Updates to ASON Routing for OSPFv2 Protocols (RFC 5787bis)
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Abstract

The ITU-T has defined an architecture and requirements for operating an Automatically Switched Optical Network (ASON).

The Generalized Multiprotocol Label Switching (GMPLS) protocol suite is designed to provide a control plane for a range of network technologies including optical networks such as time division multiplexing (TDM) networks including SONET/SDH and Optical Transport Networks (OTNs), and lambda switching optical networks.

The requirements for GMPLS routing to satisfy the requirements of ASON routing, and an evaluation of existing GMPLS routing protocols are provided in other documents. This document defines extensions to the OSPFv2 Link State Routing Protocol to meet the requirements for routing in an ASON.

Note that this work is scoped to the requirements and evaluation expressed in RFC 4258 and RFC 4652 and the ITU-T Recommendations current when those documents were written. Future extensions of revisions of this work may be necessary if the ITU-T Recommendations are revised or if new requirements are introduced into a revision of RFC 4258.

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1. Introduction

The Generalized Multiprotocol Label Switching (GMPLS) [RFC3945] protocol suite is designed to provide a control plane for a range of network technologies including optical networks such as time division multiplexing (TDM) networks including SONET/SDH and Optical Transport Networks (OTNs), and lambda switching optical networks.

The ITU-T defines the architecture of the Automatically Switched Optical Network (ASON) in [G.8080].

[RFC4258] describes 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. This document describes the OSPFv2 specifics for ASON routing.

Multi-layer transport networks are constructed from multiple networks of different technologies operating in a client-server relationship. The ASON routing model includes the definition of routing levels that provide scaling and confidentiality benefits. In multi-level routing, domains called routing areas (RAs) are arranged in a hierarchical relationship. Note that as described in [RFC4652], there is no implied relationship between multi-layer transport networks and multi-level routing. The multi-level routing mechanisms described in this document work for both single-layer and multi-layer networks.

Implementations may support a hierarchical routing topology (multi-level) for multiple transport network layers and/or a hierarchical routing topology for a single transport network layer.

This document describes the processing of the generic (technology-independent) link attributes that are defined in [RFC3630], [RFC4202], and [RFC4203] and that are extended in this document. As described in Section 5.2, technology-specific traffic engineering attributes and their processing may be defined in other documents that complement this document.

Note that this work is scoped to the requirements and evaluation expressed in [RFC4258] and [RFC4652] and the ITU-T Recommendations current when those documents were written. Future extensions of revisions of this work may be necessary if the ITU-T Recommendations are revised or if new requirements are introduced into a revision of
1.1. Conventions Used in This Document

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 described in [RFC4652].

General ASON terminology is provided in Appendix A. ASON routing terminology is described in Appendix B.

2. Routing Areas, OSPF Areas, and Protocol Instances

An ASON routing area (RA) represents a partition of the data plane, and its identifier is used within the control plane as the representation of this partition.

RAs are hierarchically contained: a higher-level (parent) RA contains lower-level (child) RAs that in turn MAY also contain RAs, etc. Thus, RAs contain RAs that recursively define successive hierarchical RA levels. Routing information may be exchanged between levels of the RA hierarchy, i.e., Level N+1 and N, where Level N represents the RAs contained by Level N+1. The links connecting RAs may be viewed as external links (inter-RA links), and the links representing connectivity within an RA may be viewed as internal links (intra-RA links). The external links to an RA at one level of the hierarchy may be internal links in the parent RA. Intra-RA links of a child RA MAY be hidden from the parent RA’s view. [RFC4258]

An ASON RA can be mapped to an OSPF area, but the hierarchy of ASON RA levels does not map to the hierarchy of OSPF areas. Instead, successive hierarchical levels of RAs MUST be represented by separate instances of the protocol. Thus, inter-level routing information exchange (as described in Section 7) involves the export and import of routing information between protocol instances.

