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Service Distribution using OSPF
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Abstract

The Open Shortest Path First (OSPF) protocol is used to carry data on behalf of other services using the Opaque Link State Advertisements. The protocol's flooding mechanism is well suited to cover the data propagation requirements of services such as Traffic Engineering. The current mechanism cannot scale for a large number of services nor satisfy some of their new set of requirements. This document describes a new mechanism in OSPF to support service and data distribution for a large number of services, computation of preferred service access points and a controlled service data exchange.

Status of This Memo

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1. Introduction

Originally, routing protocols were designed to propagate routing related information only. With the advent of Traffic Engineering, the IGPs started to be used as a transport mechanism. Most of the applications using IGPs as transport are still very much limited and confined to routing applications with similar requirements.

Today, OSPF can carry data for applications using Opaque LSAs. These Opaque LSAs are an integral part of the OSPF database and will be flooded, synchronized and updated just as any other LSA. However,

they do not contribute directly to any routes or trigger an SPF.

Opaque LSAs will need to be flooded across all the OSPF area or domain and neighbor adjacencies to FULL state will depend on successful exchange of these LSAs.

The Link State IGPs are limited on the size of payload information they can carry as it will be flooded and stored in every single router all across their areas or domain regardless whether it is of interest or not.

This document describes a new mechanism in OSPF to support service and data distribution for a large number of services, computation of preferred service access points and controlled distribution of service data.

We presuppose familiarity with the contents of [RFC4970], [RFC5250], [RFC2328] and [RFC5340] .

2. Specification of Requirements

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 [RFC2119].

3. Requirements for service data propagation

Services requirements differ from the traditional routing information dissemination model. The service data may be unrelated to routing or be of interest only to some routers. The new set of requirements for using OSPF as Service Distribution Router (SDR) is as follows

Scale to a large number of services

No assumption regarding size, format or nature of the data

No assumption regarding topology

Routing and service data separated and independent

Must support cases where minimal number of routers only may be upgraded

Must support dynamic events

Routers only store and process data of interest

Ability to compute the shortest path to a producer or consumer of a service per IGP metrics or service metrics.

There is no assumptions regarding producers and consumers of services, their location or uniqueness.

Secured data may reside only on some routers.

In addition the routing requirements for OSPF as Service data distribution are

Backward compatible with Open Standard OSPF

Minimal/No impact on routing convergence and performance

4. Typical Scenario for Services Distribution Router

A SDR is typically reachable by multiple consumers or producers of data. The router itself may not be connected directly to any other router with Service Distribution Capability. The intermediate routers may have limited storage capability or cannot store the data for security reasons.

The SDR is aware of the topological information of the other service routers and can compute paths to the preferred Producer SDR (PSDR) or the Consumers SDR (CSDR) of a service.The SDR will implement tables of producers and consumers for services.

The SDR ensures that interested subscribers to a service are notified with the latest updates.

Producers or consumers can join or leave a service at any time using APIs. The SDR receiving the notification of "registration" or "de-registration" flood the change of state to all the known SDRs in its topology. Therefore, all SDR have the same view of the producers/ consumers topology.

5. OSPF Service Distribution Router

A SDR leverages OSPF's capability to store and flood the topology and other attributes of SDR capable routers. SDRs form an overlay and do not require to be directly connected to each other. SDRs do not need to maintain adjacency between them other than the normal OSPF adjacency for routing purposes. The SDRs rely on the OSPF underlying network for reachability to other SDR routers.

SDRs advertise a directory of producers and consumers of services and are capable to compute preferred producers. The SDRs delegate data exchange processing to remote SDRs to an external agent. This agent is described in detail in section 9 of this document.

The OSPF Opaque LSAs is used to carry relevant and interesting information for reachability and nature of SDR capable routers.

In order to limit the service data dissemination costs (storage, bandwidth, security, ..), SDRs may store only data of interest.


```
       Access other           Distribute data to
       OSPF Routers           other Data Exchange Agent
             ^                          ^
             |                          |
             |                          |
       +----------------------------------------+
       |     |                          |       |
       |     |                          |       |
       |    +-------------+       +----------+  |
       |    |   OSPF      |       | Data     |  |
       |    |             |<-->   | Exchange |  |
       | +->|             |       | Agent    |  |
       | |  +-------------+       +----------+  |
       | |  | OSPF Area DB|         |           |
       | |  |             |         |           |
       | |  |             |         |           |   +------------+
       | |  |             |         |           |   |            |
       | |  +-------------+         |APIs       |   | Producer   |
       | |  | OSPF Opaque |         |(Access)   |   |  Apps.     |
       | |  |    LSAs     |         |           |   +------------+
       | |  |             |         |           |           |
       | |  |             |         |           |           |
```

```
       | |  +-------------+         |           |           |
       | |                          |           |           |
       | |    +---------------------v------+    |API(Update)|
       | +-> |    Service Data Database   |<---------------+
       |APIs  |     May be unrelated to    |    |(secured access)
       |      |         routing            |    |
       |      |                            | API|   +------------+
       |      |                           |<------->|            |
       |      +----------------------------+    |   | Consumer   |
       |                                        |   |  Apps      |
       |                                        |   +------------+
       +----------------------------------------+
              Service Distribution Router
```

The OSPF Service Distribution Router

The following sections describe the extensions in OSPF protocol to support this capability.

