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A. Lindem
Cisco Systems
Y. Qu
Futurewei
A. Roy
Arrcus, Inc.
S. Mirtorabi
Cisco Systems
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OSPF Transport Instance Extensions
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Abstract

OSPFv2 and OSPFv3 include a reliable flooding mechanism to disseminate routing topology and Traffic Engineering (TE) information within a routing domain. Given the effectiveness of these mechanisms, it is convenient to envision using the same mechanism for dissemination of other types of information within the domain. However, burdening OSPF with this additional information will impact intra-domain routing convergence and possibly jeopardize the stability of the OSPF routing domain. This document presents mechanism to relegate this ancillary information to a separate OSPF instance and minimize the impact.

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1. Introduction

OSPFv2 [RFC2328] and OSPFv3 [RFC5340] include a reliable flooding mechanism to disseminate routing topology and Traffic Engineering (TE) information within a routing domain. Given the effectiveness of these mechanisms, it is convenient to envision using the same mechanism for dissemination of other types of information within the domain. However, burdening OSPF with this additional information will impact intra-domain routing convergence and possibly jeopardize the stability of the OSPF routing domain. This document presents mechanism to relegate this ancillary information to a separate OSPF instance and minimize the impact.

This OSPF protocol extension provides functionality similar to "Advertising Generic Information in IS-IS" [RFC6823]. Additionally, OSPF is extended to support sparse non-routing overlay topologies Section 4.7.

2. 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 BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

3. Possible Use Cases

3.1. MEC Service Discovery

Multi-Access Edge Computing (MEC) plays an important role in 5G architecture. MEC optimizes the performance for ultra-low latency and high bandwidth services by providing networking and computing at the edge of the network [ETSI-WP28-MEC]. To achieve this goal, it's important to expose the network capabilities and services of a MEC device to 5G User Equipment UE, i.e. UEs.

The followings are an incomplete list of the kind of information that OSPF transport instance can help to disseminate:

- o A network service is realized using one or more physical or virtualized hosts in MEC, and the locations of these service points might change. The auto-discovery of these service locations can be achieved using an OSPF transport instance.

- o UEs might be mobile, and MEC should support service continuity and application mobility. This may require service state transferring and synchronization. OSPF transport instance can be used to synchronize these states.
- o Network resources are limited, such as computing power, storage. The availability of such resources is dynamic, and OSPF transport instance can be used to populate such information, so applications can pick the right location of such resources, hence improve user experience and resource utilization.

3.2. Application Data Dissemination

Typically a network consists of routers from different vendors with different capabilities, and some applications may want to know whether a router supports certain functionality or where to find a router supports a functionality, so it will be ideal if such kind of information is known to all routers or a group of routers in the network. For example, an ingress router needs to find an egress router that supports In-situ Flow Information Telemetry (IFIT) [I-D.wang-lsr-igp-extensions-ifit] and obtain IFIT parameters.

OSPF transport instance can be used to populate such router capabilities/functionalities without impacting the performance or convergence of the base OSPF protocol.

3.3. Intra-Area Topology for BGP-LS Distribution

In some cases, it is desirable to limit the number of BGP-LS [RFC5572] sessions with a controller to the a one or two routers in an OSPF domain. However, many times those router(s) do not have full visibility to the complete topology of all the areas. To solve this problem without extended the BGP-LS domain, the OSPF LSAs for non-local area could be flooded over the OSPF transport instance topology using remote neighbors Section 4.7.1.

4. OSPF Transport Instance

In order to isolate the effects of flooding and processing of non-routing information, it will be relegated to a separate protocol instance. This instance should be given lower priority when contending for router resources including processing, backplane bandwidth, and line card bandwidth. How that is realized is an implementation issue and is outside the scope of this document.

Throughout the document, non-routing refers to routing information that is not used for IP or IPv6 routing calculations. The OSPF

transport instance is ideally suited for dissemination of routing information for other protocols and layers.

4.1. OSPFv2 Transport Instance Packet Differentiation

OSPFv2 currently does not offer a mechanism to differentiate Transport instance packets from normal instance packets sent and received on the same interface. However, the [RFC6549] provides the necessary packet encoding to support multiple OSPF protocol instances.

4.2. OSPFv3 Transport Instance Packet Differentiation

Fortunately, OSPFv3 already supports separate instances within the packet encodings. The existing OSPFv3 packet header instance ID field will be used to differentiate packets received on the same link (refer to section 2.4 in [RFC5340]).

4.3. Instance Relationship to Normal OSPF Instances

In OSPF transport instance, we must guarantee that any information we've received is treated as valid if and only if the router sending it is reachable. We'll refer to this as the "condition of reachability" in this document.

The OSPF transport instance is not dependent on any other OSPF instance. It does, however, have much of the same as topology information must be advertised to satisfy the "condition of reachability".

