OSPFv2 Routing Protocols Extensions for ASON Routing

draft-ietf-ccamp-gmpls-ason-routing-ospf-03.txt

Status of this Memo

By submitting this Internet-Draft, each author represents that any applicable patent or other IPR claims of which he or she is aware have been or will be disclosed, and any of which he or she becomes aware will be disclosed, in accordance with Section 6 of BCP 79.

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF), its areas, and its working groups. Note that other groups may also distribute working documents as Internet-Drafts.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

The list of current Internet-Drafts can be accessed at http://www.ietf.org/ietf/1id-abstracts.txt.

The list of Internet-Draft Shadow Directories can be accessed at http://www.ietf.org/shadow.html.

Copyright Notice

Copyright (C) The IETF Trust (2007).

Abstract

The Generalized MPLS (GMPLS) suite of protocols has been defined to control different switching technologies as well as different applications. These include support for requesting TDM connections including SONET/SDH and Optical Transport Networks (OTNs).

This document provides the extensions of the OSPFv2 Link State Routing Protocol to meet the routing requirements for an Automatically Switched Optical Network (ASON) as defined by ITU-T.
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].

The reader is assumed to be familiar with the terminology and requirements developed in [RFC4258] and the evaluation outcomes detailed in [ASON-EVAL].

2. Introduction

There are certain capabilities that are needed to support the ITU-T Automatically Switched Optical Network (ASON) control plane architecture as defined in [G.8080].

[RFC4258] details the routing requirements for the GMPLS suite of routing protocols to support the capabilities and functionality of ASON control planes identified in [G.7715] and in [G.7715.1].

[RFC4652] evaluates the IETF Link State Routing Protocols against the requirements identified in [RFC4258]. Section 7.1 of [RFC4652] summarizes the capabilities to be provided by OSPFv2 [RFC2328] in support of ASON routing. From the candidate routing protocols identified in [RFC4652] (OSPFv2 and IS-IS), this document details the OSPFv2 specifics for ASON routing.

Note that here is no implied relationship between multi-layer transport networks and multi-level routing [RFC4652]. Implementations MAY support a hierarchical routing topology (multi-level) for multiple transport switching layers and/or a hierarchical routing topology for one transport switching layer.

This document details the processing of the generic (technology independent) link attributes that are defined in this document and in [RFC3630], [RFC4202], and [RFC4203]. As detailed in Section 4.2, technology specific traffic engineering attributes (and their processing) MAY complement this document.

ASON (Routing) terminology sections are provided in Appendix 1 and 2.

3. Reachability

In order to advertise blocks of reachable address prefixes a summarization mechanism is introduced that complements the techniques described in [OSPF-NODE].

This extension takes the form of a network mask (a 32-bit number indicating the range of IP addresses residing on a single IP network/subnet). The set of local addresses are carried in an OSPFv2 TE LSA node attribute TLV (a specific sub-TLV is defined per address family, e.g., IPv4 and IPv6).
level TLV (of Type TBD). This document defines the following sub-TLVs:

- Node IPv4 Local Prefix sub-TLV: Type 3 - Length: variable
- Node IPv6 Local Prefix sub-TLV: Type 4 - Length: variable

3.1 Node IPv4 local prefix sub-TLV

The node IPv4 local prefix sub-TLV has a type of 3 and contains one or more local IPv4 prefixes. It has the following format:

```
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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              3                |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Network Mask 1                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         IPv4 Address 1                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
.                               .                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Network Mask n                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         IPv4 Address n                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The length is set to 8 * n where n is the number of local prefixes included in the sub-TLV.

Network mask: A 32-bit number indicating the IPv4 address mask for the advertised destination prefix.

Each <Network mask, IPv4 Address> pair listed as part of this sub-TLV represents a reachable destination prefix hosted by the advertising Router ID.

The local addresses that can be learned from TE LSAs i.e. router address and TE interface addresses SHOULD not be advertised in the node IPv4 local prefix sub-TLV.

3.2 Node IPv6 local prefix sub-TLV

The node IPv6 local prefix sub-TLV has a type of 4 and contains one or more local IPv6 prefixes. IPv6 Prefix Representation uses RFC 2740 Section A.4.1. It has the following format:

```
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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              4                |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Network Mask n                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         IPv6 Address n                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
<table>
<thead>
<tr>
<th>PrefixLength</th>
<th>PrefixOptions</th>
<th>(0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPv6 Address Prefix 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PrefixLength</td>
<td>PrefixOptions</td>
<td>(0)</td>
</tr>
<tr>
<td>IPv6 Address Prefix n</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PrefixLength: length in bits of the prefix.

PrefixOptions: 8-bit field describing various capabilities associated with the prefix (see [RFC2740] Section A.4.2).

Address Prefix: encoding of the prefix itself as an even multiple of 32-bit words, padding with zero bits as necessary.

The Length is set to Sum[n][4 + #32-bit words/4] where n is the number of local prefixes included in the sub-TLV.

The local addresses that can be learned from TE LSAs i.e. router address and TE interface addresses SHOULD not be advertised in the node IPv6 local prefix sub-TLV.

4. Link Attribute

4.1 Local Adaptation

The Local Adaptation is defined as TE link attribute (i.e. sub-TLV) that describes the cross/inter-layer relationships.

The Interface Switching Capability Descriptor (ISCD) TE Attribute [RFC4202] identifies the ability of the TE link to support cross-connection to another link within the same layer and the ability to use a locally terminated connection that belongs to one layer as a data link for another layer (adaptation capability). However, the information associated to the ability to terminate connections within that layer (referred to as the termination capability) is embedded with the adaptation capability.

For instance, a link between two optical cross-connects will contain at least one ISCD attribute describing LSC switching capability. Whereas a link between an optical cross-connect and an IP/MPLS LSR will contain at least two ISCD attributes: one for the description...
of the LSC termination capability and one for the PSC adaptation capability.

In OSPFv2, the Interface Switching Capability Descriptor is a sub-TLV (of type 15) of the top-level Link TLV (of type 2) [RFC4203].

The adaptation and termination capabilities are advertised using two separate ISCD sub-TLVs within the same top-level link TLV.

Per [RFC4202] and [RFC4203], an interface MAY have more than one ISCD sub-TLV. Hence, the corresponding advertisements should not result in any compatibility issue.

4.2 Bandwidth Accounting

GMPLS Routing defines an Interface Switching Capability Descriptor (ISCD) that delivers among others the information about the (maximum/minimum) bandwidth per priority an LSP can make use of. Per [RFC4202] and [RFC4203], one or more ISCD sub-TLVs can be associated to an interface. This information combined with the Unreserved Bandwidth (sub-TLV defined in [RFC3630], Section 2.5.8) provides for the base bandwidth accounting.

In the ASON context, additional optional and informational accounting information may be included in the technology specific field of the ISCD sub-TLV according to the technology supported. For example, when the switching capability field is set to indicate TDM, additional optional and informational accounting information may be included per timeslot. This information may be included when the representation and information in the other advertised fields are not sufficient for the specific technology.

The definition of processing rules for technology-specific information elements are beyond the scope of this document. Some technologies will not require additional information beyond what is already contained in the advertisements, but others may require the addition of further data carried in the technology specific field of the ISCD sub-TLV. When included, the format and encoding of such data MUST follow the rules defined in [RFC4202], and the presence and processing rules MUST be defined in a separate document.

5. Routing Information Scope

5.1. Terminology and Identification

- Pi is a physical (bearer/data/transport plane) node.
- Li is a logical control plane entity that is associated to a single data plane (abstract) node. Each Li is identified by a unique TE Router_ID. The latter is a control plane identifier, defined as the Router_Address top level TLV of the Type 1 TE LSA [RFC3630].