6. Storage Of Service Data

The service data can be stored in an independent Service Data Database(SDD). There is no assumption made here on the size, format or nature of data. The data can even be stored on the disk of the router and accessible by APIs to OSPF and other applications for

query and update. A SDD is not part of OSPF and does not participate in the bringing up of adjacencies.

It is desirable that the service data database have a very flexible format to cater for a broad range of applications. A possible solution is that the database records be defined as container objects which themselves contain service metadata.

7. Mechanics of the OSPF Service Information Distribution Implementation

7.1. Advertising and Signaling of SDR Capability

The OSPF SDR router will identify itself to the rest of the domain by advertising its capability and a routable ip address. For example,

this address MAY be a loopback interface configured to uniquely identify an OSPF SDR router. A new bit for SDR capability is reserved in the Router Information Capabilities TLV of the Router Information LSA, as defined in section 2.1 of [RFC4970].

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            LS age             |     Options   |  11           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|       4       |                    0                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Advertising Router                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     LS sequence number                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         LS checksum           |             length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+-                            TLVs                             -+
|                             ...                               |
```

The OSPF Router Information LSA

Flooding scope for AS 11

The format of the Router Informational Capabilities TLV is defined in 2.3 and 2.4 of [RFC4970]


```
 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            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             Informational Capabilities                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The Router Informational Capabilities TLV

A new informational capability bit is defined for Service Distribution Routers

Bit Capabilities

6 Service Distribution Router Capability

7.2. Advertising the Service Distribution Router and its address mapping

A new TLV is defined in the Router Information LSA is used to advertise a routable address to reach the router.

```
TLV
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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            2                  |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Address Format            |         Address length        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Reachable IPv4/IPv6 address mapping to SDR                |
:                                                               :
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        SDR Metric             |        Type of metric         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Service router TLV and address Mapping

Type: A 16-bit field set to 2 representing the Service Distribution Router Address Mapping This TLV is applicable both to OSPFv2 and OSPFv3.

Length: A 16-bit field that indicates the length of the value portion in octets.

Address Format: A 16-bit field that indicates the length of the

value portion in octets.

Possible values

1 : IPv4 Address

2 : IPv6 Address

Address Length: A 16-bit field that indicates the length of the value portion in octets.

Address : Routable IPv4/IPv6 address mapped to SDR

SDR metric: A 16-bit field that indicates SDR metric greater than 0.

Type of metric:

0 : None defined - Ignore SDR Metric

1 : SDR metric overrides the IGP metric

2 : Computed metric is composite of IGP metric + SDR metric

7.3. Advertising the Directory of Producers and Consumers

Opaque LSAs with autonomous system flooding scope as described in [RFC5250], are used to describe the services reachable through this router using TLVs.

Definition of TLV

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           3                   |              Length           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Producer      |      Number of services(subTLVs)              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              Sub TLV Description Serv n                       :
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+ ~
:                               .                               :
~+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+~
```

```
   |               Sub TLV Description Serv m                      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | Subscriber    |    Number of services of interest (SubTLVs)   |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |               Sub TLV Subscribe Serv x                        :
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+ ~
   :                               .                               :
   ~+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+~
   |               Sub TLV Subscribe Serv y                        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   :                               .                               :
```

Example of TLV for Directory of Producers and Subscribers

Type: A 16-bit field set to 3 representing the Directory of the Service Distribution Router. This TLV is applicable both to OSPFv2 and OSPFv3.

Length: A 16-bit field that indicates the length of the value portion in octets.

Services are described in a unique sub-TLV. The sub-TLV should contain a Service Identifier which uniquely identifies the service with network wide significance. The sub-TLV format should be flexible and it MAY be used to advertise a preference metric for the service.

```
   TLV
   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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |            1                  |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                           Service ID                          |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |Service metric                 |        Type of metric         |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Service Description Sub-TLV

Type: A 16-bit field set to 1 representing the Service Description Sub-TLV This TLV is applicable both to OSPFv2 and OSPFv3.

Length: A 16-bit field that indicates the length of the value portion

in octets.

Service ID: A 32-bit field representing the Service Identifier. This TLV is applicable both to OSPFv2 and OSPFv3.

Service Metric: A 16-bit field that indicates the metric associated with the service. A metric of 0 would represent undefined. An unreachable or oversubscribed service has a metric of 0xFFFFFFFF.

Type of metric:

0 : None defined - Ignore Service Metric

1 : Service metric overrides the IGP/SDR metric

2 : Computed metric is composite of IGP metric + SDR metric + Service metric

The Services of interest (Consumers exist) are described in a unique sub-TLV. The sub-TLV should contain a Service Identifier which uniquely identifies the service with network wide significance. The sub-TLV format should be flexible and MUST contained the preferred SDR ID. If no producer exists yet for the service then the Preferred SDR ID should be set to 0.