Further optimizations and coupling between an OSPF transport instance and a normal OSPF instance are beyond the scope of this document. This is an area for future study.

4.4. Network Prioritization

While OSPFv2 (section 4.3 in [RFC2328]) are normally sent with IP precedence Internetwork Control, any packets sent by an OSPF transport instance will be sent with IP precedence Flash (B'011'). This is only appropriate given that this is a pretty flashy mechanism.

Similarly, OSPFv3 transport instance packets will be sent with the traffic class mapped to flash (B'011') as specified in ([RFC5340]).

By setting the IP/IPv6 precedence differently for OSPF transport instance packets, normal OSPF routing instances can be given priority during both packet transmission and reception. In fact, some router

implementations map the IP precedence directly to their internal packet priority. However, internal router implementation decisions are beyond the scope of this document.

4.5. OSPF Transport Instance Omission of Routing Calculation

Since the whole point of the transport instance is to separate the routing and non-routing processing and fate sharing, a transport instance SHOULD NOT install any IP or IPv6 routes. OSPF routers SHOULD NOT advertise any transport instance LSAs containing IP or IPv6 prefixes and OSPF routers receiving LSAs advertising IP or IPv6 prefixes SHOULD ignore them. This implies that an OSPF transport instance Link State Database should not include any of the LSAs as shown in Table 1.

OSPFv2	summary-LSAs (type 3) AS-external-LSAs (type 5) NSSA-LSAs (type 7)
OSPFv3	inter-area-prefix-LSAs (type 2003) AS-external-LSAs (type 0x4005) NSSA-LSAs (type 0x2007) intra-area-prefix-LSAs (type 0x2009)
OSPFv3 Extended LSA	E-inter-area-prefix-LSAs (type 0xA023) E-as-external-LSAs (type 0xC025) E-Type-7-NSSA (type 0xA027) E-intra-area-prefix-LSA (type 0xA029)

LSAs not included in OSPF transport instance

If these LSAs are erroneously advertised, they will be flooded as per standard OSPF but MUST be ignored by OSPF routers supporting this specification.

4.6. Non-routing Instance Separation

It has been suggested that an implementation could obtain the same level of separation between IP routing information and non-routing information in a single instance with slight modifications to the OSPF protocol. The authors refute this contention for the following reasons:

- o Adding internal and external mechanisms to prioritize routing information over non-routing information are much more complex

than simply relegating the non-routing information to a separate instance as proposed in this specification.

- o The instance boundary offers much better separation for allocation of finite resources such as buffers, memory, processor cores, sockets, and bandwidth.
- o The instance boundary decreases the level of fate sharing for failures. Each instance may be implemented as a separate process or task.
- o With non-routing information, many times not every router in the OSPF routing domain requires knowledge of every piece of non-routing information. In these cases, groups of routers which need to share information can be segregated into sparse topologies greatly reducing the amount of non-routing information any single router needs to maintain.

4.7. Non-Routing Sparse Topologies

With non-routing information, many times not every router in the OSPF routing domain requires knowledge of every piece of non-routing information. In these cases, groups of routers which need to share information can be segregated into sparse topologies. This will greatly reduce the amount of information any single router needs to maintain with the core routers possibly not requiring any non-routing information at all.

With normal OSPF, every router in an OSPF area must have every piece of topological information and every intra-area IP or IPv6 prefix. With non-routing information, only the routers needing to share a set of information need be part of the corresponding sparse topology. For directly attached routers, one only needs to configure the desired topologies on the interfaces with routers requiring the non-routing information. When the routers making up the sparse topology are not part of a unconnected graph, two alternatives exist. The first alternative is configure tunnels to form a fully connected graph including only those routers in the sparse topology. The second alternative is use remote neighbors as described in Section 4.7.1.

4.7.1. Remote OSPF Neighbor

With sparse topologies, OSPF routers sharing non-routing information may not be directly connected. OSPF adjacencies with remote neighbors are formed exactly as they are with regular OSPF neighbors. The main difference is that a remote OSPF neighbor's address is configured and IP routing is used to deliver OSPF protocol packets to

the remote neighbor. Other salient feature of the remote neighbor include:

- o All OSPF packets have the remote neighbor's configured IP address as the IP destination address.
- o The adjacency is represented in the router Router-LSA as a router (type-1) link with the link data set to the remote neighbor's configured IP address.
- o Similar to NBMA networks, a poll-interval is configured to determine if the remote neighbor is reachable. This value is normally much higher than the hello interval with 40 seconds RECOMMENDED as the default.

