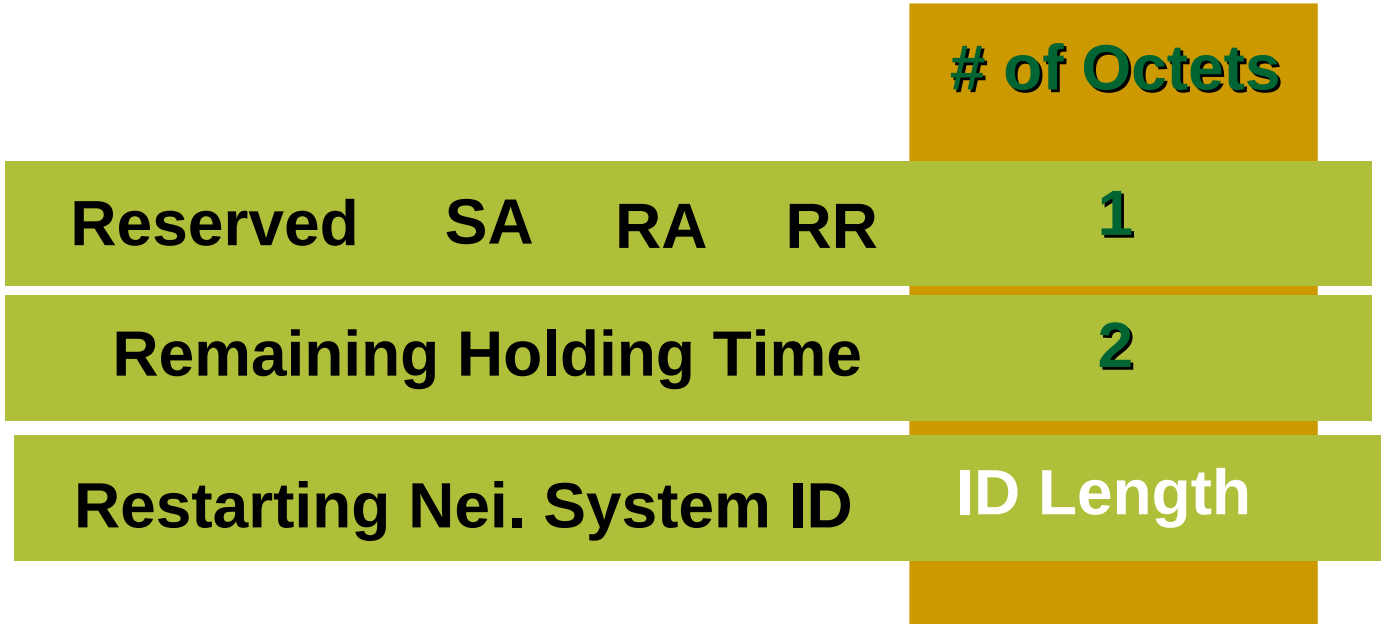
- The Checkpointing Method involves the Restarting event localized to the router only
- It doesn't involve having the Restart Capability on the Neighbor Routers.

IS-IS for HA – ietf method

- A similar mechanism is also proposed in IETF.
- Which accomplishes a similar thing by making the changes to the IS-IS Protocol
- Introduces a new TLV 211 [RR/RA bits]

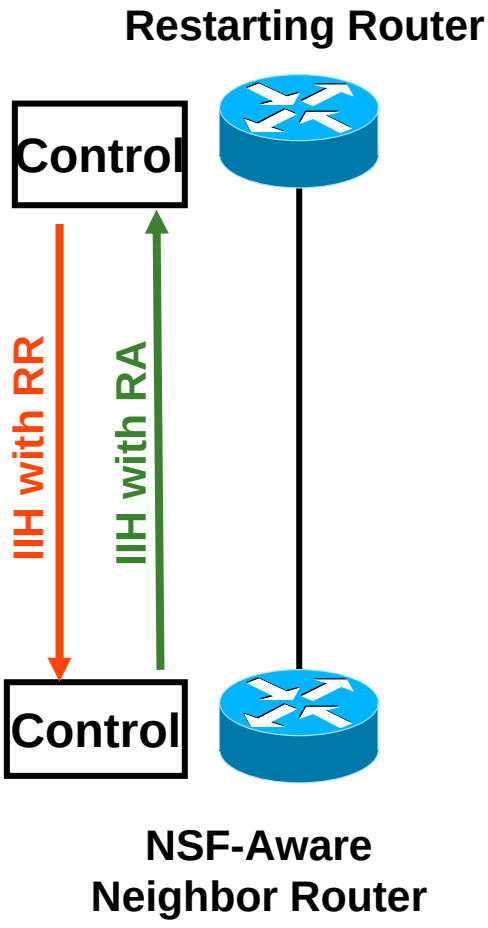
IS-IS – ietf method

- New Restart Option TLV 211



IS-IS for HA – ietf method

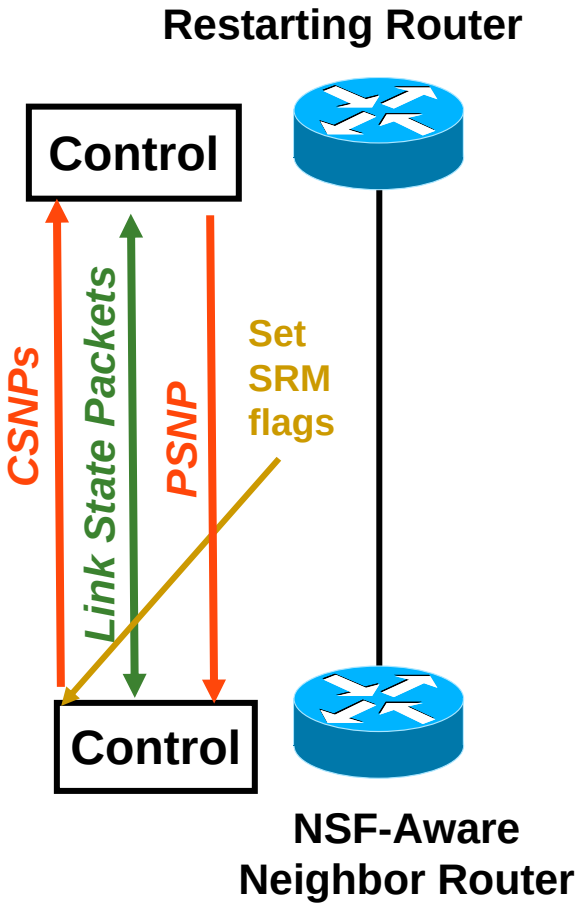
- **IS-IS adds a new TLV to the IIH packet, the restart option. The restart option TLV contains a Restart Request (RR) bit and a Restart Acknowledgement (RA) bit.**
- **Restarting-Router transmits its hellos with RR bit set.**
- **Neighbor Router transmits hellos to Restarting Router with the RA bit set and it maintains its adjacency with Restarting-Router.**