Note: the Router_Address top-level TLV definition, processing and usage remain per [RFC3630]. This TLV specifies a stable IP address
of the advertising router (Ri) that is always reachable if there is any IP connectivity to it. Moreover, each advertising router advertises a unique, reachable IP address for each Pi on behalf of which it makes advertisements.

o) Ri is a logical control plane entity that is associated to a control plane "router". The latter is the source for topology information that it generates and shares with other control plane "routers". The Ri is identified by the (advertising) Router_ID (32-bit) [RFC2328].

The Router_ID, which is represented by Ri and which corresponds to the RC_ID [RFC4258], does not enter into the identification of the logical entities representing the data plane resources such as links. The Routing DataBase (RDB) is associated to the Ri.

Aside from the Li/Pi mappings, these identifiers are not assumed to be in a particular entity relationship except that the Ri may have multiple Lis in its scope. The relationship between Ri and Li is simple at any moment in time: an Li may be advertised by only one Ri at any time. However, an Ri may advertise a set of one or more Lis. Hence, the OSPFv2 routing protocol must support a single Ri advertising on behalf of more than one Li.

5.2 Link Advertisement (Local and Remote TE Router ID sub-TLV)

A Router_ID (Ri) advertising on behalf multiple TE Router_IDs (Lis) creates a 1:N relationship between the Router_ID and the TE Router_ID. As the link local and link remote (unnumbered) ID association is not unique per node (per Li unicity), the advertisement needs to indicate the remote Lj value and rely on the initial discovery process to retrieve the [Li;Lj] relationship. In brief, as unnumbered links have their ID defined on per Li bases, the remote Lj needs to be identified to scope the link remote ID to the local Li. Therefore, the routing protocol MUST be able to disambiguate the advertised TE links so that they can be associated with the correct TE Router ID.

For this purpose, a new sub-TLV of the (OSPFv2 TE LSA) top level Link TLV is introduced that defines the local and the remote TE_Router_ID.

D.Papadimitriou et al. - Expires September 2007

draft-dimitri-ccamp-gmpls-ason-routing-ospf-03.txt

The type of this sub-TLV is 17, and length is eight octets. The value field of this sub-TLV contains four octets of Local TE Router Identifier followed by four octets of Remote TE Router Identifier. The value of the Local and the Remote TE Router Identifier SHOULD NOT be set to 0.

The format of this sub-TLV is the following:

```
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
This sub-TLV is optional and SHOULD only be included as part of the top level Link TLV if the Router_ID is advertising on behalf of more than one TE_Router_ID. In any other case, this sub-TLV SHOULD be omitted except if operator plans to start of with 1 Li and progressively add more Li’s (under the same Ri) such as to maintain consistency.

Note: The Link ID sub-TLV that identifies the other end of the link (i.e. Router ID of the neighbor for point-to-point links) MUST appear exactly once per Link TLV. This sub-TLV MUST be processed as defined in [RFC3630].

5.3 Reachability Advertisement (Local TE Router ID sub-TLV)

When the Router_ID advertises on behalf of multiple TE Router_IDs (Lis), the routing protocol MUST be able to associate the advertised reachability information with the correct TE Router ID.

For this purpose, a new sub-TLV of the (OSPFv2 TE LSA) top level Node Attribute TLV is introduced. This TLV associates the local prefixes (sub-TLV 3 and 4, see above) to a given TE Router_ID.

The type of this sub-TLV is 5, and length is four octets. The value field of this sub-TLV contains four octets of Local TE Router Identifier [RFC3630].

The format of this sub-TLV is the following:

```
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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      5                |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                 Local TE Router Identifier                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

This sub-TLV is optional and SHOULD only be included as part of the Node Attribute TLV if the Router_ID is advertising on behalf of more than one TE_Router_ID. In any other case, this sub-TLV SHOULD be omitted.

6. Routing Information Dissemination

An ASON RA represents a partition of the data plane and its identifier is used within the control plane as the representation of this partition. A RA may contain smaller RAs inter-connected by links. The limit of the subdivision results in a RA that contains two
sub-networks interconnected by a single link. ASON RA levels do not reflect routing protocol levels (such as OSPF areas). OSPF routing areas containing routing areas that recursively define successive hierarchical levels of RAs can be represented by separate instances of the protocol.

