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OSPF Two-part Metric
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Abstract

This document specifies an optional extension to the OSPF protocol, to represent the metric on a multi-access network as two parts: the metric from a router to the network, and the metric from the network to the router. The router to router metric would be the sum of the two. This document updates RFC 2328 and RFC 5340.

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 [RFC2119].

Status of This Memo

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1. Introduction

With Open Shortest Path First (OSPF, [RFC2328], [RFC5340]) protocol, for a broadcast network, a Network-LSA is advertised to list all routers on the network, and each router on the network includes a

link in its Router-LSA to describe its connection to the network. The link in the Router-LSA includes a metric but the listed routers in the Network LSA do not include a metric. This is based on the assumption that from a particular router, all others on the same network can be reached with the same metric.

With some broadcast networks, different routers can be reached with different metrics. [RFC6845] extends the OSPF protocol with a hybrid interface type for that kind of broadcast network, where no Network LSA is advertised and Router-LSAs simply include p2p links to all routers on the same network with individual metrics. Broadcast capability is still utilized to optimize database synchronization and adjacency maintenance.

That works well for broadcast networks where the metric between different pair of routers are really independent. For example, VPLS networks.

With certain types of broadcast networks, further optimization can be made to reduce the size of the Router-LSAs and number of updates.

Consider a satellite radio network with fixed and mobile ground terminals. All communication goes through the satellite. When the mobile terminals move about, their communication capability may change. When OSPF runs over the radio network (routers being or in tandem with the terminals), [RFC6845] hybrid interface can be used, but with the following drawbacks.

Consider that one terminal/router moves into an area where its communication capability degrades significantly. Through the radio control protocol, all other routers determine that the metric to this particular router changed and they all need to update their Router-LSAs accordingly. The router in question also determines that its metric to reach all others also changed and it also needs to update its Router-LSA. Consider that there could be many terminals and many of them can be moving fast and frequently, the number/frequency of updates of those large Router-LSAs could inhibit network scaling.

2. Proposed Enhancement

Notice that in the above scenario, when one terminal's communication capability changes, its metric to all other terminals and the metric from all other terminals to it will all change in a similar fashion. Given this, the above problem can be easily addressed by breaking the metric into two parts: the metric to the satellite and the metric from the satellite. The metric from terminal R1 to R2 would be the sum of the metric from R1 to the satellite and the metric from the satellite to R2.

Now instead of using the [RFC6845] hybrid interface type, the network is just treated as a regular broadcast network. A router on the network no longer lists individual metrics to each neighbor in its Router-LSA. Instead, each router advertises the metric from the network to itself in addition to the normal metric for the network. With the normal Router-to-Network and additional Network-to-Router metrics advertised for each router, individual router-to-router metric can be calculated.

With the proposed enhancement, the size of Router-LSA will be significantly reduced. In addition, when a router's communication capability changes, only that router needs to update its Router-LSA.

Note that while the example uses the satellite as the relay point at the radio level (layer-2), at layer-3, the satellite does not participate in packet forwarding. In fact, the satellite does not need to be running any layer-3 protocol. Therefore for generality, the metric is abstracted as to/from the "network" rather that specifically to/from the "satellite".

3. Speficications

The following protocol specifications are added to or modified from the base OSPF protocol. If an area contains one or more two-part metric networks, then all routers in the area must support the extensions specified herein. This is ensured by procedures described in Section 3.7.

3.1. Router Interface Parameters

The "Router interface parameters" have the following additions:

- Two-part metric: TRUE if the interface connects to a multi-access network that uses two-part metric. All routers connected to the same network SHOULD have the same configuration for their corresponding interfaces.

- Interface input cost: Link state metric from the two-part-metric network to this router. Defaulted to "Interface output cost" but not valid for normal networks using a single metric. May be configured or dynamically adjusted to a value different from the "Interface output cost".

3.2. Advertising Network-to-Router Metric in OSPFv2

For OSPFv2, the Network-to-Router metric is encoded in an OSPF Extended Link TLV Sub-TLV [RFC7684], defined in this document as the Network-to-Router Metric Sub-TLV. The type of the Sub-TLV is TBD.