IS-IS for HA – ietf method

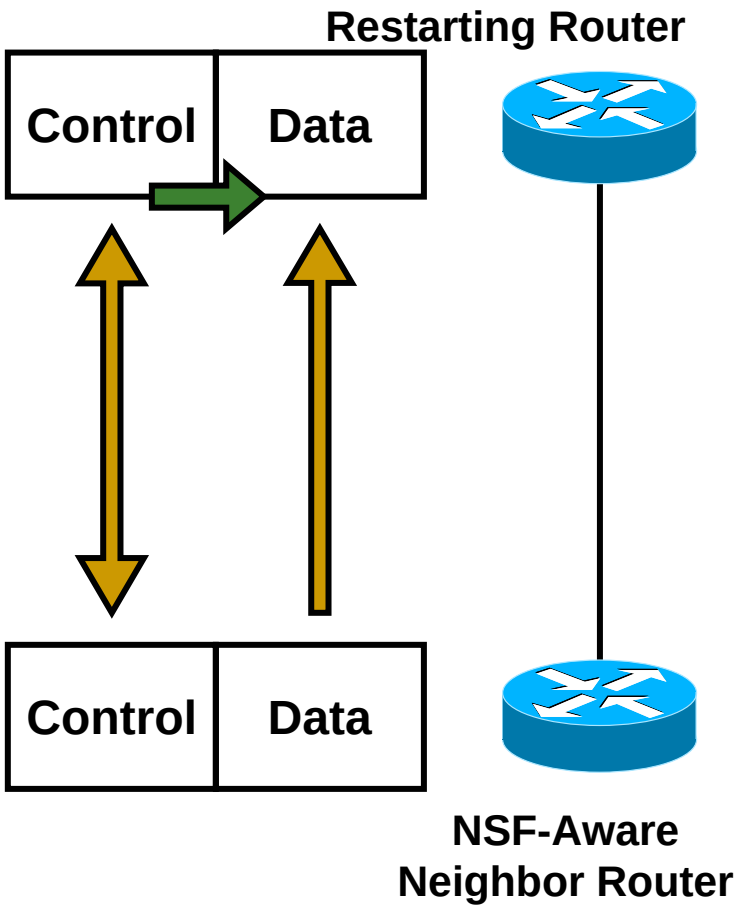
- **Neighbor Router then sets the flags which indicate routing data that needs to be transmitted to Restarting Router (the SRM flags).**

- **Restarting Router and Neighbor Router then use IS-IS normal synchronization process using complete sequence number packets (CSNPs) to describe their databases, and exchanging link state packets (LSPs).**



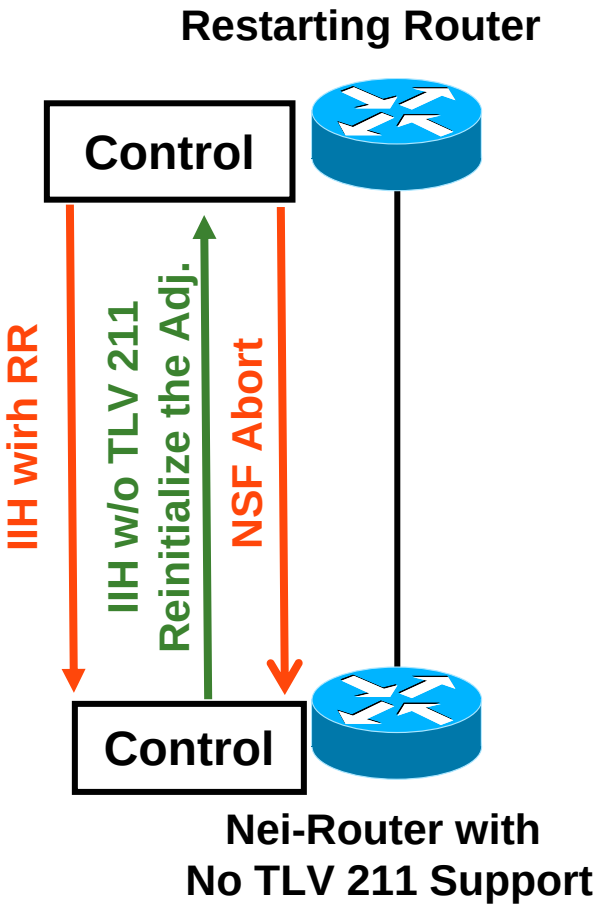
IS-IS for HA – ietf method

- **When Restarting Router and Neighbor Router have resynchronized their databases, the Restarting Router will run SPF.**
- **After running SPF, the local routing table is updated on the Restarting Router.**



IS-IS for HA – ietf method

- In response to the TLV 211 with RR bit set, if there is a Neighbor-Router with no TLV 211 Support on the other side, then it will send the IIH packet with no TLV 211.
- This will cause the re-initialization of the Adjacency by the Non-NSF-Aware Router to the Restarting Router because it doesn't see itself in the Neighbor list.
- On Restarting Router this causes for NSF to abort to the Non-NSF-Capable Router



IS-IS – ietf Method

- **SA Suppress Adjacency Advertisement**
- Purpose:
- Is to avoid temporary black holes caused by the presence of stale LSPs from a previous incarnation of Starting Router in the network.

IS-IS – ietf Method

- SA Suppress Adjacency Advertisement

- On Starting-Router
  - ✓ Used by Starting-router to request that its neighbor suppress advertisement of the adjacency to the Starting router in the Neighbor's LSPs.
  - ✓ The RR bit remains Clear and the SA bit remains set in subsequent transmissions of IIHs until adj. has reached UP state
  - ✓ Before the CSNPs exchanged, the zeroth-LSP will have the Overload-Bit set to prevent other routers to compute the routes through the Starting-Router

IS-IS – ietf Method

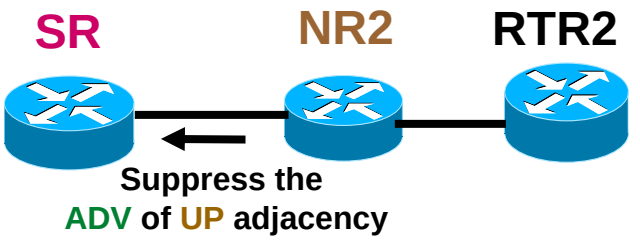
- SA Suppress Adjacency Advertisement

- On Neighbor Router
  - ✓ Adjacency to the Starting-Router in the LSPs MUST be suppressed, if IIH that received has "SA" bit set
  - ✓ Also, it should not include the Suppressed adjacency in any SPF Calculation it does.