RCs supporting RAs disseminate downward/upward this hierarchy. The vertical routing information dissemination mechanisms described in this section do not introduce or imply a new OSPF routing area hierarchy. RCs supporting RAs at multiple levels are structured as separate OSPF instances with routing information exchanges between levels described by import/export rules.

The implication is that an RC that performs import/export of routing information as described in this document does not implement an Area Border Router (ABR) functionality.

6.1 Import/Export Rules

RCs supporting RAs disseminate downward/upward the hierarchy by importing/exporting this routing information as Opaque TE LSA (Opaque Type 1) of LS Type 10. The information that MAY be exchanged between adjacent levels includes the Router_Address, Link and Node_Attribute top level TLV.

The Opaque TE LSA import/export rules are governed as follows:
- If the export target interface is associated to the same area as the one associated with the import interface, the Opaque LSA MUST NOT imported.
- If a match is found between the Advertising Router ID in the header of the received Opaque TE LSA and one of the Router ID belonging to the area of the export target interface, the Opaque LSA MUST NOT be imported.
- If these two conditions are not met the Opaque TE LSA MAY be imported and MAY be disseminated following the OSPF flooding rules. The Advertising Router ID is set to the importing router's router ID.

The imported/exported routing information content MAY be transformed e.g. filtered or aggregated, as long as the resulting routing information is consistent. In particular, when more than one RC are bound to adjacent levels and both are allowed to import/export routing information it is expected that these transformation are performed in consistent manner. Definition of these policy-based mechanisms is outside the scope of this document.

In practice, and in order to avoid scalability and processing overhead, routing information imported/exported downward/upward the hierarchy is expected to include reachability information (see Section 3) and upon strict policy control link topology information.

6.2 Discovery and Selection
6.2.1 Upward Discovery and Selection

In order to discover RCs that are capable to disseminate routing information upward the routing hierarchy, the following Capability Descriptor bit [OSPF-CAP] are defined:

- U bit: when set, this flag indicates that the RC is capable to disseminate routing information upward the adjacent level.

In case of multiple RC are advertized with their U bit set, the RC with the highest Router ID, among the RCs having set the U bit, SHOULD be selected as the RC for upward dissemination of routing information. The other RCs MUST NOT participate in the upward dissemination of routing information as long as the opaque LSA information corresponding to the highest Router ID RC does not reach MaxAge. This mechanism prevents from having more than one RC advertizing routing information upward the routing hierarchy.

Note that alternatively if this information cannot be discovered automatically, it MUST be manually configured.

Once an RC has been selected, it remains unmodified even if an RC with a highest Router ID is introduced and advertizes its capability to disseminate routing information upward the adjacent level (i.e. U-bit set). This hysteresis mechanism prevents from disturbing the upward routing information dissemination process in case e.g. of flapping.

6.2.2 Downward Discovery and Selection

The same discovery mechanism is used for selecting the RC taking in charge dissemination of routing information downward the hierarchy. However, an additional restriction MUST be applied such that the RC selection process takes into account that an upper level may be adjacent to one or more lower (routing area) levels. For this purpose a specific TLV indexing the (lower) area ID to which the RC’s are capable to disseminate routing information is needed.

OSPF Downstream Associated Area ID TLV format carried in the OSPF router information LSA [OSPF-CAP] is defined. This TLV has the following format:

```
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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              Type             |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Associated Area ID                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|                                                               |
//                             ...                             //
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Associated Area ID                      |
```
Type (16 bits): identifies the TLV type
Length (16 bits): length of the value field in octets
Value (n x 32 bits): Associated Area ID whose value space is the
Area ID as defined in [RFC2328].

Note that this information MUST be present when the D bit is set. To
discover RCs that are capable to disseminate routing information
downward the routing hierarchy, the following Capability Descriptor
bit [OSPF-CAP] is defined, that MUST be advertised together with the
OSPF Downstream Associated Area ID TLV:

- D bit: when set, this flag indicates that the RC is capable to
disseminate routing information downward the adjacent level(s).

