

Network Working Group
Internet-Draft
Intended status: Standards Track
Expires: January 30, 2020

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Flooding Topology Computation Algorithm
draft-cc-lsr-flooding-reduction-05

Abstract

This document proposes an algorithm for a node to compute a flooding topology, which is a subgraph of the complete topology per underline physical network. When every node in an area automatically calculates a flooding topology by using a same algorithm and floods the link states using the flooding topology, the amount of flooding traffic in the network is greatly reduced. This would reduce convergence time with a more stable and optimized routing environment.

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](#)].

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Table of Contents

1.	Introduction	2
2.	Terminology	3
3.	Flooding Topology	3
3.1.	Flooding Topology Construction	3
4.	Algorithms to Compute Flooding Topology	4
4.1.	Algorithm with Considering Degree	5
4.2.	Algorithm with Considering Others	5
5.	Security Considerations	6
6.	IANA Considerations	6
7.	Acknowledgements	6
8.	References	6
8.1.	Normative References	7
8.2.	Informative References	7
	Authors' Addresses	7

[1.](#) Introduction

For some networks such as dense Data Center (DC) networks, the existing Link State (LS) flooding mechanism is not efficient and may have some issues. The extra LS flooding consumes network bandwidth. Processing the extra LS flooding, including receiving, buffering and decoding the extra LSs, wastes memory space and processor time. This may cause scalability issues and affect the network convergence negatively.

This document proposes an algorithm for a node to compute a flooding topology, which is a subgraph of the complete topology per underline physical network. When every node in an area automatically calculates a flooding topology by using a same algorithm and floods the link states using the flooding topology, the amount of flooding traffic in the network is greatly reduced. This would reduce convergence time with a more stable and optimized routing environment.

There may be multiple algorithms for computing a flooding topology. Users can select one they prefer, and smoothly switch from one to another.

2. Terminology

LSA: A Link State Advertisement in OSPF.

LSP: A Link State Protocol Data Unit (PDU) in IS-IS.

LS: A Link Sate, which is an LSA or LSP.

FT: Flooding Topology.

FTC: Flooding Topology Computation.

3. Flooding Topology

For a given network topology, a flooding topology is a sub-graph or sub-network of the given network topology that has the same reachability to every node as the given network topology. Thus all the nodes in the given network topology MUST be in the flooding topology. All the nodes MUST be inter-connected directly or indirectly. As a result, LS flooding will in most cases occur only on the flooding topology, that includes all nodes but a subset of links. Note even though the flooding topology is a sub-graph of the original topology, any single LS MUST still be disseminated in the entire network.

3.1. Flooding Topology Construction

Many different flooding topologies can be constructed for a given network topology. For example, a chain connecting all the nodes in the given network topology is a flooding topology. A circle connecting all the nodes is another flooding topology. A tree connecting all the nodes is a flooding topology. In addition, the tree plus the connections between some leaves of the tree and branch nodes of the tree is a flooding topology.

The following parameters need to be considered for constructing a flooding topology:

- o Degree: The degree of the flooding topology is the maximum degree among the degrees of the nodes on the flooding topology. The degree of a node on the flooding topology is the number of connections on the flooding topology it has to other nodes.
- o Number of links: The number of links on the flooding topology is a key factor for reducing the amount of LS flooding. In general, the smaller the number of links, the less the amount of LS flooding.
- o Diameter: The diameter of the flooding topology is the shortest distance between the two most distant nodes on the flooding topology. It is a key factor for reducing the network convergence time. The smaller the diameter, the less the convergence time.
- o Redundancy: The redundancy of the flooding topology means a tolerance to the failures of some links and nodes on the flooding topology. If the flooding topology is split by some failures, it is not tolerant to these failures. In general, the larger the number of links on the flooding topology is, the more tolerant the flooding topology to failures.

Note that the flooding topology constructed by a node is dynamic in nature, that means when the base topology (the entire topology graph) changes, the flooding topology (the sub-graph) MUST be re-computed/ re-constructed to ensure that any node that is reachable on the base topology MUST also be reachable on the flooding topology.

4. Algorithms to Compute Flooding Topology

There are many algorithms to compute a flooding topology. A simple and efficient one is briefed below.

- o Select a node R_0 according to a rule such as the node with the smallest node ID;
- o Build a tree using R_0 as root of the tree; and then
- o Connect each node whose degree is one to the tree to have a flooding topology.