IS-IS – ietf Method [SA Bit]

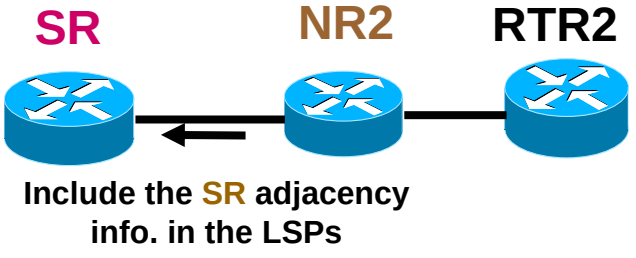
When SA Bit is set

- Neighbor LSPs have IS-Neighbor Advertisement to other Neighbors.
- But they suppress advertising an Adjacency to the starting router



When SA Bit is Clear

- Neighbor LSPs now also have IS-Neighbor advertisement to Starting Router

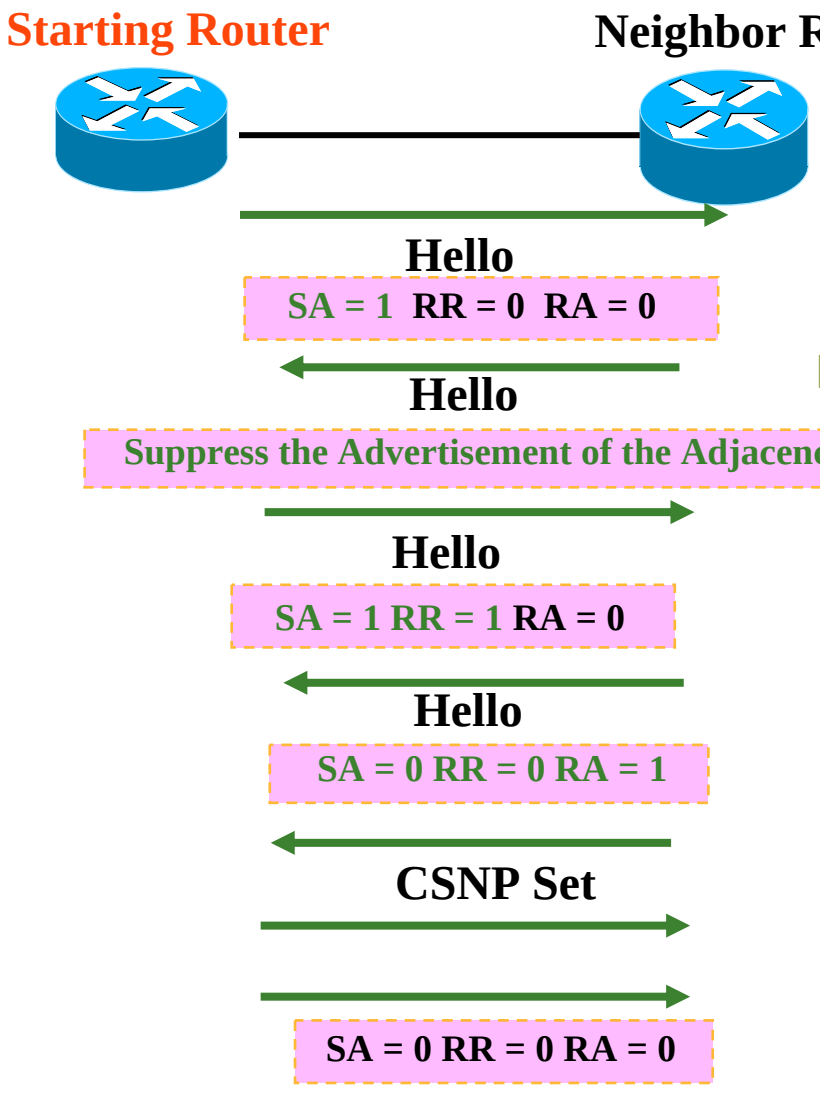


Adjacency will be UP – But it is the Advertisement of the UP Adjacency that is Suppressed.

IS-IS – ietf Method

- Restarting Neighbor System ID
  - ✓ The System ID of the Neighbor to which the RA refers.
- Remaining Time
  - ✓ The Remaining Holding time [in seconds]

IS-IS – ietf method Switchover



Existing Adjacency will be re-initialized

New Adjacency comes up

LSPs Exchanged
LSP DB Sync achieved

Adj. will be Advertised to the Neighbors.

IS-IS – ietf method Switchover

- Sequence of Steps [ReStarting]

[1] Restarting-Router [RR] will set the RR=1 RA=0 in IIH

[2] Neighbor-Router [NR], on receipt of this IIH will do:

  - set RA= 1 in IIH packet back
  - doesn't reinitialize the adjacency with RR
  - set the SRM bit for all LSPs in Neighbor Router's Database
  - send the complete set of CSNPs to Restarting-Router

- The below steps are part of normal UPDATE Process

[3] In the mean time, RR will be receiving CSNPs from Neighbors on its interfaces

[4] NR will also start flooding the LSP Fragments

[5] This causes the RR to set the SSN bit set and in turn ACK in the form of PSNPs

[6] NR will clear the SRM bit after it achieves Synchronization

CSNP exchange is made reliable by having RR send IIH-RR until both RA and complete a CSNP set is received.

