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B. Liu, Ed.
Huawei Technologies
B. Decraene
Orange
I. Farrer
Deutsche Telekom AG
M. Abrahamsson
T-Systems
L. Ginsberg
Cisco Systems
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ISIS Auto-Configuration
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Abstract

This document specifies IS-IS auto-configuration mechanisms. The key components are IS-IS System ID self-generation, duplication detection and duplication resolution. These mechanisms provide limited IS-IS functions, and so are suitable for networks where plug-and-play configuration is expected.

Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [\[RFC2119\]](#) when they appear in ALL CAPS. When these words are not in ALL CAPS (such as "should" or "Should"), they have their usual English meanings, and are not to be interpreted as [\[RFC2119\]](#) key words.

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1. Introduction

This document specifies mechanisms for IS-IS [[RFC1195](#)] [[ISO_IEC10589](#)] [[RFC5308](#)] to be auto-configuring. Such mechanisms could reduce the management burden for configuring a network, especially where plug-and-play device configuration is required.

IS-IS auto-configuration is comprised of the following functions:

1. IS-IS default configuration.
2. IS-IS System ID self-generation.
3. System ID duplication detection and resolution.
4. ISIS TLV utilization (Authentication TLV, metrics in reachability advertisements, and Dynamic Host Name TLV).

This document also defines mechanisms to prevent the unintentional interoperation of auto-configured routers with non-autoconfigured routers. See [Section 3.3](#).

2. Scope

The auto-configuration mechanisms support both IPv4 and IPv6 deployments.

These auto-configuration mechanisms aim to cover simple deployment cases. The following important features are not supported:

- o Multiple IS-IS instances.
- o Multi-area and level-2 routing.
- o Interworking with other routing protocols.

IS-IS auto-configuration is primarily intended for use in small (i.e. 10s of devices) and unmanaged deployments. It allows IS-IS to be used without the need for any configuration by the user. It is not recommended for larger deployments.

3. Protocol Specification

3.1. IS-IS Default Configuration

- o IS-IS interfaces **MUST** be auto-configured to an interface type corresponding to their layer-2 capability. For example, Ethernet interfaces will be auto-configured as broadcast networks and

Point-to-Point Protocol (PPP) interfaces will be auto-configured as Point-to-Point interfaces.

- o IS-IS auto-configuration instances MUST be configured as level-1, so that the interfaces operate as level-1 only.
- o `originatingLSPBufferSize` is set to 512.
- o `MaxAreaAddresses` is set to 3
- o Extended IS Reachability and IP Reachability TLVs [[RFC5305](#)] MUST be used i.e. a router operating in auto configuration mode MUST NOT use any of the following TLVs:
 - * IS Neighbors (2)
 - * IP Internal Reachability (128)
 - * IP External Reachability (130)

[3.2.](#) IS-IS NET Generation

In IS-IS, a router (known as an Intermediate System) is identified by a Network Entity Title (NET) which is a type of Network Service Access Point (NSAP). The NET is the address of an instance of the IS-IS protocol running on an Intermediate System (IS).

The auto-configuration mechanism generates the IS-IS NET as the following:

- o Area address

In IS-IS auto-configuration, this field MUST be 13 octets long and set to all 0.

- o System ID

This field follows the area address field, and is 6 octets in length. There are two basic requirements for the System ID generation:

- As specified by the IS-IS protocol, this field must be unique among all routers in the same area.
- After its initial generation, the System ID SHOULD remain stable. It SHOULD NOT be changed due to device status change (such as interface enable/disable, interface connect/disconnect, device reboot, firmware update etc.) or

configuration change (such as changing system configuration or IS-IS configuration); but MUST support change as part of the System ID collision resolution process and SHOULD allow being cleared by a user initiated system reset.

More specific considerations for System ID generation are described in [Section 3.4.5](#).