```
TLV
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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             2                 |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Service ID                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             PSDR ID                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Service Subscription Sub-TLV

Type: A 16-bit field set to 2 representing the Service Subscription Sub-TLV This TLV is applicable both to OSPFv2 and OSPFv3.

Length: A 16-bit field that indicates the length of the value portion in octets.

Service ID: A 32-bit field representing the Service Identifier. A Service Identifier may only be defined in a unique sub-tlv. This TLV is applicable both to OSPFv2 and OSPFv3.

PSDR ID: A 32-bit field that indicates the PSDR for data exchange. Set to 0 if there is no producer for the service.

The topological view and characteristics of the OSPF Overlay Service Distribution Routers can be used to compute preferred producer independent of IGP metrics. It is possible to have multiple LSAs for large directories however a service must be described in a unique sub-tlv for the SDR.

7.4. Service Routing Capable Router Operations

The additional requirements are

No assumption on topology

Multiple producers may exists

Multiple consumers can all have different service interest

Producers/Consumers may join and leave at anytime

Consumers and Producers have access to the Service Data database

The SDR capable routers advertise the consumers who subscribe to a service. The producers may connect to the SDR router to update the services/data in the Service Data database. The SDR router then builds the Opaque LSA describing the producer services which are reachable through it as well as the services its consumers are interested in.

When the router has a full neighbor relationship, it now has the topological view of all SDR capable routers in the domain as well as

the services they offer and are interested in.

Leveraging the fact that the OSPF has already run its SPF, the reachability of overlay SDR capable routers and services offered. It is possible to calculate the preferred Producer SDR for a service by using a composite of the IGP metric, the SDR metric and the service metric. The list of preferred producers for a service can then be evaluated at each SDR.

The list of Consumer SDRs interested in service can also easily be computed from the directory of consumers.

7.4.1. Operation due to Producer changes

The producer service operations are

New producer advertises a service

Existing Producer start advertising a new service

Existing Producer stops advertising a service.

The router will be notified by the application regarding the new producer and the services offered. The router will then either update or create an Opaque LSA to advertise this new information and flood it to all SR routers.

Upon receiving this information, remote SDR routers can recalculate the preferred PSDR. It may also need to perform some operations if it have consumers for this new service.

7.4.2. Operation due to Consumer changes

The consumer service operations are

A new consumer join and add subscription

An existing consumer stops subscriptions

An existing consumer adds subscriptions

The router will be notified by the application regarding the new consumer and the services it is interested in. The router will then either update or create an Opaque LSA to advertise this new information and flood it to all SDR routers.

Upon receipt of the new Opaque LSA the remote SDR routers can then update the list of CSDRs interested in their services per latest information.

8. Calculation of Optimal Producer

Leveraging OSPF capability to store and compute paths on a topology, the same mechanisms can be used to compute the Optimal PSDRs using the SPF for SDR reachable address using IGP metrics, SDR metric and the service metric. The Optimal PSDR is used in the consumer subtlv.

9. Service Router Data Operations

OSPF SDR delegates the task of SDD distribution to the Data Exchange Agent. This text defines an implementation of such an agent and named it the Service Data Distribution Agent (SDDA). OSPF SDR provides SDDA information about which Consumer SDR is interested which service provided by this OSPF (Producer) SDR. The SDDA makes

use of such information to setup distribution channel for SDD distribution from this OSPF Producer SDR to other OSPF Consumer SDRs.

For each OSPF Consumer SDR which subscribes to at least one service provided by this OSPF Producer SDR, there will be a different distribution channel created.

The distribution channel is setup when the OSPF Consumer SDR has subscribed to its first service provided by this OSPF Producer SDR. When the OSPF Consumer SDR subscribes to additional service provided by this OSPF Producer SDR, service data for the new service will be carried over the existing distribution channel. In order words, the same distribution channel can carry service data for different services. The services carried are said to be bound to the distribution channel.

When a distribution channel is first setup for a service or a new service is bound to the channel, the SDDA will notify the SDD. In

turn, the SDD will send the latest data for that service to the SDDA for distribution over that channel.

On the other hand, whenever the SDD has new version of data for a service, the SDD will send those data to the SDDA, which will distribute the new data to all the distribution channels which carry the service.

9.1. Implementation of SDDA

The SDDA can be implemented in many ways and beyond the scope of this document. For example, the SDDA can use BGP capability to transport service data as described in [BGPSERV] as its transport protocol for service data distribution.

10. Security Considerations

The new extensions defined in this document do not introduce any new security concerns other than those already defined in Section 6 of [RFC2328] and [RFC5340].

11. IANA Considerations

This document has no actions for IANA.

12. Contributors

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14. Normative References

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