IS-IS – ietf method Switchover

IIH

RR = 1, RA = 0

Causes RA bit in IIH
SRM Flag set

Learn the adj info, adj up

IIH

RR = 0, RA = 1

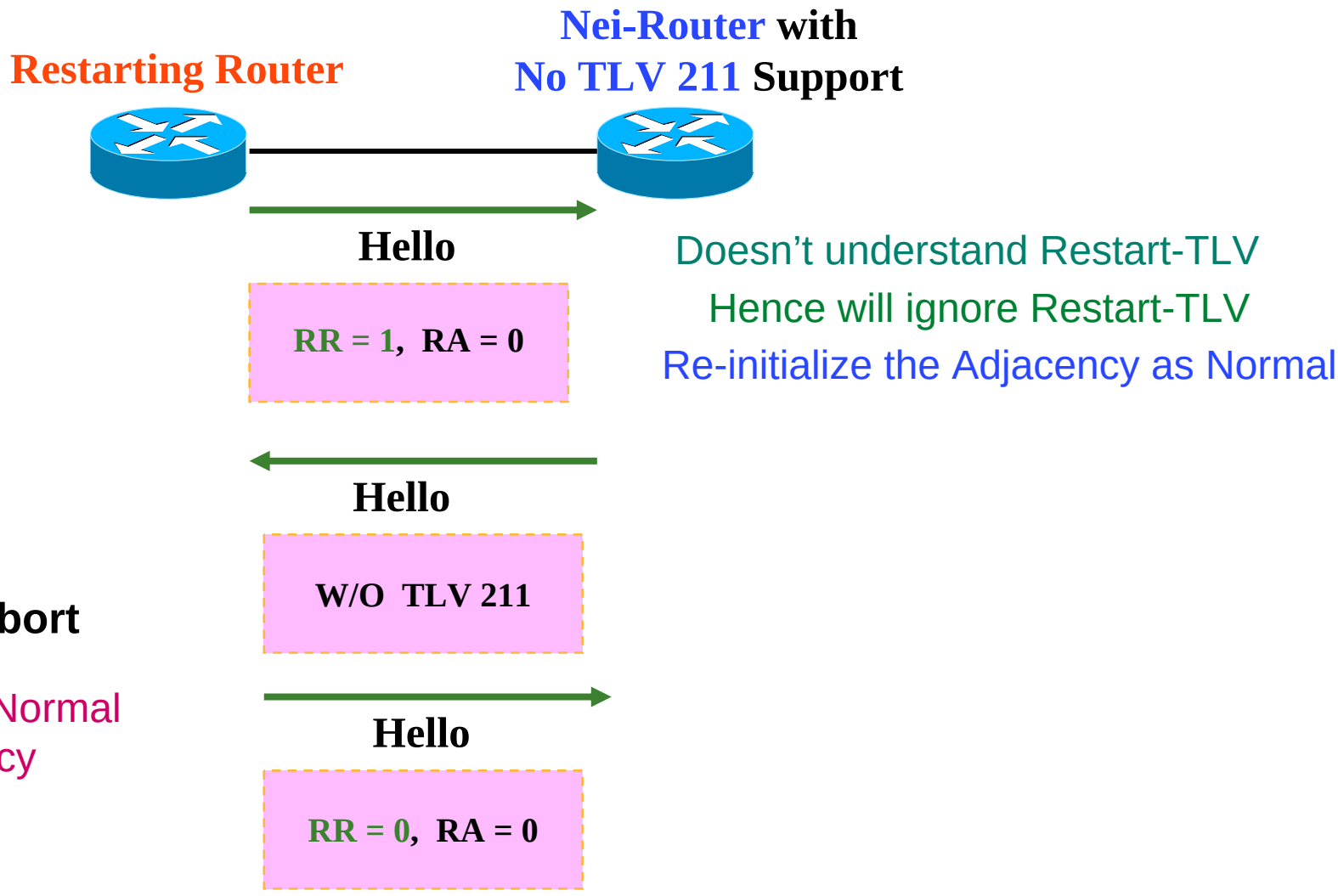
CSNP/*LSPDU

Set the SSN Bit

PSNP

Clear the SRM Flag

IS-IS – ietf method Switchover



IS-IS for HA: Check Pointing vs IETF

- Summary

Check pointing	IETF
Checkpoint the Adjacency & database information between Active-RP and Stanbdy-RP	There is no Checkpointing of Information. Uses TLV 211
NSF mechanism - Incremental	NSF Mechanism - Bulk
"delta" between Active-RP & Standby-RP is less, i.e., the overhead to Sync	There is more overhead for to sync. information
Deployment *May* be much easier	For Interoperability, you need TLV 211
Doesn't Require support from Restarting Router	Depends up on support from Restart Capable Neighbors

IS-IS for IPv6

IS-IS for IPv6

- Existing IS-IS implementations run for IP [RFC 1195] & CLNS
- Now IPv6 Routing Capability has been added to the existing IS-IS Protocol.
- By adding two New TLVs & a Protocol Identifier

IS-IS for IPv6

- Two New TLVs are defined to carry IPv6 Information.
  - IPv6 Reachability TLV [Type 236] [0xEC]
  - IPv6 Interface Address TLV [Type 232] [0xE8]
- TLV 236 similar to TLV 128[130]/135
- TLV 232 similar to TLV 132

IS-IS for IPv6

- Also, defines a new IPv6 Protocol Identifier
- IPv6 NLPID 142 (0x8E)

- This is carried in the “Protocol Supported” TLV 129, which also carries IPv4, CLNS.
  - IPv4 NLPID 204 (0xCC)
  - CLNS NLPID 129 (0x81)

IS-IS for IPv6

- IPv6 Reachability TLV
- describes network reachability information includes
  - routing prefix
  - metric information
  - up/down bit
  - existence of sub-TLVs [optional]

IS-IS for IPv6

- **IPv6 Reachability TLV 236**

	# of Octets
Type = 236	1
Length	1
Metric	4
U X S Reserve	1
Prefix Len	1
Prefix	4
Sub-TLV Len *	1
Sub-TLVs *	

IS-IS for IPv6

- **IPv6 Interface Address TLV 232**

	# of Octets
Type = 232	1
Length	1
Interface Address 1*	16
Interface Address 2*	16

* - if NOT present, then the TLV need not be sent

IS-IS for IPv6

- IPv6 Interface Address TLV
  - Hello PDUs will contain the Link-Local-IPv6 addresses assigned to the interface which is sending the Hello.
  - LSPs contain only the non-Link-Local-IPv6 addesses assigned to the IS

IS-IS for Multi-Topology

IS-IS for MT

- A mechanism that allows IS-IS, in a single domain, to maintain a set of independent topologies.

- Multi-Topologies extension can be used to maintain separate topologies for:
  - IPv4
  - IPv6
- Topologies need not be congruent.

IS-IS for MT – Problem

- **Current IS-IS spec and implementation forces all protocols carried by IS-IS to agree on a common Shortest Path Tree**

  Single SPF run for all protocols

- **Single SPT means congruent topologies**

- **Single SPT means all links need to understand all address families present in the domain**
  - **IPv4 and IPv6 Topologies need to be congruent**

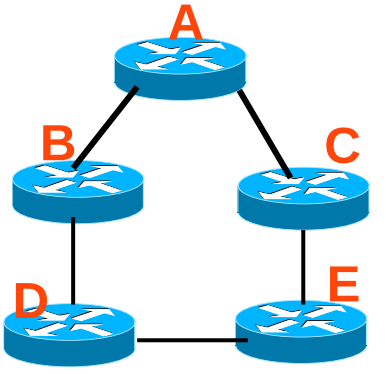
  - **Creates some undesirable effects**
    - ✓ **Unsupported Network [configured for ISIS IPv6 only]**
      - **IPv4 traffic may be mistakenly routed via IPv6 only.**
    - ✓ **IPv6 packets may be mistakenly routed via MPLS-TE tunnels**

IS-IS for MT – the Need

After SPF **[assume all the interfaces have same cost]**

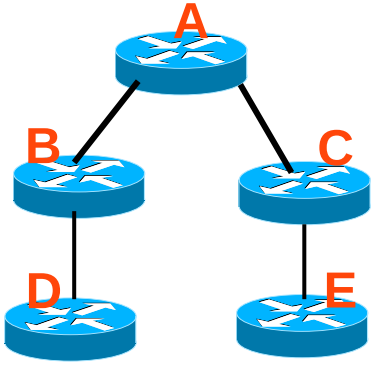
- From A perspective
- **E is only reachable through C**

  There is no valid active path from D to E



Physical Topology

- All protocols carried by IS-IS have to agree on the same SPT



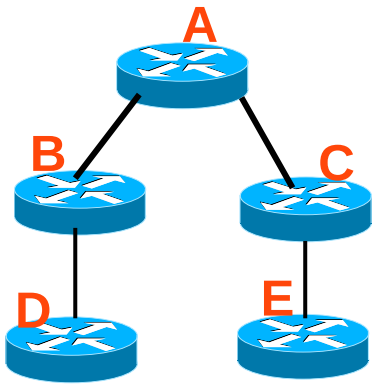
Shortest Path Tree

No way to distribute traffic across the domain

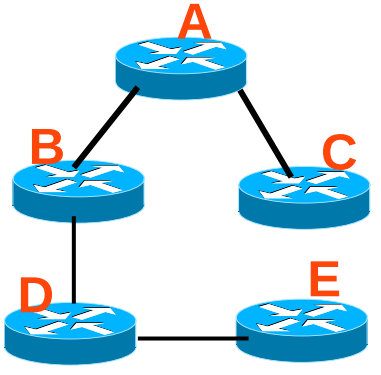
All links need to understand all protocols

IS-IS for MT – the Need

Ability to distribute traffic across all links.