4.1. Algorithm with Considering Degree

The algorithm starts from node R_0 as root with a given maximum degree $MaxD$ such as $MaxD = 3$, a candidate queue $Cq = \{(R_0, D = 0, PHs = \{ \})\}$, and an empty flooding topology $FT = \{ \}$. Cq contains one element $(R_0, D = 0, PHs = \{ \})$, where node R_0 is the root, $D = 0$ indicates that the Degree (D for short) of R_0 is 0 (i.e., the number of links on the flooding topology connected to R_0 is 0), $PHs = \{ \}$ indicates that the Previous Hops (PHs for short) of R_0 is empty.

1. Finding and removing the first element with node A in Cq that is not on FT and one PH 's D in $PHs < MaxD$.

If A is root R_0 , then add the element into FT

otherwise (i.e., $A \neq R_0$ with one PH 's D in $PHs < MaxD$. Assume that PH is the first one in PHs whose $D < MaxD$), PH 's $D++$, and add A with $D = 1$ and $PHs = \{PH\}$ into FT .

Note: if there is no element in Cq satisfying the conditions, then algorithm may be restarted from R_0 , $++MaxD$, $Cq = \{(R_0, D=0, PHs = \{ \})\}$, $FT = \{ \}$;

2. If all the nodes are on the FT , then goto step 4;
3. Suppose that node X_i ($i = 1, 2, \dots, n$) is connected to node A and not on FT , and X_1, X_2, \dots, X_n are in an increasing order by their IDs (i.e., X_1 's ID $<$ X_2 's ID $< \dots <$ X_n 's ID). If X_i is not in Cq , then add it into the end of Cq with $D = 0$ and $PHs = \{A\}$; otherwise (i.e., X_i is in Cq), add A into the end of X_i 's PHs ; Goto step 1.
4. For each node B in FT whose D is one (from minimum to maximum node ID), find a link L attached to B such that L 's remote node R has minimum D and ID, add link L between B and R into FT and increase B 's D and R 's D by one. Return FT .

4.2. Algorithm with Considering Others

There may be some constraints on some nodes in a network. For example, in a spine-and-leaf network, there may be a constraint on the degree of every leaf node on the flooding topology, which is that the degree of every leaf node is not greater than a given number $ConMaxD$ such as $ConMaxD = 2$. For each of the other nodes such as the spine nodes, there is no such constraint, that is that $ConMaxD$ is a huge number for each of these nodes.

Step 1 of the algorithm described above is updated below to consider this constraint. In addition to checking constraint PH's $D < \text{MaxD}$, step 1 checks another constraint PH's $D < \text{PH's ConMaxD}$.

1. Finding and removing the first element with node A in Cq that is not on FT and one PH's D in PHs $< \text{MaxD}$ and PH's $D < \text{PH's ConMaxD}$.

If A is root R0, then add the element into FT

otherwise (i.e., $A \neq R0$ with one PH's D in PHs $< \text{MaxD}$ and PH's $D < \text{PH's ConMaxD}$. Assume that PH is the first one in PHs whose $D < \text{MaxD}$ and PH's $D < \text{PH's ConMaxD}$), PH's $D++$, and add A with $D = 1$ and PHs = {PH} into FT.

Note: if there is no element with a node in Cq satisfying the conditions, then algorithm may be restarted from R0, $++\text{MaxD}$, $Cq = \{(R0, D=0, \text{PHs} = \{ \})\}$, $FT = \{ \}$;

5. Security Considerations

This document does not introduce any new security issue.

6. IANA Considerations

Under Registry Name: "IGP Algorithm Type For Computing Flooding Topology" under an existing "Interior Gateway Protocol (IGP) Parameters" IANA registries (refer to [Section 7.3](#). IGP [[I-D.ietf-lsr-dynamic-flooding](#)]), IANA is requested to assign one value of IGP Algorithm Type For Computing Flooding Topology as follows:

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Type Value		Type Name	reference
+=====+=====+=====+			
1		Breadth First Minimum Degree Algorithm	This document
+-----+-----+-----+			

7. Acknowledgements

The authors would like to thank Acee Lindem, Zhibo Hu, Robin Li, Stephane Litkowski and Alvaro Retana for their valuable suggestions and comments on this draft.

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