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OSPF Synchronization Group
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Abstract

OSPF is a fundamental component for a routing system. It depends on the flooding mechanism to advertise and synchronize link-state database among distributed nodes in a network. As modern networks become larger and more complex, more and more nodes and adjacencies are involved. As a result, massive link-state information are generated and synchronized which are becoming an overhead of networks nowadays.

This document proposes a new design of OSPF database synchronization that is slightly different from the one stated in OSPF. This new design can help to alleviate the overhead by dividing OSPF routers into independent synchronization groups and limiting synchronization across the group border. Since less burden from synchronization, it is possible to accommodate more OSPF routers and adjacencies in a network.

Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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1. Introduction

OSPF is a fundamental component for a routing system. It depends on the flooding mechanism to advertise and synchronize link-state database among distributed nodes in a network. As modern networks become larger and more complex, more and more nodes and adjacencies

are involved. As a result, massive link-state information are generated and synchronized which are becoming an overhead of networks nowadays.

This document proposes a new design of OSPF database synchronization that is slightly different from the one stated in [RFC2328]. This new design can help to alleviate the overhead by dividing OSPF routers into independent synchronization groups and limiting synchronization across the group border. Since less burden from synchronization, it is possible to accommodate more OSPF routers and adjacencies in a network.

In some scenarios, the routers in those networks suffer from limited CPU or storage resource which make them unqualified for large networks. With the help from this new design the situation can be improved.

2. Terminology

Synchronization Group (SG) : A sub-domain of one OSPF area in which the link-state database synchronization only happened among those routers in the same group.

Synchronization Group ID (SGID) : The identity of a Synchronization Group which MUST be unique in one OSPF network.

Synchronization Group Member (SGM) : One role of OSPF router which belongs to an unique Synchronization Group by carrying the SGID in its Hello packet. Adjacencies MUST NOT be established among SGMs from different SGs.

Synchronization Group Member Interface (SGMI) : The interface of a Synchronization Group Member.

Synchronization Group Director (SGD) : One role of OSPF router whose adjacencies MUST follow the standard procedure instead of affected by

SGIDs.

Synchronization Group Director Interface (SGDI) : The interface of a Synchronization Group Director.

3. Problem Statement

As stated in [RFC2328], the flooding procedure supplied a reliable advertisement mechanism through which the link-state database is synchronized in an OSPF network. Forwarding loops or routing black-hole can be introduced if synchronization status is not achieved. There are some devices for which it is difficult to host the whole

link-state database since they may possess limited CPU or storage resource. Even for those devices which have enough resource, it is still an unneglectable overhead in a periodical manner.

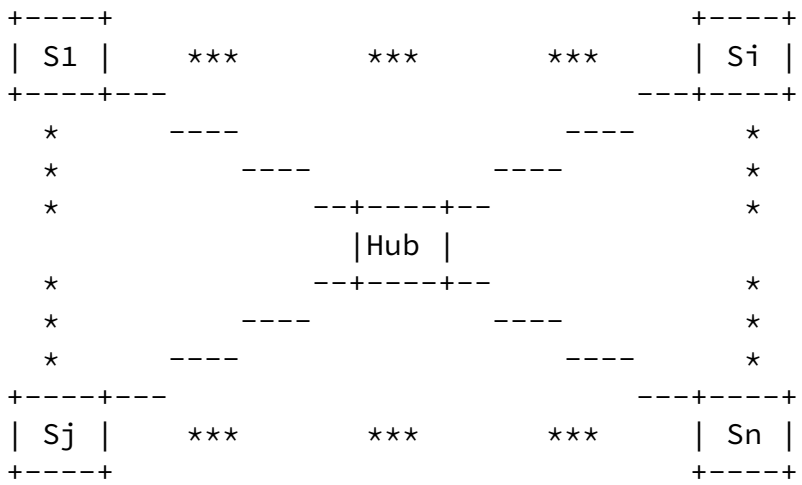


Figure 1 Hub and Spoke scenario

As showed in Figure 1, the hub sub-network established OSPF adjacencies with many spoke sub-networks indexed from S1 to Sn separately. Every LSAs generated by a single spoke have to be flooded to the rest of spokes through hub and vice versa. Let's assume there are m LSAs originated by each spoke then the total number of LSAs advertised among hub and spokes can be roughly counted as m * n, excluding the number of retransmission. What is worse, these LSA copies have to be refreshed every LSRefreshTime. This advertisement is indeed an unnecessary burden for devices with

limited resources and even those devices with enough resources since all routes in one spoke share the same next hop which is the hub.

4. Proposed Solution

This document introduces a new mechanism which can solve the issue stated above through limiting synchronization scope inside a Synchronization Group instead of an area. The solution metioned here should be effective primarily in the hub-and-spoke scenario.