An ASON RA may therefore be identified by the combination of its OSPF instance identifier and its OSPF area identifier. With proper and careful network-wide configuration, this can be achieved using just the OSPF area identifier, and this process is RECOMMENDED in this document. These concepts are discussed in Section 7.

A key ASON requirement is the support of multiple transport planes or layers. Each transport node has associated topology (links and
reachability) which is used for ASON routing.

3. Terminology and Identification

This section describes the mapping of key ASON entities to OSPF entities. Appendix A contains a complete glossary of ASON routing terminology.

There are three categories of identifiers used for ASON routing (G7715.1): transport plane names, control plane identifiers for components, and SCN addresses. This section discusses the mapping between ASON routing identifiers and corresponding identifiers defined for GMPLS routing, and how these support the physical (or logical) separation of transport plane entities and control plane components. GMPLS supports this separation of identifiers and planes.

In the context of OSPF Traffic Engineering (TE), an ASON transport node corresponds to a unique OSPF TE node. An OSPF TE node is uniquely identified by the TE Router Address TLV [RFC3630]. In this document, this TE Router Address is referred to as the TE Router ID, which is in the ASON transport plane name space. The TE Router ID should not be confused with the OSPF Router ID which uniquely identifies an OSPF router within an OSPF routing domain [RFC2328] and is in a name space for control plane components.

Note: The Router Address top-level TLV definition, processing, and usage are unchanged from [RFC3630]. This TLV specifies a stable OSPF TE node IP address, i.e., the IP address is always reachable when there is IP connectivity to the associated OSPF TE node.

ASON defines a Routing Controller (RC) as an entity that handles (abstract) information needed for routing and the routing information exchange with peering RCs by operating on the Routing Database (RDB). ASON defines a Protocol Controller (PC) as an entity that 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 Routing Controller (RC) [RFC4258]. In this document, an OSPF router advertising ASON TE topology information will perform both the functions of the RC and PC. Each OSPF router is uniquely identified by its OSPF Router ID [RFC2328].

4. Reachability

Reachability in ASON refers to the set of endpoints reachable in the transport plane by a node or the reachable endpoints of a level N. Reachable entities are identified in the transport plane name space
(ASON SNPP name space). In order to advertise blocks of reachable address prefixes, a summarization mechanism is introduced that is based on the techniques described in [RFC5786]. For ASON reachability advertisement, blocks of reachable address prefixes are advertised together with the associated data plane node. The data plane node is identified in the control plane by its TE Router ID, as discussed in section 6.

In order to support ASON reachability advertisement, the Node Attribute TLV defined in [RFC5786] is used to advertise the combination of a TE Router ID and its set of associated reachable address prefixes. The Node Attribute TLV can contain the following sub-TLVs:

- TE Router ID sub-TLV: Length: 4; Defined in Section 6.2
- Node IPv4 Local Address sub-TLV: Length: variable; [RFC5786]
- Node IPv6 Local Address sub-TLV: Length: variable; [RFC5786]

A router may support multiple transport nodes as discussed in section 6, and, as a result, may be required to advertise reachability (ASON TRIs) separately for each transport node. As a consequence, it MUST be possible for the router to originate more than one TE LSA containing the Node Attribute TLV when used for ASON reachability advertisement.

Hence, the Node Attribute TLV [RFC5786] advertisement rules must be relaxed for ASON. A Node Attribute TLV MAY appear in more than one TE LSA originated by the RC when the RC is advertising reachability information for a different transport node identified by the Local TE Router Sub-TLV (refer to section 6.1).

5. Link Attribute

With the exception of local adaptation (described below), the mapping of link attributes and characteristics to OSPF TE Link TLV Sub-TLVs is unchanged [RFC4652]. OSPF TE Link TLV Sub-TLVs are described in [RFC3630] and [RFC4203]. Advertisement of this information SHOULD be supported on a per-layer basis, i.e., one TE LSA per unique switching capability and bandwidth granularity combination.