In case of multiple supporting RCs for the same Associated Area ID,
the RC with the highest Router ID, among the RCs having set the D
bit, MUST be selected as the RC for downward dissemination of
routing information. The other RCs for the same Associated Area ID
MUST not participate in the downward dissemination of routing
information as long as the opaque LSA information corresponding to
the highest Router ID RC does not reach MaxAge. This mechanism
prevents from having more than one RC advertising routing
information downward the routing hierarchy.

Note that alternatively if this information cannot be discovered
automatically, it MUST be manually configured.

The OSPF Router information opaque LSA (opaque type of 4, opaque ID
of 0) and its content in particular, the Router Informational
Capabilities TLV [OSPF-CAP] and TE Node Capability Descriptor TLV
[OSPF-TE-CAP] MUST NOT be re-originated.

6.3 Loop prevention

When more than one RC are bound to adjacent levels of the hierarchy,
configured and selected to redistribute upward and downward the
routing information, a specific mechanism is required to avoid
looping/re-introduction of routing information back to the upper
level. This specific case occurs e.g. when the RC advertising
routing information downward the hierarchy is not the one
advertising routing upward the hierarchy (or vice-versa).

When these conditions are met, it is necessary to have a mean by
which an RC receiving an Opaque TE LSA imported/exported downward by
an RC associated to the same area, omits to import/export back the
content of this LSA upward into the (same) upper level.

Note that configuration and operational simplification can be
obtained when both functionality are configured on a single RC (per
pair of adjacent level) fulfilling both roles. Figure 1 provides an
example where such simplification applies.
Figure 1. Hierarchical Environment (Example)

In this case, the procedure described in this section MAY be omitted, as long as these conditions are permanently guaranteed. In all other cases, without exception, the procedure described in this section MUST be applied.

6.3.1 Associated Area ID

Thus, we need some way of filtering the downward/upward re-originated Opaque TE LSA. Per [RFC2370], the information contained in Opaque LSAs may be used directly by OSPF. Henceforth, by adding the Area ID associated to the incoming routing information the loop prevention problem can be solved. This additional information that MAY be carried in opaque LSAs including the Router Address TLV, in opaque LSAs including the Link TLV, and in opaque LSAs including the Node Attribute TLV, is referred to as the Associated Area ID.

The format of the Associated Area ID TLV is defined as follows:

```
 0                   1                   2                   3
+------------------+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              Type             |             Length            |
+------------------+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Associated Area ID                      |
+------------------+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Type (16 bits): identifies the TLV type
Length (16 bits): length of the value field in octets
Value (32 bits): Associated Area ID whose value space is the Area ID as defined in [RFC2328].

6.3.2 Processing

When fulfilling the rules detailed in Section 6.1 a given Opaque LSA is imported/exported downward or upward the routing hierarchy, the Associated Area ID TLV is added to the received opaque LSA list of
TLVs such as to identify the area from where this routing information has been received.

When the RC adjacent to the lower or upper level routing level receives this opaque LSA, the following rule is applied (in addition to the rule governing the import/export of opaque LSAs as detailed in Section 6.1).

- If a match is found between the Associated Area ID of the received Opaque TE LSA and the Area ID belonging to the area of the export target interface, the Opaque LSA MUST NOT be imported.

- Otherwise, this opaque LSA MAY be imported and disseminated downward or upward the routing hierarchy following the OSPF flooding rules.

This mechanism ensures that no race condition occurs when the conditions depicted in Figure 2 are met.