IPv4 Shortest Path Tree



IPv6 Shortest Path Tree

IS-IS for MT – Adjacency

- Each router knows on which topologies it will establish adjacencies and build SPTs
- During adjacency establishment, peers need to agree on topologies
  - Topologies identifiers are exchanged in IIH packets

IS-IS for MT – Adjacency

- Maintaining MT Adjacencies
  - Each adjacency formed MUST be classified as belonging to a set of MTs on the interface.
  - MT membership advertised in IIH packets
  - Standard ISIS Topology is defined to be MT ID #: 0
  - Boundaries between levels will be the same for all MTs.

IS-IS for MT – Adjacency

- Adjacencies over LANs
  - Two Routers on a LAN will always establish adjacency regardless whether they have common MT set or not.
  - For simplicity, we keep a unique DIS.
  - The DIS, CSNP and PSNP functions are not changed by MT extension.
  - Flooding is unchanged

IS-IS for MT – Adjacency

- Adjacencies over p2p Interfaces

  - Adj. only formed when the MT-IDs are matching on at least one common MT set over the interface.

  - If MT-ID is not detected in remote side's IIHs, the local router wont' include that Neighbor within it's MT LSPs.

IS-IS for MT – OL/Partition/ATT Bits

- MT with OL, Partition & Attached Bits
- Attached & OL bits are part of the MT TLV being distributed with in a node's LSP fragment Zero.
- The OL bit in the MT TLV can be used to signal the topology being overloaded.
- Since each Adj. can belong to different MTs, it is possible that some MTs are L2 attached, and others are not on the same router.
- MT Extensions doesn't support Partition Repair

IS-IS for MT – OL/Partition/ATT Bits

- MT with OL, Partition & Attached Bits
  - Each MT topology has its own ATT and OL bit set in the MT TLV.
  - TWCC within SPF follow according to MT to assure the bi-directional reachability within the same MT
  - The results to be stored in a separate RIB in the case of overlapping addresses in different topologies.

IS-IS for MT – LSP Flooding

- The LSP Flooding mechanism is not changed by this MT extension.

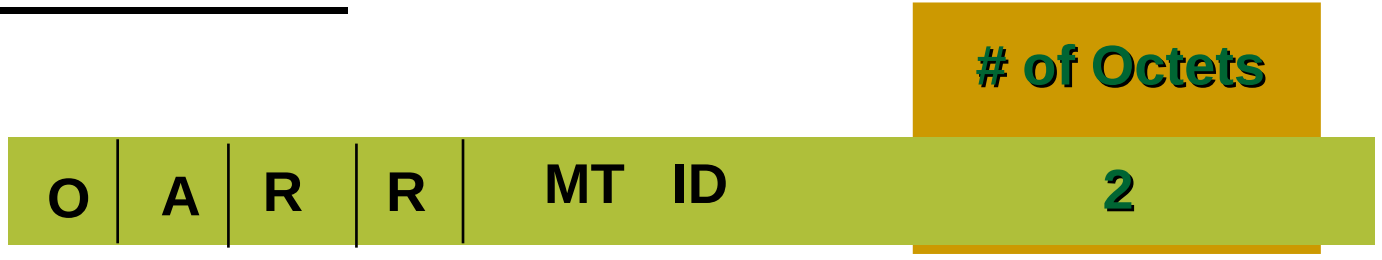
- If the LSP and Adjacencies of an outgoing interface do not share any common MT capability, an implementation may have the option not to flood this LSP out on that interface.

IS-IS for MT – New TLVs

- There are New TLVs are defined to advertise Neighbors and IP Prefixes.
  - **TLV 229 – Multi-Topology Identifier**
  - **TLV 222 – Multi-Topologies Intermediate System**
  - **TLV 235 – Multi-Topologies Reachable IPv4 prefixes**
  - **TLV 237 – Mutli-Topologies Reachable IPv6 prefixes**

IS-IS for MT – TLV 229

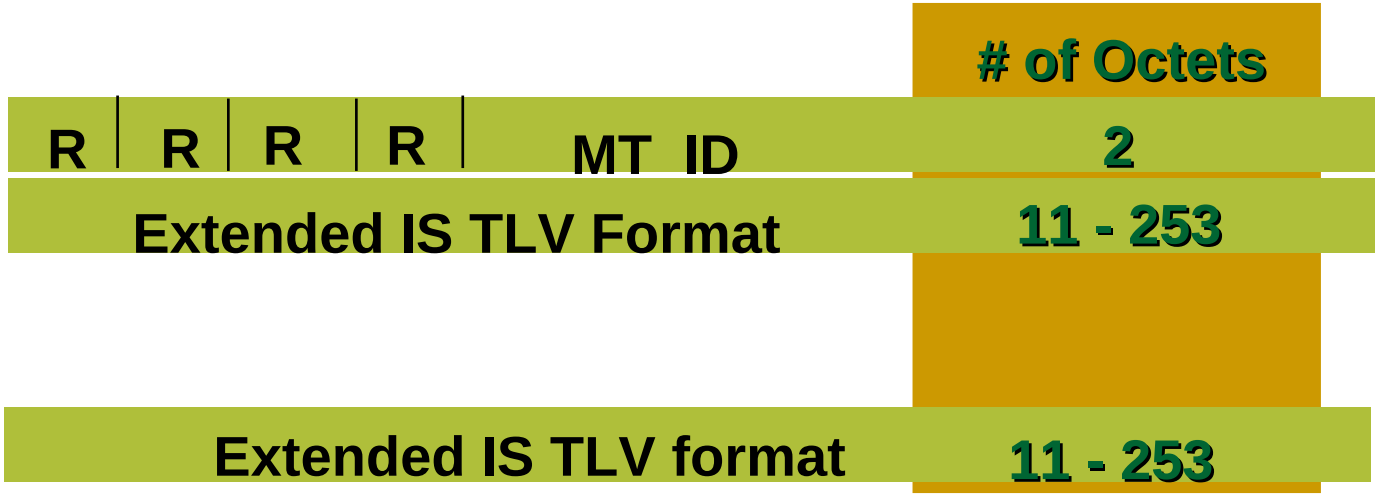
- MT TLV 229



O	OverLoad Bit for the MT
A	Attached Bit for the MT
R	Reserved Bit (s)
MT ID	ID of the topology being announced