5.1. Local Adaptation

Local adaptation is defined as a 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. When advertising
link adaptation, it also identifies 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 with the ability to terminate connections within that layer (referred to as the termination capability) is advertised with the adaptation capability.

For instance, a link between two optical cross-connects will contain at least one ISCD attribute describing the Lambda Switching Capable (LSC) switching capability. Conversely, a link between an optical cross-connect and an IP/MPLS Label Switching Router (LSR) will contain at least two ISCD attributes, one for the description of the LSC termination capability and one for the Packet Switching Capable (PSC) adaptation capability.

In OSPFv2, the Interface Switching Capability Descriptor (ISCD) is a sub-TLV (type 15) of the top-level Link TLV (type 2) [RFC4203]. The adaptation and termination capabilities are advertised using two separate ISCD sub-TLVs within the same top-level Link TLV.

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

5.2. Bandwidth Accounting

GMPLS routing defines an Interface Switching Capability Descriptor (ISCD) that provides, among other things, the available (maximum/minimum) bandwidth per priority available for Label Switched Path (LSPs). One or more ISCD sub-TLVs can be associated with an interface, [RFC4202] and [RFC4203]. This information, combined with the Unreserved Bandwidth Link TLV sub-TLV [RFC3630], provides the basis for bandwidth accounting.

In the ASON context, additional information may be included when the representation and information in the other advertised fields are not sufficient for a specific technology, e.g., SDH. The definition of technology-specific information elements is beyond the scope of this document. Some technologies will not require additional information beyond what is already defined in [RFC3630], [RFC4202], and [RFC4203].

6. Routing Information Scope

For ASON routing, the control plane component routing adjacency topology (i.e., the associated Protocol Controller (PC) connectivity) and the transport topology are NOT assumed to be congruent [RFC4258]. Hence, a single OSPF router (i.e., the PC) MUST be able to advertise
on behalf of multiple transport layer nodes. The OSPF routers are identified by OSPF Router ID and the transport nodes are identified by TE Router ID.

The Router Address TLV [RFC3630] is used to advertise the TE Router ID associated with the advertising Routing Controller. TE Router IDs for additional transport nodes are advertised through specification of the Local TE Router Identifier in the Local and Remote TE Router TE sub-TLV and the Local TE Router Identifier sub-TLV described in the sections below. These Local TE Router Identifiers are typically used as the local endpoints for TE Label Switched Paths (LSPs) terminating on the associated transport node.

It MAY be feasible for multiple OSPF Routers to advertise TE information for the same transport node. However, this is not considered a required use case and is not discussed further.

6.1. Link Advertisement (Local and Remote TE Router ID Sub-TLV)

An OSPF router advertising on behalf of multiple transport nodes will require additional information to distinguish the link endpoints amongst the subsumed transport nodes. In order to unambiguously specify the transport topology, the local and remote transport nodes MUST be identified by 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 Remote TE Router ID.

The Type field of the Local and Remote TE Router ID sub-TLV is assigned a value TBD. The Length field takes the value 8. The Value field of this sub-TLV contains 4 octets of the Local TE Router Identifier followed by 4 octets of the Remote TE Router Identifier. The value of the Local and Remote TE Router Identifier SHOULD NOT be set to 0.