```
RC_5  ----------------  RC_6
       |                   |
       |                   |
       |                   |
       |                   |
       |                   |
RC_3  --- . . ---  RC_4

```

Assume that RC_1b is configured for exporting routing information upward toward Area Y (upward the routing hierarchy) and that RC_2a is configured for exporting routing information toward Area X (downward the routing hierarchy).

Assumes that routing information advertised by RC_3 would reach faster to RC_4 across Area Y through hierarchy.

If RC_2b is not able to prevent from importing that information, RC_4 may receive that information before the same advertisement would propagate in Area X (from RC 3) to RC_4.

6.4 Resiliency

OSPF creates adjacencies between neighboring routers for the purpose of exchanging routing information. After a neighbor has been discovered, bidirectional communication is ensured, and a routing adjacency is formed between RCs, loss of communication may result in partitioned areas.

Consider for instance (see Figure 2.) the case where RC_1a and RC 1b
is configured for exchanging routing information downward and upward Area Y, resp., and that RC_2a and RC_2b are not configured for exchanging routing any routing information toward Area X. If the communication between RC 1a and RC 2a is broken (due e.g. to RC 5 – RC 6 communication failure), Area Y could be partitioned.

In these conditions, it is RECOMMENDED that RC 2a to be re-configurable such as to allow for exchanging routing information downward to Area X. This reconfiguration MAY be performed manually or automatically. In the latter cases, automatic reconfiguration uses the mechanism described in Section 6.2 (forcing MaxAge of the corresponding opaque LSA information in case the originating RC becomes unreachable). Manual reconfiguration MUST be supported.

6.5 Neighbor Relationship and Routing Adjacency

It is assumed that (point-to-point) IP control channels are provisioned/configured between RCs belonging to the same routing level. Provisioning/configuration techniques are outside the scope of this document.

Once established, the OSPF Hello Protocol is responsible for establishing and maintaining neighbor relationships. This protocol also ensures that communication between neighbors is bidirectional. Routing adjacency can subsequently be formed between RCs following mechanisms defined in [RFC2328].

7. OSPFv2 Extensions

D.Papadimitriou et al. - Expires September 2007

draft-dimitri-ccamp-gmpls-ason-routing-ospf-03.txt March 2007

7.1 Compatibility

Extensions specified in this document are associated to the Opaque TE LSA:

- Router Address top level TLV (Type 1):
  - Associated Area ID sub-TLV: optional sub-TLV for loop avoidance (see Section 6.2)

- Link top level TLV (Type 2):
  - Local and Remote TE Router ID sub-TLV: optional sub-TLV for scoping link attributes per TE_Router ID
  - Associated Area ID sub-TLV: optional sub-TLV for loop avoidance (see Section 6.2)

- Node Attribute top level TLV (Type TBD):
  - Node IPv4 Local Prefix sub-TLV: optional sub-TLV for IPv4 reachability advertisement
  - Node IPv6 Local Prefix sub-TLV: optional sub-TLV for IPv6 reachability advertisement
  - Local TE Router ID sub-TLV: optional sub-TLV for scoping reachability per TE_Router ID
  - Associated Area ID sub-TLV: optional sub-TLV for loop avoidance (see Section 6.3)
Opaque RI LSA:

- Routing information dissemination
  - U bit in Capability Descriptor TLV [OSPF-CAP]
  - D bit in Capability Descriptor TLV [OSPF-CAP]
  - Downstream Associated Area ID TLV in the OSPF Routing Information LSA [OSPF-CAP]

7.2 Scalability

- Routing information exchange upward/downward the hierarchy between adjacent areas SHOULD by default be limited to reachability. In addition, several transformations such as prefix aggregation are recommended when allowing decreasing the amount of information imported/exported by a given RC without impacting consistency.

- Routing information exchange upward/downward the hierarchy when involving TE attributes MUST be under strict policy control. Pacing and min/max thresholds for triggered updates are strongly recommended.

- The number of routing levels MUST be maintained under strict policy control.

8. Acknowledgements

The authors would like to thank Dean Cheng, Acee Lindem, Pandian Vijay, Alan Davey and Adrian Farrel for their useful comments and suggestions.

9. References

9.1 Normative References


D. Papadimitriou et al. - Expires September 2007

draft-dimitri-ccamp-gmpls-ASON-routing-ospf-03.txt

8.2 Informative References


For information on the availability of ITU Documents, please see http://www.itu.int


Appendix I: ASON Terminology

This document makes use of the following terms:

Administrative domain: (see Recommendation G.805) for the purposes of [G7715.1] an administrative domain represents the extent of resources which belong to a single player such as a network operator, a service provider, or an end-user. Administrative domains of different players do not overlap amongst themselves.