IS-IS for MT – TLV 222

- MT Intermediate System TLV 222

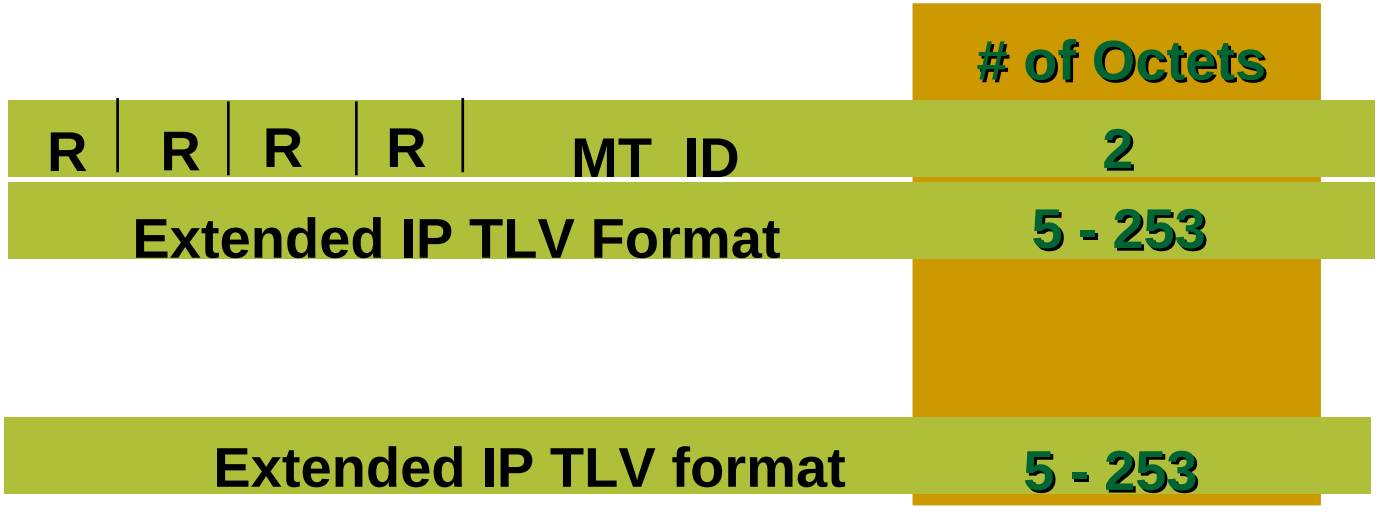


Similar to –Extended-IS-Rechability TLV 22

Has an Extra 2 byte MT-Membership Info.
The Rest of the TLV is same as TLV 22
With a Maximum 23 Neighbors of the same MT.

IS-IS for MT – TLV 235

- MT Reachable IPv4 Prefixes TLV 235

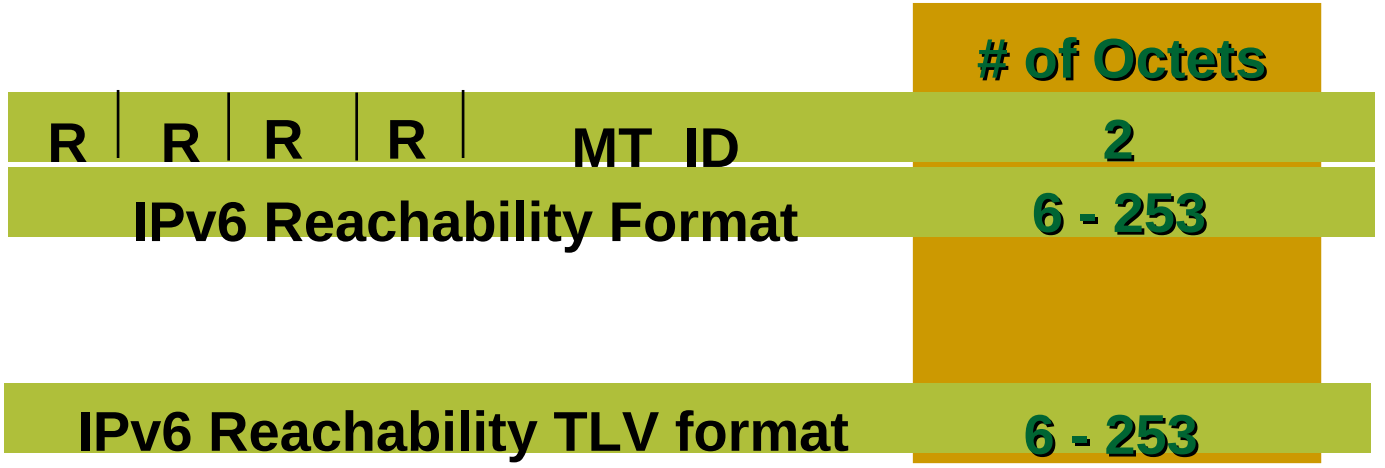


Similar to Extended-IP-Reachability TLV 135

Has an Extra 2 byte MT-Membership Info.
The Rest of the TLV is same as TLV 135

IS-IS for MT – TLV 237

- MT Reachable IPv6 Prefixes TLV 237



Similar to IPv6-Reachability TLV 236

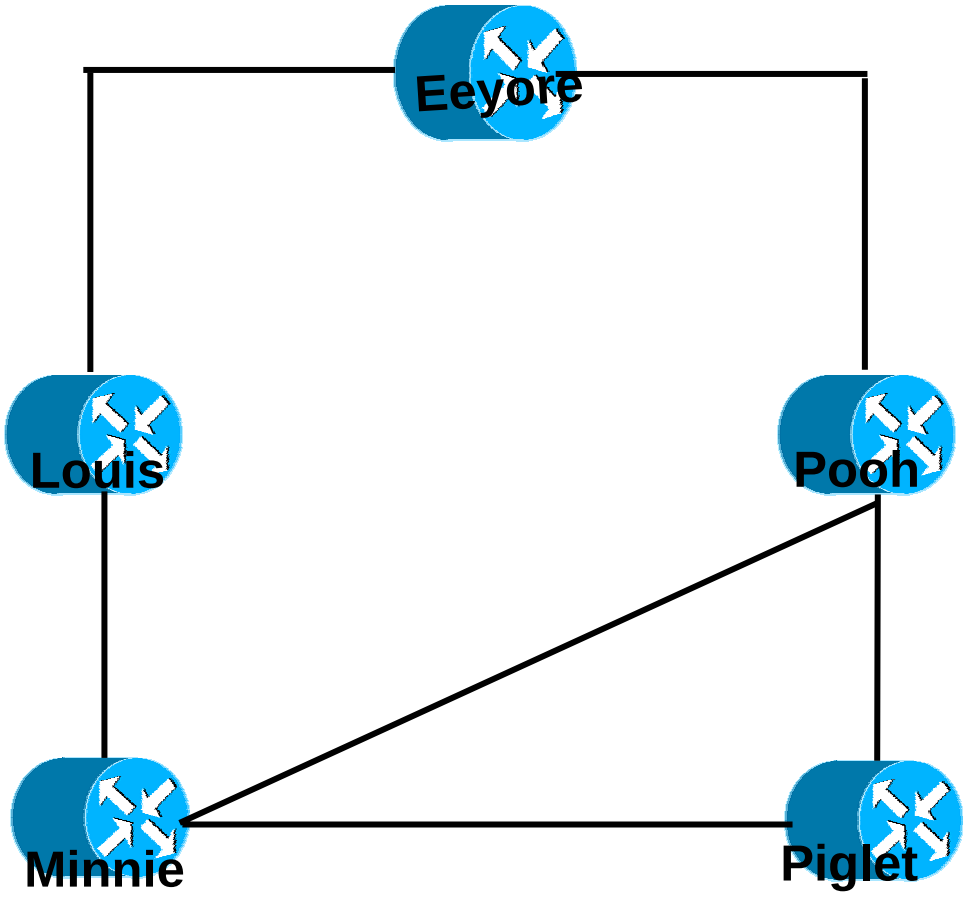
Has an Extra 2 byte MT-Membership Info.
The Rest of the TLV is same as TLV 236