The format of the Local and Remote TE Router ID sub-TLV is:

```
 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 (8)           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                 Local TE Router Identifier                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                 Remote TE Router Identifier                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

This sub-TLV MUST be included as a sub-TLV of the top-level Link TLV.
if the OSPF router is advertising on behalf of one or more transport
nodes having TE Router IDs different from the TE Router ID advertised
in the Router Address TLV. Therefore, it MUST be included if the
OSPF router is advertising on behalf of multiple transport nodes.

Note: The Link ID sub-TLV identifies the other end of the link (i.e.,
Router ID of the neighbor for point-to-point links) [RFC3630]. When
the Local and Remote TE Router ID Sub-TLV is present, it MUST be used
to identify local and remote transport node endpoints for the link
and the Link-ID sub-TLV MUST be ignored. The Local and Remote ID sub-
TLV, if specified, MUST only be specified once.

6.2. Reachability Advertisement (Local TE Router ID sub-TLV)

When an OSPF router is advertising on behalf of multiple transport
nodes, the routing protocol MUST be able to associate the advertised
reachability information with the correct transport node.

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
(see above) to a given transport node identified by TE Router ID.

The Type field of the Local TE Router ID sub-TLV is assigned a value
TBD. The Length field takes the value 4. The Value field of this
sub-TLV contains the Local TE Router Identifier [RFC3630] encoded
over 4 octets.

The format of the Local TE Router ID sub-TLV is:

```
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 (4)           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                 Local TE Router Identifier                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

This sub-TLV MUST be included as a sub-TLV of the top-level Node
Attribute TLV if the OSPF router is advertising on behalf of one or
more transport nodes having TE Router IDs different from the TE
Router ID advertised in the Router Address TLV. Therefore, it MUST
be included if the OSPF router is advertising on behalf of multiple
transport nodes.
7. Routing Information Dissemination

An ASON routing area (RA) represents a partition of the data plane, and its identifier is used within the control plane as the representation of this partition. An RA may contain smaller RAs inter-connected by links. ASON RA levels do not map directly to OSPF areas. Rather, hierarchical levels of RAs are represented by separate OSPF protocol instances.

Routing controllers (RCs) supporting multiple RAs disseminate information downward and upward in this ASON hierarchy. The vertical routing information dissemination mechanisms described in this section do not introduce or imply hierarchical OSPF areas. RCs supporting RAs at multiple levels are structured as separate OSPF instances with routing information exchange between levels described by import and export rules between these instances. The functionality described herein does not pertain to OSPF areas or OSPF Area Border Router (ABR) functionality.

7.1 Import/Export Rules

RCs supporting RAs disseminate information upward and downward in the hierarchy by importing/exporting routing information as TE LSAs. TE LSAs are area-scoped opaque LSAs with opaque type 1 [RFC3630]. The information that MAY be exchanged between adjacent levels includes the Router Address, Link, and Node Attribute top-level TLVs.

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 is bound to adjacent levels and both are allowed to import/export routing information, it is expected that these transformations are performed in a 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 in the hierarchy is expected to include reachability information (see Section 4) and, upon strict policy control, link topology information.

7.2 Loop Prevention

When more than one RC is bound to an adjacent level of the ASON hierarchy, and is configured to export routing information upward or downward, a specific mechanism is required to avoid looping of routing information. Looping is the re-advertisement of routing information into an RA that had previously advertised that routing
information upward or downward into an upper or lower level RA in the
ASON hierarchy. For example, without loop prevention mechanisms, this
could happen when the RC advertising routing information downward in
the hierarchy is not the same one that advertises routing information
upward in the hierarchy.

7.2.1 Inter-RA Export Upward/Downward Sub-TLVs

The Inter-RA Export Sub-TLVs can be used to prevent the re-
advertisement of OSPF TE routing information into an RA which
previously advertised that information. The type value TBD will
indicate that the associated routing information has been exported
downward. The type value TBD will indicate that the associated
routing information has been exported upward. While it is not
required for routing information exported downward, both Sub-TLVs
will include the Routing Area (RA) ID from the which the routing
information was exported. This RA is not necessarily the RA
originating the routing information but RA from which the information
was immediately exported.

These additional Sub-TLVs MAY be included in TE LSAs that include any
of the following top-level TLVs:
- Router Address top-level TLV
- Link top-level TLV
- Node Attribute top-level TLV

The Type field of the Inter-RA Export Upward and Inter-RA Export
Downward sub-TLVs are respectively assigned the values TBD1 and TBD2.
The Length of the Associated RA ID TLV is 4 octets. The Value field
in these sub-TLVs contains the associated RA ID. The RA ID value must
be a unique identifier for the RA within the ASON routing domain.