4.8. Multiple Topologies

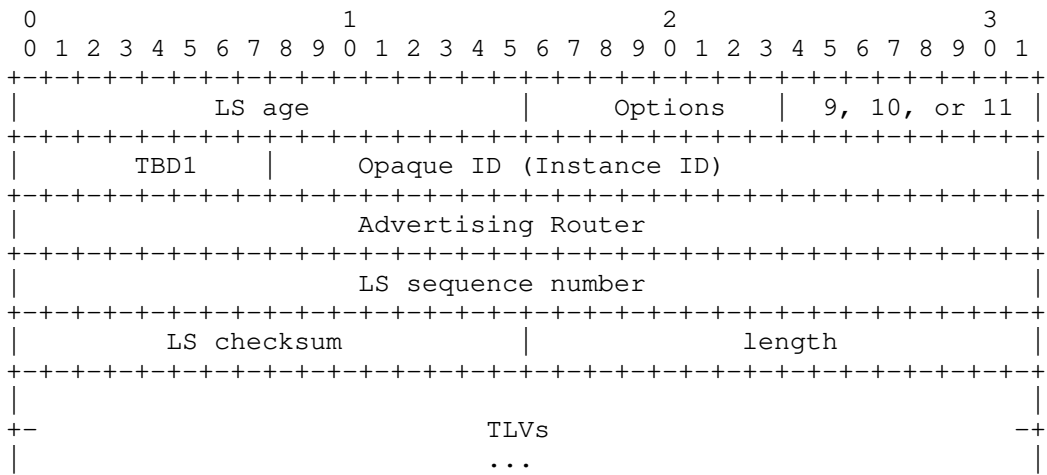
For some applications, the information need to be flooded only to a topology which is a subset of routers of the transport instance. This allows the application specific information only to be flooded to routers that support the application. A transport instance may support multiple topologies as defined in [RFC4915]. But as pointed out in Section 4.5, a transport instance or topology SHOULD NOT install any IP or IPv6 routes.

Each topology associated with the transport instance MUST be fully connected in order for the LSAs to be successfully flooded to all routers in the topology.

5. OSPF Transport Instance Information (TII) Encoding

5.1. OSPFv2 Transport Instance Information Encoding

Application specific information will be flooded in opaque LSAs as specified in [RFC5250]. An Opaque LSA option code will be reserved for Transport Instance Information (TII) as described in Section 8. The TII LSA can be advertised at any of the defined flooding scopes (link, area, or autonomous system (AS)).



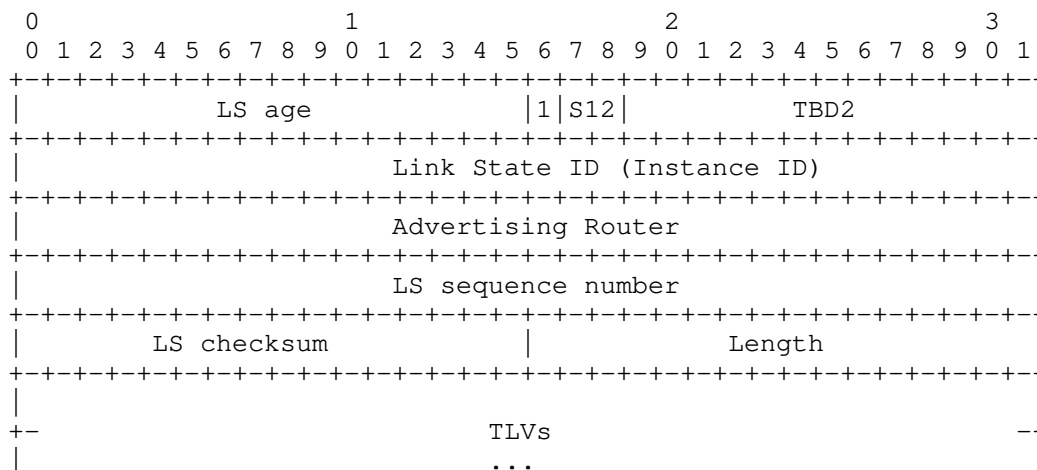
g

OSPFv2 Transport Instance Information Opaque LSA

The format of the TLVs within the body of an TII LSA is as defined in Section 5.3.

5.2. OSPFv3 Transport Instance Information Encoding

Application specific information will be flooded in separate LSAs with a separate function code. Refer to section A.4.2.1 of [RFC5340]. for information on the LS Type encoding in OSPFv3, and section 2 of [RFC8362] for OSPFv3 extended LSA types. An OSPFv3 function code will be reserved for Transport Instance Information (TII) as described in Section 8. Same as OSPFv2, the TII LSA can be advertised at any of the defined flooding scopes (link, area, or autonomous system (AS)). The U bit will be set indicating that OSPFv3 TTI LSAs should be flooded even if it is not understood.