IS-IS for MT – Identifiers

- Reserved MT ID Values

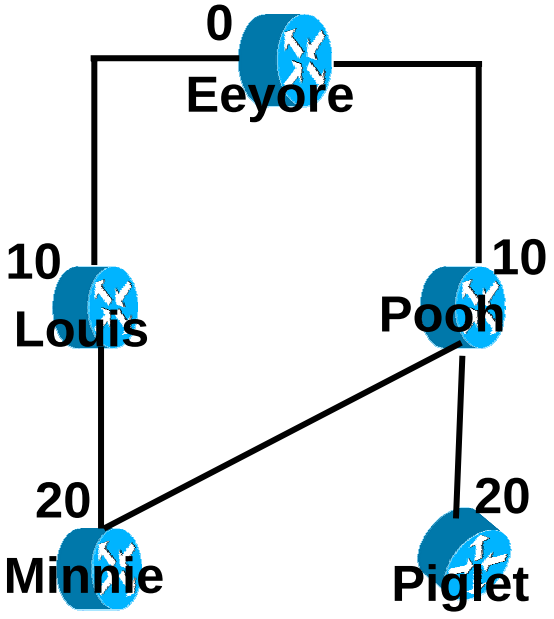
	MT ID Values
Standard Topology	0
For IPv4 in-band management purposes	1
IPv6 Routing Topology	2
IPv4 Multicast Routing Topology	3
IPv6 Multicast Routing Topology	4
Reserved for IETF consensus	5-3995
Reserved for development, experimental and proprietary features	3996-4095

Example Topology

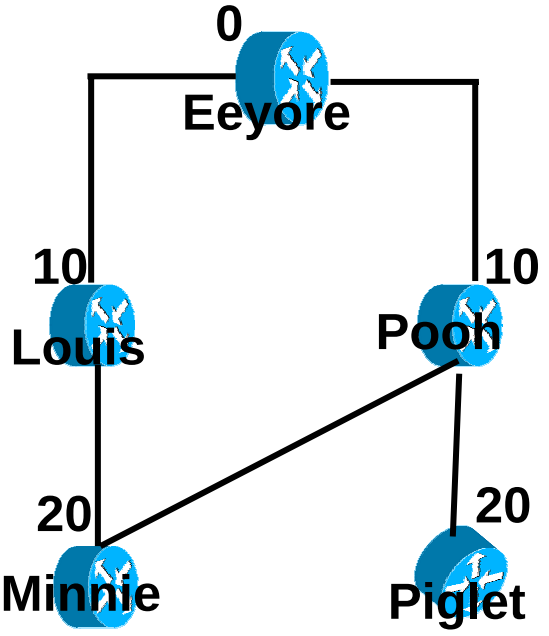


IPv4 and IPv6 Topologies

- IPv4 Topology



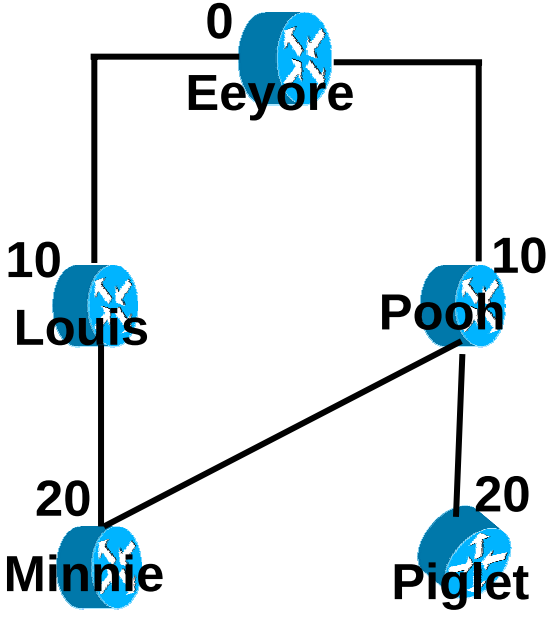
- IPv6 Topology



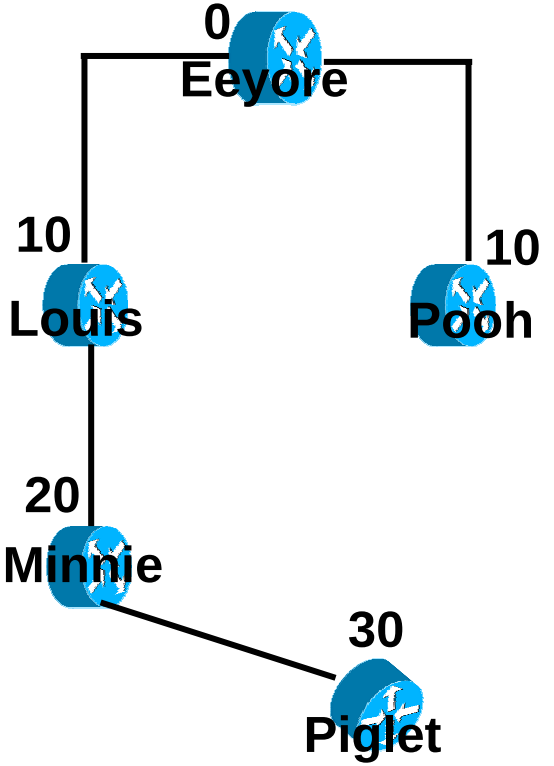
Congruent Topology
Both IPv4 & IPv6 are using the same SPF Tree

IPv4 and IPv6 Topologies

- IPv4 Topology



- IPv6 Topology



IPv4 and IPv6 are using different Topologies

MD5 Authentication Support

MD5 Authentication Support

- The Base specification defined in ISO 10589 allows for multiple authentication algorithms.
- Plain-text Authentication Value-Type 1
- HMAC-MD5 Authentication Value-Type 54
  - as defined in RFC 3567

MD5 Authentication Support

- Plain-Text Password doesn't provide useful protection against intentional mis-behavior
- Since Password is transmitted in clear without encryption, it is easy for a hostile system to intercept the passwords.
- Plain-text passwords provide weak protection against accidental errors/mis-configuration.