4.1. Overview of a Synchronization Group

A Synchronization Group (SG) is a sub-domain of one OSPF area in which the link-state database synchronization only happened among those routers in the same group. Each SG is identified uniquely by an identification number which is called SGID.

There are two roles involved into one Synchronization Group: Synchronization Group Member (SGM) and Synchronization Group Director

(SGD). The same SGD may be involved into several SGs simultaneously. Different SGDs are REQUIRED to interconnect with each other without passing through SGMs. The interfaces SGM and SGD used to form adjacencies are inherently called SGMI and SGDI. A SGMI or SGDI MUST belong to a single SG.

4.2. LSA Synchronization in a Group

Link-state database synchronization among SGDs follows the same procedure stated in [RFC2328]. They maintain the complete database of the area they belong to. This database is used to advertise among SGDs and consumed in the SPF calculation.

On the other side, SGMs only possess those LSAs that are learned from other SDMs and several LSAs leaked by their corresponding SGDs. SGMs advertise and use their LSDB in the manner as the standard document specified.

When OSPF adjacencies built between a SGD and a SGM, the synchronization between them SHOULD follow the specification defined in this document. In order to decrease the size of SGM's LSDB, a SGD only advertise necessary LSAs to its adjacent SGMs. Those LSAs in

necessity include the Router-LSAs of SGDs in the same SG, the Network-LSAs if some of SGDs are DR for their corresponding networks and some Extended Prefix Opaque LSAs[I-D.ietf-ospf-prefix-link-attr] originated by SGDs to serve for limited reachability for SGMs.

5. Changes to the protocol

This document introduced some changes to OSPF[RFC2328] which is necessary to support SG.

5.1. Changes to the Flooding mechanism

SGDI and SGMI SHOULD be used to send and receive the LSAs updating in one SG. The LSA's SG belonging is identified by its originator's SGID. If MaxAge LSA is received, it SHOULD be processed as described in section 13 of OSPF[RFC2328]. If a LSA is received from a neighbor that does not support SG, it SHOULD be processed as standardized since SG feature is ineffective between them.

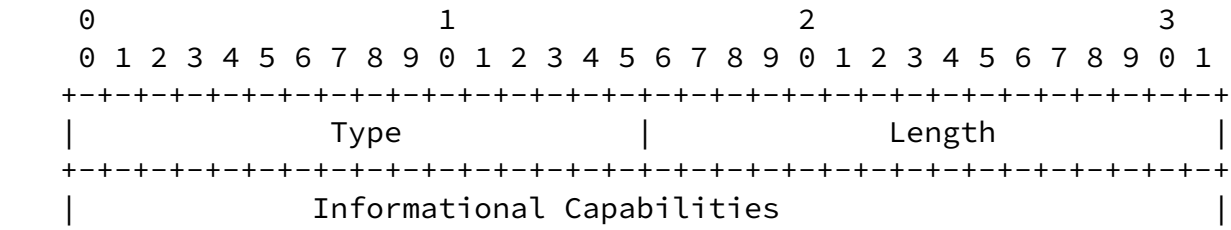
When LSDB synchronization happened between SGDs and SGMs, only limited LSDB SHOULD be flooded from SGDs to SGMs. As stated above, instead of flooding all LSAs to SGMs, only Router-LSAs and Network-LSAs in the same Group SHOULD be flooded to SGMs. On the contrary, SGMs SHOULD synchronize their whole LSDB to SGDs as standandized.

5.2. Route Calculation

No change introduced for route calculation in this document.

5.3. Protocol Extension

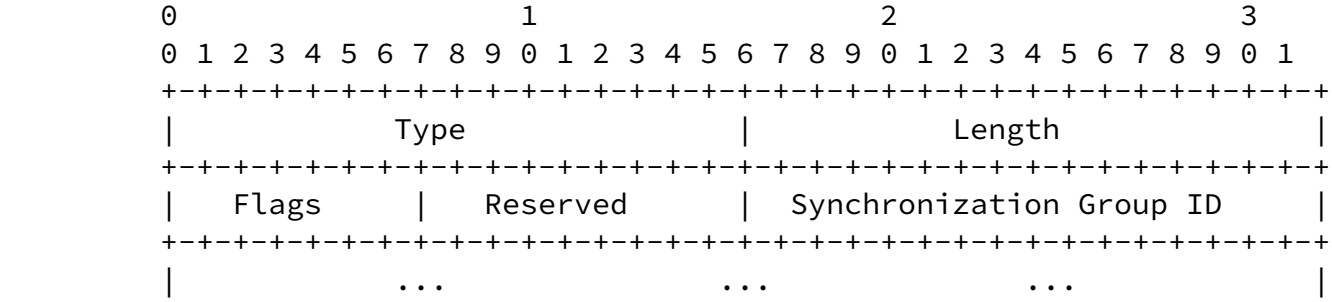
One new bit is introduced into Router Informational Capabilities TLV to indicate its originator supporting SG capability or not.