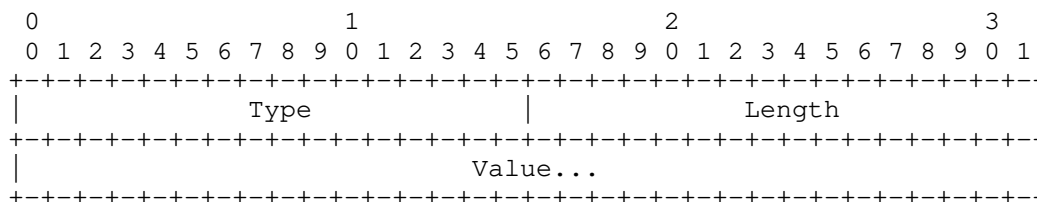


OSPFv3 Transport Instance Information LSA

The format of the TLVs within the body of an TII LSA is as defined in Section 5.3.

5.3. Transport Instance Information (TII) TLV Encoding

The format of the TLVs within the body of the LSAs containing non-routing information is the same as the format used by the Traffic Engineering Extensions to OSPF [RFC3630]. The LSA payload consists of one or more nested Type/Length/Value (TLV) triplets. The format of each TLV is:

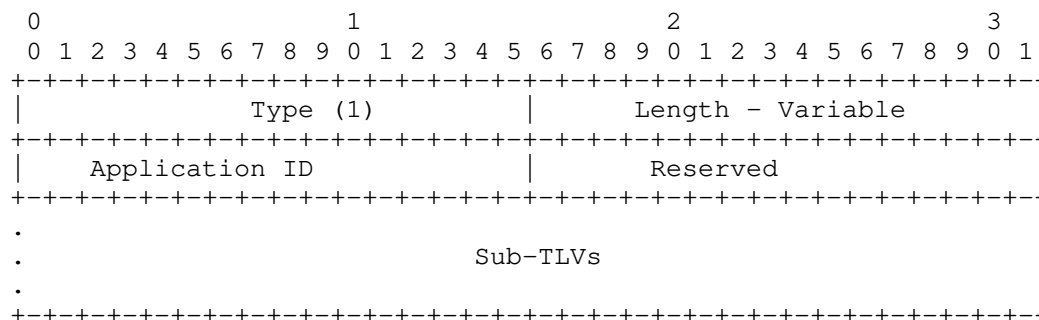


TLV Format

5.3.1. Top-Level TII Application TLV

An Application top-level TLV will be used to encapsulate application data advertised within TII LSAs. This top-level TLV may be used to handle the local publication/subscription for application specific

data. The details of such a publication/subscription mechanism are beyond the scope of this document. An Application ID is used in the top-level application TLV and shares the same code point with IS-IS as defined in [RFC6823].



Application ID:

An identifier assigned to this application via the IANA registry, as defined in RFC 6823. Each unique application will have a unique ID.

Additional Application-Specific Sub-TLVs:

Additional information defined by applications can be encoded as Sub-TLVs. Definition of such information is beyond the scope of this document.

Top-Level TLV

The specific TLVs and sub-TLVs relating to a given application and the corresponding IANA considerations MUST be specified in the document corresponding to that application.

6. Manageability Considerations

7. Security Considerations

The security considerations for the Transport Instance will not be different for those for OSPFv2 [RFC2328] and OSPFv3 [RFC5340].

8. IANA Considerations

8.1. OSPFv2 Opaque LSA Type Assignment

IANA is requested to assign an option type, TBD1, for Transport Instance Information (TII) LSA from the "Opaque Link-State Advertisements (LSA) Option Types" registry.

8.2. OSPFv3 LSA Function Code Assignment

IANA is requested to assign a function code, TBD2, for Transport Instance Information (TII) LSAs from the "OSPFv3 LSA Function Codes" registry.

8.3. OSPF Transport Instance Information Top-Level TLV Registry

IANA is requested to create a registry for OSPF Transport Instance Information (TII) Top-Level TLVs. The first available TLV (1) is assigned to the Application TLV Section 5.3.1. The allocation of the unsigned 16-bit TLV type are defined in the table below.

Range	Assignment Policy
0	Reserved (Not to be assigned)
1	Application TLV
2-16383	Unassigned (IETF Review)
16383-32767	Unassigned (FCFS)
32768-32777	Experimentation (No assignments)
32778-65535	Reserved (Not to be assigned)

TII Top-Level TLV Registry Assignments

9. Acknowledgement

The authors would like to thank Les Ginsberg for review and comments.

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Authors' Addresses

Acee Lindem
Cisco Systems
301 Midenhall Way
CARY, NC 27513
UNITED STATES

Email: acee@cisco.com

Yingzhen Qu
Futurewei
2330 Central Expressway
Santa Clara, CA 95050
USA

Email: yingzhen.qu@futurewei.com

Abhay Roy
Arrcus, Inc.

Email: abhay@arrcus.com

Sina Mirtorabi
Cisco Systems
170 West Tasman Drive
San Jose, CA 95134
USA

Email: smirtora@cisco.com