Control plane: performs the call control and connection control functions. Through signaling, the control plane sets up and releases connections, and may restore a connection in case of a failure.

(Control) Domain: represents a collection of (control) entities that are grouped for a particular purpose. The control plane is subdivided into domains matching administrative domains. Within an administrative domain, further subdivisions of the control plane are recursively applied. A routing control domain is an abstract entity that hides the details of the RC distribution.

External NNI (E-NNI): interfaces are located between protocol controllers between control domains.

Internal NNI (I-NNI): interfaces are located between protocol controllers within control domains.

Link: (see Recommendation G.805) a "topological component" which describes a fixed relationship between a "subnetwork" or "access group" and another "subnetwork" or "access group". Links are not limited to being provided by a single server trail.
Management plane: performs management functions for the Transport Plane, the control plane and the system as a whole. It also provides coordination between all the planes. The following management functional areas are performed in the management plane: performance, fault, configuration, accounting and security management.

Management domain: (see Recommendation G.805) a management domain defines a collection of managed objects which are grouped to meet organizational requirements according to geography, technology, policy or other structure, and for a number of functional areas such as configuration, security, (FCAPS), for the purpose of providing control in a consistent manner. Management domains can be disjoint, contained or overlapping. As such the resources within an administrative domain can be distributed into several possible overlapping management domains. The same resource can therefore belong to several management domains simultaneously, but a management domain shall not cross the border of an administrative domain.

Subnetwork Point (SNP): The SNP is a control plane abstraction that represents an actual or potential transport plane resource. SNPs (in different subnetwork partitions) may represent the same transport resource. A one-to-one correspondence should not be assumed.

Subnetwork Point Pool (SNPP): A set of SNPs that are grouped together for the purposes of routing.

Termination Connection Point (TCP): A TCP represents the output of a Trail Termination function or the input to a Trail Termination Sink function.

Transport plane: provides bi-directional or unidirectional transfer of user information, from one location to another. It can also provide transfer of some control and network management information. The Transport Plane is layered; it is equivalent to the Transport Network defined in G.805 Recommendation.

User Network Interface (UNI): interfaces are located between protocol controllers between a user and a control domain. Note: there is no routing function associated with a UNI reference point.
Appendix 2: ASON Routing Terminology

This document makes use of the following terms:

Routing Area (RA): a RA represents a partition of the data plane and its identifier is used within the control plane as the representation of this partition. Per [G.8080] a RA is defined by a set of sub-networks, the links that interconnect them, and the interfaces representing the ends of the links exiting that RA. A RA may contain smaller RAs inter-connected by links. The limit of subdivision results in a RA that contains two sub-networks interconnected by a single link.

Routing Database (RDB): repository for the local topology, network topology, reachability, and other routing information that is updated as part of the routing information exchange and may additionally contain information that is configured. The RDB may contain routing information for more than one Routing Area (RA).

Routing Components: ASON routing architecture functions. These functions can be classified as protocol independent (Link Resource Manager or LRM, Routing Controller or RC) and protocol specific (Protocol Controller or PC).

Routing Controller (RC): handles (abstract) information needed for routing and the routing information exchange with peering RCs by operating on the RDB. The RC has access to a view of the RDB. The RC is protocol independent.

Note: Since the RDB may contain routing information pertaining to multiple RAs (and possibly to multiple layer networks), the RCs accessing the RDB may share the routing information.

Link Resource Manager (LRM): supplies all the relevant component and TE link information to the RC. It informs the RC about any state changes of the link resources it controls.

Protocol Controller (PC): handles protocol specific message exchanges according to the reference point over which the information is exchanged (e.g. E-NNI, I-NNI), and internal exchanges with the RC. The PC function is protocol dependent.