3.3. Router-Fingerprint TLV

The Router-Fingerprint TLV is similar to the Router-Hardware-Fingerprint TLV defined in [\[RFC7503\]](#). However, the TLV defined here includes a flags field to support indicating that the router is in Start-up mode and is operating in auto-configuration mode.

```

      0                   1                   2                   3
      0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|   Type   |   Length   |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|S|A| Reserved |
+---+---+---+---+---+---+ Router Fingerprint (Variable)
.
.
.
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Router Fingerprint TLV Format

The length of the Router-Fingerprint is variable but MUST be 32 octets or greater. For correct operation, the Router-Fingerprint MUST be unique among all the routers participating in the IS-IS area.

- o Type: to be assigned by IANA.
- o Length: the length of the value field. Must be ≥ 33 .
- o Flags field (1 octet)

S flag: when set, indicates the router is in "start-up" mode.

A flag: when set, indicates that the router is operating in auto-configuration mode. The purpose of the flag is so that two routers can identify if they are both using auto-configuration. If the A flag setting does not match in hellos then no adjacency should be formed.

Reserved: these bits MUST be set to zero and MUST be ignored by the receiver.

- o Router Fingerprint: uniquely identifies a router, variable length.

More specific considerations for Router-Fingerprint are described in [Section 3.4.5](#).

Router Fingerprint TLV MUST be included in Intermediate System to Intermediate System Hellos (IIHs) originated by a router operating in auto-configuration mode.

Router Fingerprint TLV MUST be included in Link State PDU (LSP) #0 originated by a router operating in auto-configuration mode. The router fingerprint TLV MUST NOT be included in an LSP with a non-zero number.

[3.4. Protocol Operation](#)

This section describes the operation of a router supporting auto-configuration mode.

[3.4.1. Start-Up mode](#)

When a router starts operation in auto-configuration mode, both the S and A bits MUST be set in the Router Fingerprint TLV included in both hellos and LSP #0. During this mode only LSP #0 is generated and IS or IP/IPv6 reachability TLVs MUST NOT be included in LSP #0. A router remains in Start-up mode for a minimum period of time (recommended to be 1 minute). This time should be sufficient to bring up adjacencies to all expected neighbors. A router leaves Start-up mode once the minimum time has elapsed and full LSP database synchronization is achieved with all neighbors in the UP state.

When a router exits startup-mode it clears the S bit in Router Fingerprint TLVs it sends in hellos and LSP#0. The router MAY now advertise IS neighbor and IP/IPv6 prefix reachability in its LSPs and MAY generate LSPs with a non-zero number.

The purpose of Start-up Mode is to minimize the occurrence of System ID changes for a router once it has become fully operational. Any System ID change during Start-up mode will have minimal impact on a running network because while in Start-up mode the router is not yet being used for forwarding traffic.

[3.4.2. Adjacency Formation](#)

Routers operating in auto-configuration mode MUST NOT form adjacencies with routers which are NOT operating in auto-configuration mode. The presence of the Router Fingerprint TLV with

the A bit set indicates the router is operating in auto-configuration mode.

NOTE: The use of the special area address of all 0's makes it unlikely that a router which is not operating in auto-configuration mode will be in the same area as a router operating in auto-configuration mode. However, the check for the Router Fingerprint TLV with A bit set provides additional protection.

3.4.3. IS-IS System ID Duplication Detection and Resolution

The System ID of each node MUST be unique. As described in [Section 3.4.5](#), the System ID is generated based on entropies (e.g. MAC address) which are generally expected to be unique. However, since there may be limitations to the available entropies, there is still the possibility of System ID duplication. This section defines how IS-IS detects and resolves System ID duplication. Duplicate System ID may occur between neighbors or between routers in the same area which are not neighbors.

Duplicate System ID with a neighbor is detected when the System ID received in an IIH is identical to the local System ID and the Router-Fingerprint in the received Router-Fingerprint TLV does NOT match the locally generated Router-Fingerprint.

Duplicate System ID with a non-neighbor is detected when an LSP #0 is received, the System ID of the originator is identical to the local System ID, and the Router-Fingerprint in the Router-Fingerprint TLV does NOT match the locally generated Router-Fingerprint.

3.4.4. Duplicate System ID Resolution Procedures

When duplicate System ID is detected one of the systems MUST assign itself a different System ID and perform a protocol restart. The resolution procedure attempts to minimize disruption to a running network by choosing a router which is in Start-up mode to be restarted whenever possible.

The contents of the Router-Fingerprint TLVs for the two routers with duplicate System IDs are compared.

If one TLV has the S bit set (router is in Start-up mode) and one TLV has the S bit clear (router is NOT in Start-up mode) the router in Start-up mode MUST generate a new System ID and restart the protocol.

If both TLVs have the S bit set (both routers are in Start-up mode) or both TLVs have the S bit clear (neither router is in Start-up

mode) then the router with numerically smaller Router-Fingerprint MUST generate a new System ID and restart the protocol.

Fingerprint comparison is performed octet by octet starting from the first received octet until a difference is detected. If the fingerprints have different lengths and all octets up to the shortest length are identical then the fingerprint with smaller length is considered smaller.

If the fingerprints are identical in both content and length (and state of the S bit is identical) and the duplication is detected in hellos then the both routers MUST generate a new System ID and restart the protocol.

If fingerprints are identical in both content and length and the duplication is detected in LSP #0 then the procedures defined in [Section 3.4.6](#) MUST be followed.

[3.4.5.](#) System ID and Router-Fingerprint Generation Considerations