The length of the Sub-TLV is 4 (for the value part only). The value part of the Sub-TLV is defined as follows:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      MT       |        0      |          MT   metric          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Multiple such Sub-TLVs can exist in a single OSPF Extended Link TLV, one for each topology [RFC4915]. The OSPF Extended Link TLV identifies the transit link to the network, and is part of an OSPFv2 Extended-Link Opaque LSA. The Sub-TLV MUST ONLY appear in Extended-Link TLVs for Link Type 2 (link to transit network), and MUST be ignored if received for other link types.

3.3. Advertising Network-to-Router Metric in OSPFv3

For OSPFv3, the same Network-to-Router Metric Sub-TLV definition is used, though it is part of the Router-Link TLV of E-Router-LSA [I-D.ietf-ospf-ospfv3-lsa-extend]. Currently OSPFv3 Multi-Toplogy is not defined so the only valid value for the MT field is 0 and only one such Sub-TLV SHOULD be included in the Router-Link TLV. Received Sub-TLVs with non-zero MT field MUST be ignored.

Similarly, the Sub-TLV MUST ONLY appear in Router-Link TLVs for Link Type 2 (connection to a transit network) and MUST be ignored if received for other link types.

3.4. Advertising Network-to-Router TE Metric

A Traffic Engineering Network-to-Router Metric Sub-TLV is defined, similar to the Traffic Engineering Metric Sub-TLV defined in Section 2.5.5 of [RFC3630]. The only difference is the TLV type, which is TBD. The Sub-TLV MUST only appear in type 2 Link TLVs (Multi-access) of Traffic Engineer LSAs (OSPF2) or Intra-Area-TE-LSAs (OSPFv3) [RFC5329], and MUST appear at most once in one such Link TLV.

3.5. OSPF Stub Router Behavior

When an OSPF router with interfaces including two-part metric is advertising itself as a stub router [RFC6987], only the Router-to-Network metric in the stub router's OSPF Router-LSA links is set to the MaxLinkMetric. This is fully backward compatible and will result in the same behavior as [RFC6987].

3.6. SPF Calculation

During the first stage of shortest-path tree calculation for an area, when a vertex V corresponding to a Network-LSA is added to the shortest-path tree and its adjacent vertex W (joined by a link in V's corresponding Network LSA), the cost from V to W, which is W's network-to-router cost, is determined as follows:

- o For OSPFv2, if vertex W has a corresponding Extended-Link Opaque LSA with an Extended Link TLV for the link from W to V, and the Extended Link TLV has a Network-to-Router Metric Sub-TLV for the corresponding topology, then the cost from V to W is the metric in the Sub-TLV. Otherwise, the cost is 0.

- o For OSPFv3, if vertex W has a corresponding E-Router-LSA with a Router-Link TLV for the link from W to V, and the Router-Link TLV has a Network-to-Router Metric Sub-TLV, then the cost from V to W is the metric in the Sub-TLV. If not, the cost is 0.

3.7. Backward Compatibility

Due to the change of procedures in the SPF calculation, all routers in an area that includes one or more two-part metric networks must support the changes specified in this document. To ensure that, if an area is provisioned to support two-part metric networks, all routers supporting this capability must advertise a Router Information (RI) LSA with a Router Functional Capabilities TLV [RFC7770] that includes the following Router Functional Capability Bit:

Bit	Capabilities
0	OSPF Two-part Metric [TPM]

Upon detecting the presence of a reachable Router-LSA without a companion RI LSA that has the bit set, all routers MUST recalculate routes w/o considering any network-to-router costs.

4. IANA Considerations

This document requests the following IANA assignments:

- o A new bit in Registry for OSPF Router Informational Capability Bits, to indicate the capability of supporting two-part metric.

- o A new Sub-TLV type in OSPF Extended Link TLV Sub-TLV registry, for the Network-to-Router Metric Sub-TLV.

- o A new Sub-TLV type in OSPFv3 Extended-LSA Sub-TLV registry, for the Network-to-Router Metric Sub-TLV.

- o A new Sub-TLV type in Types for sub-TLVs of TE Link TLV (Value 2) registry, for the Network-to-Router TE Metric Sub-TLV.

5. Security Considerations

This document does not introduce new security risks.

6. References

6.1. Normative References

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Appendix A. Acknowledgements

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