MD5 Authentication Support

- With plain-text and MD5, now you can apply authentication on all 5 types of PDUs
  - LSP :: LAN-Hello :: p2p-Hello :: CSNP :: PSNP
- On different IS-IS Levels Independently
- Passwords can be rolled-over with new ones with out any disruption of adj. flapping/routing messages.

MD5 Authentication Support

- Can also optionally configured to accept any PDUs with or without wrong authentication, but still send out PDUs with authentication during transition phase.
- Operators can decide, if the authentication is only for L1/L2, for LSPs only or for interface related PDUs: Hello, SNP, or both
- For additional security, the router can also be configured to encrypt the password string.

MD5 Authentication Support

- Authentication TLV 10 Values

	Authentication Type
Reserved	0
Cleartext Password	1
HMAC-MD5	54
Routing Domain Private Authentication Method	255

MD5 Authentication Support

- HMAC-MD5 Authentication Value-Type 54

	# of Octets
Length	17
Value	16

Default-Metric Change

Default Metric Change

- At present, the default-metric is 10 on all the interfaces when ISIS gets enabled.
- There is no mechanism at this time to force the IS-router to change the default-value
- This mayn't be optimal with the introduction of "wide-metric" option.

Default Metric Change

- Also, an Operator may remove the metric from the interface and mayn't put it back.
- This has the side-effect of having this interface attracting all the traffic.
  - Applications like MPLS-TE will result in undesirable affect on the network.

Default Metric Change

- A New router-mode configuration command has been introduced:

```
[no] metric <nn> [level-1 | level-2]
```

- Command appears under “router isis” applies to
  - IPv4
  - CLNS
  - under AF of IPv6

Default Metric Change

- By default it applies to all the interfaces
- When IS-IS configured under an interface, the metric will be the configured value instead of the default value of 10
- Also, if a metric is configured under the interface, then it has the higher preference.
- For passive-interface(s), the default value will always be 0

IS-IS Protocol Shutdown

IS-IS Protocol Shutdown

- To have the ability for gracefully shut the IS-IS Routing process.

- At present there exists no method either in
  - **in Global mode** **OR**
  - **at Interface Level**

  to remove IS-IS in a non-destructive way.

IS-IS Protocol Shutdown

- The only workarounds we have
- Global mode: do "**`no router isis`**" which removes the IS-IS configuration.
- Interface Level mode: do "**`no ip router isis`**" or put the interface into passive mode, which still advertises the IP address of the specified interface.

IS-IS Protocol Shutdown

- IS-IS Protocol Shutdown mechanism is useful:
  - when Network Administrator wants to turn off the operation of IS-IS Protocol with out losing the protocol Configuration.
  - useful when a series of changes to the Protocol configuration are needed with out having to transition through intermediate/undesirable states.

IS-IS Protocol Shutdown - mechanism

- Interface mode:
  - ✓ no IS-IS PDU will be sent on the interface
  - ✓ received IS-IS PDU will be discarded
  - ✓ tear-down the existing IS-IS Adjacency
  - ✓ will not form new adjacency.

IS-IS Protocol Shutdown – mechanism

- Router mode
  - ✓ will disable operation of the protocol completely
  - ✓ also, LSP-database will be cleared
  - ✓ IS-IS routes in the RIB will be removed
  - ✓ delete all the existing adjacencies

- Limit the number of Redistributed Routes

Limit the # of Redistributed Routes

- To prevent the “accidental” redistribution of routes into IGP [IS-IS, OSPF]
  - which cause increase in flooding
  - may cause result in severe network meltdown
- This may happen when BGP gets redistributed
- May also happen when

  BGP -> another IGP -> IS-IS

Limit the # of Redistributed Routes

- The solution is to address at the Source Or Redistribution Router
- By “redistribute” option to put a hard limit on the maximum # of IP-Prefixes inject in the LSP.
- Also, what action to do, when LSPFULL condition is reached.

Limit the # of Redistributed Routes

- Addressing the hard Limit on max # of IP Prefixes

```
[no]redistribute maximum-prefix <limit> [thereshold][warning-only|withdraw]
```

- limit: high water-mark
- threshold: low water-mark, causes warning
- warning-only: only issue warning when limit reached
- withdraw: build new-LSP without external IP Prefixes.

- Default: None

Limit the # of Redistributed Routes

- Addressing the LSPFULL condition

```
lsp-full suppress { { [external] [interlevel] } |
  none }
```

lsp-full: is a condition when IS-IS has more than 256 LSP fragments in a level.

- suppress: option to try to recover out of LSPFULL
- external: any redistributed routes on this router will be suppressed.
- interlevel: routes from other level will be suppressed.
- none: no suppression will be done

- Default: `lsp-full suppress external`

Limit the # of Redistributed Routes – CLI

- When the LSPFULL Condition is reached, the source Router will generate the following error message

```
Nov  3 16:08:34.548: %CLNS-3-LSPFULL: ISIS: L2 LSP filled
     to capacity (Schedule to handle suppress options)
```

- Then, the SRC-Router tries to correct this condition by itself by purging all the LSPs which have the redistributed-routes [by default – External routes will be purged]

Limit the # of Redistributed Routes – CLI

- It is recommended on the L1L2-Router to have additional option of removing inter-level routes.

- This helps as several L1-learned routes may aggregate on L1L2-Router to cause the overflow.

Update on IETF Drafts

Restart TLV Draft

- Has been approved by the IESG
- Is in the RFC Queue.
- It is going to become an Informational RFC

Recommendations for Interoperable IP Networks using IS-IS

- The draft-ietf-isis-ip-interoperable-02.txt has been approved for publication of RFC
- The purpose of this draft is to document
  - the changes in protocol for IP Routers that are not described in RFC 1195

Recommendations for Interoperable IP Networks using IS-IS

- It includes
  - Unused Features:
    - TLV 131 & 133
  - Usage of Overload Bit
  - Migration from Narrow to Wide Metric
  - ISH PDU
  - Attach Bit

Recommendations for Interoperable Networks using IS-IS

- Is documented in RFC 3719 as an Informational RFC

- This document covers the differences between the theory and practice and tries to document/close the gap.

Recommendations for Interoperable Networks using IS-IS

- It includes:
  - Variables which are constant
    - Sys-ID Length 6
    - maximumAreaAddresses 3
  - Constants which are Variable
    - MaxAge
    - ISISHoldingMultiplier
  - Padding Hello PDUs
  - Zero Checksum
  - Purging the Corrupted LSPs

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References

- IS-IS Restart

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

- IS-IS for IPv6

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

- IS-IS for MT

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

- MD5 Authentication Support

http://www.ietf.org/rfc/rfc3567.txt

References

- Recommendations for Interoperable Networks Using IS-IS

http://www.ietf.org/rfc/rfc3719.txt

- **Recommendations for Interoperable IP Networks using IS-IS**

http://www.ietf.org/internet-drafts/draft-ietf-isis-ip-interoperable-02.txt

- IS-IS Transient Blackhole Avoidance

http://www.ietf.org/rfc/rfc3277

Questions