As specified in this document, there are two distinguishing items that need to be self-generated: the System ID and Router-Fingerprint. In a network device, normally there are some resources which can provide an extremely high probability of uniqueness thus could be used as seeds to derive distinguisher (e.g. hashing or generating pseudo-random numbers), such as:

- o MAC address(es)
- o Configured IP address(es)
- o Hardware IDs (e.g. CPU ID)
- o Device serial number(s)
- o System clock at a certain specific time
- o Arbitrary received packet(s) on an interface(s)

This document recommends the use of an IEEE 802 48-bit MAC address associated with the router as the initial System ID. This document does not specify a specific method to re-generate the System ID when duplication happens.

This document also does not specify a specific method to generate the Router-Fingerprint.

There is an important concern that the seeds listed above (except MAC address) might not be available in some small devices such as home routers. This is because of hardware/software limitations and the lack of sufficient communication packets at the initial stage in home routers when doing ISIS auto-configuration. In this case, this document suggests using the MAC address as System ID and generating a pseudo-random number based on another seed (such as the memory address of a certain variable in the program) as the Router-Fingerprint. The pseudo-random number might not have a very high probability of uniqueness in this solution, but should be sufficient in home networks scenarios.

The considerations surrounding System ID stability described in section [Section 3.2](#) also need to be applied.

[3.4.6.](#) Double-Duplication of both System ID and Router-Fingerprint

As described above, the resources for generating System ID/Fingerprint might be very constrained during the initial stages. Hence, the double-duplication of both System ID and Router-Fingerprint needs to be considered. In such a case it is possible that a router will receive an LSP with System ID and Router-Fingerprint identical to the local values but the LSP is NOT identical to the locally generated copy i.e. sequence number is newer or sequence number is the same but the LSP has a valid checksum which does not match. The term DD-LSP is used to describe such an LSP.

In a benign case, this will occur if a router restarts and it receives copies of its own LSPs from its previous incarnation. This benign case needs to be distinguished from the pathological case where there are two different routers with the same System ID and the same Router-Fingerprint.

In the benign case, the restarting router will generate a new version of its own LSP with higher sequence number and flood the new LSP version. This will cause other routers in the network to update their LSPDB and synchronization will be achieved.

In the pathological case the generation of a new version of an LSP by one of the "twins" will cause the other twin to generate the same LSP with a higher sequence number - and oscillation will continue without achieving LSPDB synchronization.

Note that comparison of S bit in the Router-Fingerprint TLV cannot be performed as in the benign case it is expected that the S bit will be clear. Also note that the conditions for detecting duplicate System ID will NOT be satisfied because both the System ID and the Router-Fingerprint will be identical.

The following procedure is defined:

- DD-state is a boolean which indicates if a DD-LSP #0 has been received
- DD-count is the count of the number of occurrences of reception of a DD-LSP
- DD-timer is a timer associated with reception of DD-LSPs. Recommended value is 60 seconds.
- DD-max is the maximum number of DD-LSPs allowed to be received in DD-timer interval. Recommended value is 3.

When a DD-LSP is received:

If DD-state is FALSE:

- DD-state is set to TRUE
- DD-timer is started
- DD-count is initialized to 1.

If DD-state is TRUE:

- DD-count is incremented
- If DD-count is $\geq$ DD-max:
 - Local system MUST generate a new System ID and Router-Fingerprint and restart the protocol
- DD-state is (re)initialized to FALSE and DD-timer cancelled.

If DD-timer expires:

- DD-state is set to FALSE.

Note that to minimize the likelihood of double-duplication reoccurring, routers SHOULD have more entropies available. One simple way to achieve this is to add the LSP sequence number of the next LSP it will send to the Router-Fingerprint.

[3.5.](#) Additional IS-IS TLVs Usage Guidelines

This section describes the behavior of selected TLVs when used by a router supporting IS-IS auto-configuration.

[3.5.1.](#) Authentication TLV

It is RECOMMENDED that IS-IS routers supporting this specification offer an option to explicitly configure a single password for HMAC-MD5 authentication as specified in[RFC5304].

3.5.2. Metric Used in Reachability TLVs

It is RECOMMENDED that IS-IS auto-configuration routers use a high metric value (e.g. 100000) as default in order to allow manually configured adjacencies to be preferred over auto-configured.

3.5.3. Dynamic Host Name TLV

IS-IS auto-configuration routers MAY advertise their Dynamic Host Name TLV (TLV 137, [\[RFC5301\]](#)). The host name could be provisioned by an IT system, or just use the name of vendor, device type or serial number, etc.

To guarantee the uniqueness of the host name, the System ID SHOULD be appended as a suffix in the names.

4. Security Considerations

In general, the use of authentication is incompatible with auto-configuration as it requires some manual configuration.

For wired deployment, the wired connection itself could be considered as an implicit authentication in that unwanted routers are usually not able to connect (i.e. there is some kind of physical security in place preventing the connection of rogue devices); for wireless deployment, the authentication could be achieved at the lower wireless link layer.

5. IANA Considerations

This document requires the definition of a new IS-IS TLV to be reflected in the "IS-IS TLV Codepoints" registry:

Type	Description	IIH	LSP	SNP	Purge
----	-----	---	---	---	-----
TBA	Router-Fingerprint	Y	Y	N	Y

6. Acknowledgements

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Authors' Addresses

Bing Liu (editor)
Huawei Technologies
Q10, Huawei Campus, No.156 Beiqing Road
Hai-Dian District, Beijing, 100095
P.R. China

Email: leo.liubing@huawei.com

Bruno Decraene
Orange
France

Email: bruno.decraene@orange.com

Ian Farrer
Deutsche Telekom AG
Bonn
Germany

Email: ian.farrer@telekom.de

Mikael Abrahamsson
T-Systems
Stockholm
Sweden

Email: mikael.abrahamsson@t-systems.se

Les Ginsberg
Cisco Systems
821 Alder Drive
Milpitas CA 95035
USA

Email: ginsberg@cisco.com