OSPF Two-Part Metric

Abstract

   This document specifies an optional OSPF protocol extension to
   represent router metrics in a multi-access network in two parts: the
   metric from the router to the network and the metric from the network
   to the router. For such networks, the router-to-router metric for
   OSPF route computation is the sum of the two parts. This document
   updates RFC 2328.

Status of This Memo

   This is an Internet Standards Track document.

   This document is a product of the Internet Engineering Task Force
   (IETF). It represents the consensus of the IETF community. It has
   received public review and has been approved for publication by the
   Internet Engineering Steering Group (IESG). Further information on
   Internet Standards is available in Section 2 of RFC 7841.

   Information about the current status of this document, any errata,
   and how to provide feedback on it may be obtained at
   http://www.rfc-editor.org/info/rfc8042.

Table of Contents

1. Introduction

   With Open Shortest Path First (OSPF) [RFC2328] [RFC5340]), a Network-
   LSA (Link State Advertisement) is advertised to list all routers on a
   broadcast network. Additionally, each router on the broadcast
   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 point-to-point links
   to all routers on the same network with individual metrics.
   Broadcast capability is still used to optimize database
   synchronization and adjacency maintenance.

   This works well for broadcast networks where the metric between
   different pairs of routers are really independent, for example,
   Virtual Private LAN Service (VPLS) networks.

   With certain types of broadcast networks, further optimization can be
   made to reduce the size of Router-LSAs and the 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, [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. In addition, the router in question determines
that its metric to reach all others also changed and it 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 and
frequency of updates of those large Router-LSAs could inhibit network
scaling.

1.1. 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].

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
to it from all other terminals 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.

Instead of using the hybrid interface type described in [RFC6845],
the network is 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
metrics can be calculated.

With the proposed enhancement, the size of the 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), the satellite does not participate in
packet forwarding at layer 3. In fact, the satellite does not need
to run any layer-3 protocol. Therefore, for generality, the metric
is abstracted as to/from the "network" rather than specifically to/
from the "satellite".

3. Specifications

   The following 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
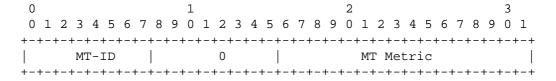   specified herein. This is ensured by procedures described in
   Section 3.7.

3.1. Router Interface Parameters

   The "Router interface parameters" have the following additions:

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

   o Interface input cost: Link-state metric from the two-part-metric
      network to this router. Defaults to "Interface output cost" but
      is 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 4. 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-ID     |       0       |           MT Metric           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Multiple such sub-TLVs can exist in a single OSPF Extended Link TLV,
   one for each topology [RFC4915]. Each sub-TLV will have a unique
   Multi-Topology Identifier (MT-ID) and will adhere to the
   advertisement rules defined in Section 3.4 of [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 Traffic Engineering (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 35. 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 such a Link TLV.

3.4. Advertising Network-to-Router Metric in OSPFv3

Network-to-Router metric advertisement in OSPFv3 Extended Router-LSA
[OSPFV3-EXTENDED-LSA] will be described in a separate document.

3.5. OSPF Stub Router Behavior

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

3.6. SPF Calculation

The first stage of the shortest-path tree calculation is described in
Section 16.1 of [RFC2328]. With a two-part metric, when a vertex V
corresponding to a Network-LSA has just been added to the Shortest
Path Tree (SPT) and an adjacent vertex W (joined by a link in V's
corresponding Network-LSA) is being added to the candidate list, the
cost from V to W (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 OSPFv3 [RFC5340] Shortest Path First (SPF) changes will be
   described in a separate document.

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

                6   Two-Part Metric support

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

4. IANA Considerations

   IANA has made the following assignments per this document:

   o Two-Part Metric support (6) was added to the "OSPF Router
      Informational Capability Bits" registry.

   o Network-to-Router Metric Sub-TLV (4) has been added to the "OSPFv2
      Extended Link TLV Sub-TLVs" registry.

   o Network-to-Router TE Metric Sub-TLV (35) has been added to the
      "Types for sub-TLVs of TE Link TLV (Value 2)" registry.

5. Security Considerations

   This document does not introduce new security risks. Existing
   security considerations in OSPFv2 and OSPFv3 apply.

6. References

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