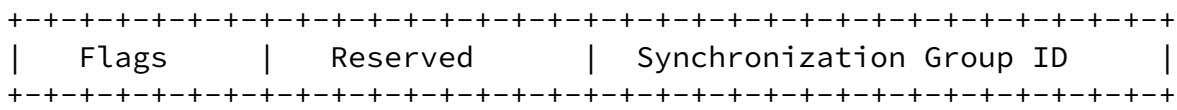


Bit TBD: OSPF Synchronization Group capable

Figure 2 SG-bit in Informational Capabilities TLV

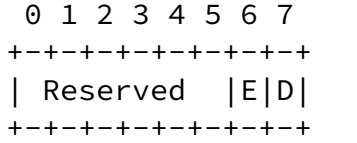
A new TLV called Synchronization Group TLV is defined to be included in Router Information Opaque LSA[RFC4970]. Every router that support SG feature MUST contain this TLV in its RI Opaque-LSA. SGID and role of SGM or SGD can be learnt by parsing this TLV and act accordingly.





Type: TBD
Length: 2 octets
Synchronization Group ID: ID of this SG.

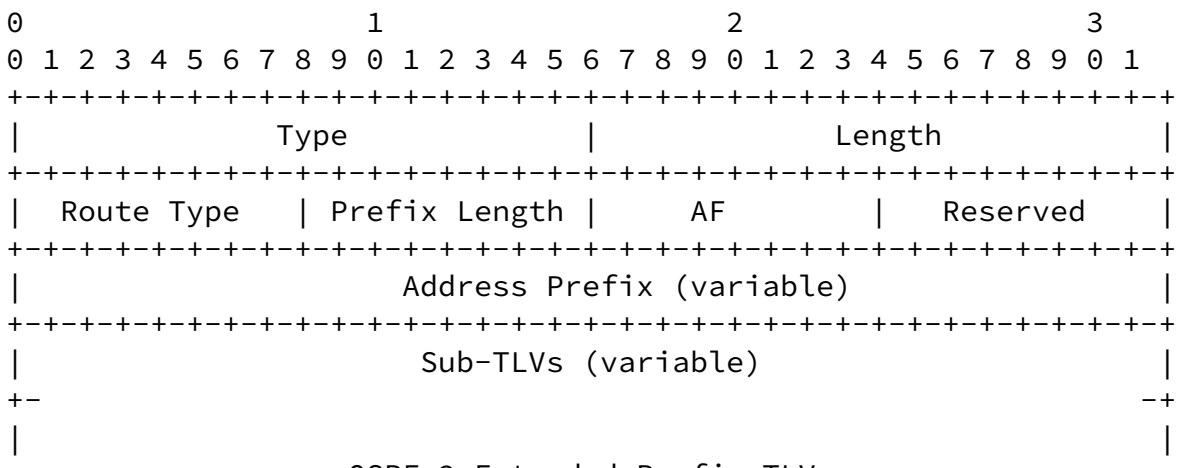
Flags:



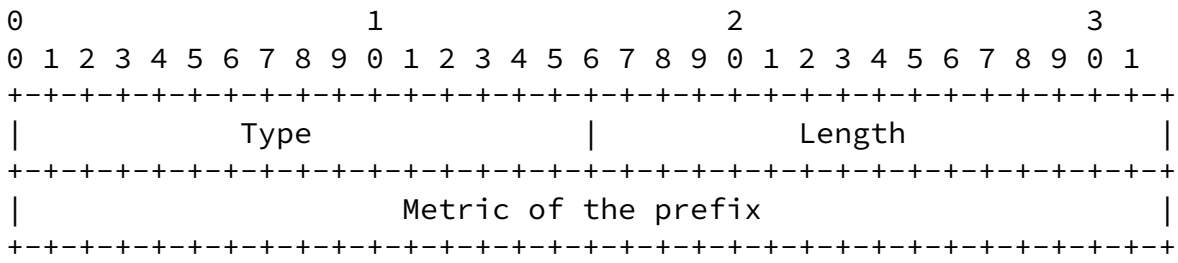
Bit-D: Set if Synchronization Group Director.
Bit-E: Set if Synchronization Group Director is elected as Designated SGD fo

Figure 3 Synchronization Group TLV

Extended Prefix TLV SHOULD be used by SGDs to advertise default route or necessary aggregated prefixes to SGMs. New sub-TLV is introduced to identify metrics for corresponding prefixes. The metric used in the sub-TLV SHOULD be the actual number from SGDs to the destination of the prefix.



OSPFv2 Extended Prefix TLV



Type: TBD
Length: 2 octets
Metric of the prefix: The actual metric for corresponding prefix.

Figure 4 Sub-TLV used to express prefix metric

5.4. Protocol Process

Synchronization Group TLV MUST be carried in the RI Opaque-LSA with SG-bit set if the originator support SG feature. It SHOULD be regarded as not supporting SG feature If this TLV is not carried or SG-bit is clear. SGDs and SGMs MUST send this TLV with corresponding SGIDs set and with correct Bit-D status. If there are more than one Synchronization Group TLVs carried in RI Opaque-LSAs then the originator SHOULD be regarded as supporing all those carried SGs.

6. Multi-homed SG consideration

6.1. Problem Statement

In certain scenario, one SG may multi-homed to two or more SGDs. Forwarding loops may be observed when topology changed since the link-state database of SGD and SGM can be different. In order to solve this issue, one tunnel is REQUIRED to be established among SGDs with the metric lower than the path through SG.

As shown below, when link between SGD2 and SG1A failed, the best path to reach SG1A is SGD2->SGD4->SG2A->SGD3->SGD1->SG1A. Since SG2A only have default route originated by its SGDs, saying SGD3 and SGD4, forwarding loops can be observed. Even special handling was taken on SGD4, such as avoiding traveling through SDMs, traffic black hole could happen on SGD4 since SGD2 will insist on its choice. What is worse, assuming SGD2 generated the same prefix as SG1A did but with shorter prefix length, since SGD4 should ignore the link between SGD4 and SG2A that will cause transversal traffic, this shorter prefix will be the best match for the original destination, so forwarding loop can be observed between SGD2 and SGD4.

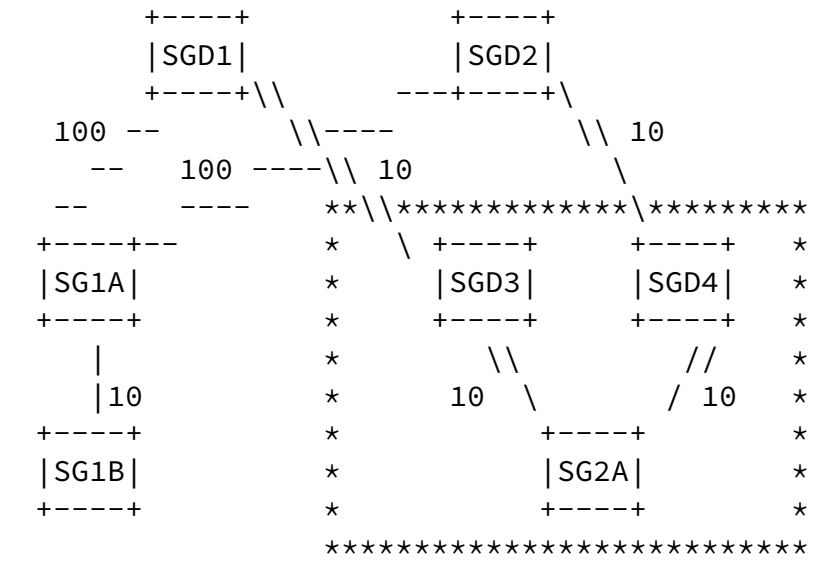


Figure 5 Multi-homed SG scenario

6.2. Proposed Solution

The root cause for the issue above is the inconsistent status of LSDB between SGDs and SGMs. In order to solve this flaw, we may simply add one restriction to SGDs that SG sub-networks can't be passed through to reach another SGD. With this restriction, inconsistent routing-table can be observed between SGDs and the rest of networks in the same area, like SGD2 and SGD4 did above. Two solutions proposed here.

Solution I: SGDs in the same SG are REQUIRED to automatically interconnect with each other using certain tunnels. The tunnel can be created when the SGD Router-LSA in the same SG is received. The

traffic SHOULD be redirected into tunnels when the SGD finds the next hop points to one SGM. The exact tunnel type used here is out of the scope of this document.

Solution II: When a SG is multi-homed to multiple SGDs, SGDs and SGMs in the same SG SHOULD elect one Designated SGD (DSGD) from those candidate SGDs. Adjacencies SHOULD NOT be built between the non-designated SGDs and SDMs. A new DSGD SHOULD be elected among left candidates when the current DSGD failed.

With one of the solutions above, forwarding loops and traffic black hole are believed to be prevented.

7. Backward Compatibility

It is RECOMMENDED that SG feature is deployed all over the network at the same time. Otherwise It will work in the standardized manner without harm introduced into current network if partial deployment is used.

8. IANA Considerations

This document requests that IANA allocate from the OSPF TLV Codepoints Registry for a new TLV, referred to as the "Synchronization Group TLV".

9. Security Considerations

This document does not introduce any new security concerns to OSPF or any other specifications referenced in this document.

10. Acknowledgement

The authors would like to thank Eric Wu for his valuable suggestion on this draft.

11. References

11.1. Normative References

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