The format of the Inter-RA Export Upward and Inter-RA Export Downward
Sub-TLVs is graphically depicted below:

```
0 1 2 3
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Upward/Downward Type       |           Length (4)          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Associated RA ID                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
7.2.2 Inter-RA Export Upward/Downward Sub-TLV Processing

TE LSAs MAY be imported or exported downward or upward in the ASON routing hierarchy. The direction and advertising RA ID are advertised in an Inter-RA Export Upward/Downward Sub-TLV. They MUST be retained and advertised in the receiving RA with the associated routing information.

When exporting routing information upward in the ASON routing hierarchy, any information received from a level above, i.e., tagged with an Inter-RA Export Downward Sub-TLV, MUST NOT be exported upward. Since an RA at level N is contained by a single RA at level N+1, this is the only checking that is necessary and the associated RA ID is used solely for informational purposes.

When exporting routing information downward in the ASON routing hierarchy, any information received from a level below, i.e., tagged with an Inter-RA Export Upward Sub-TLV MUST NOT be exported downward if the target RA ID matches the RA ID associated with the routing information. This additional checking is required for routing information exported downward since a single RA at level N+1 may contain multiple RAs at level N in the ASON routing hierarchy. In order words, routing information MUST NOT be exported downward into the RA from which it was received.

8. OSPFv2 Scalability

The extensions described herein are only applicable to ASON routing domains and it is not expected that the attendant reachability (see Section 4) and link information will ever be mixed with global or local IP routing information. If there were ever a requirement for a given RC to participate in both domains, separate OSPFv2 instances would be utilized. However, in a multi-level ASON hierarchy, the potential volume of information could be quite large and the recommendations in this section SHOULD be followed by RCs implementing this specification.

- Routing information exchange upward/downward in the hierarchy between adjacent RAs SHOULD, by default, be limited to reachability information. In addition, several transformations such as prefix aggregation are RECOMMENDED to reduce the amount of information imported/exported by a given RC when such transformations will not impact consistency.

- Routing information exchange upward/downward in the ASON hierarchy involving TE attributes MUST be under strict policy control. Pacing and min/max thresholds for triggered updates are strongly RECOMMENDED.
9. Security Considerations

This document specifies the contents and processing of OSPFv2 TE LSAs [RFC3630] and [RFC4202]. The TE LSA extensions defined in this document are not used for SPF computation, and have no direct effect on IP routing. Additionally, ASON routing domains are delimited by the usual administrative domain boundaries.

Any mechanisms used for securing the exchange of normal OSPF LSAs can be applied equally to all TE LSAs used in the ASON context. Authentication of OSPFv2 LSA exchanges (such as OSPF cryptographic authentication [RFC2328] and [RFC5709]) can be used to secure against passive attacks and provide significant protection against active attacks. [RFC5709] defines a mechanism for authenticating OSPFv2 packets by making use of the HMAC algorithm in conjunction with the SHA family of cryptographic hash functions.

If a stronger authentication were believed to be required, then the use of a full digital signature [RFC2154] would be an approach that should be seriously considered. Use of full digital signatures would enable precise authentication of the OSPF router originating each OSPF link-state advertisement, and thereby provide much stronger integrity protection for the OSPF routing domain.

10. IANA Considerations

This document is classified as Standards Track. It defines new sub-TLVs for inclusion in OSPF TE LSAs. According to the assignment policies for the registries of code points for these sub-TLVs, values must be assigned by IANA [RFC3630].

The following subsections summarize the required sub-TLVs.

10.1. Sub-TLVs of the Link TLV

This document defines the following sub-TLVs of the Link TLV advertised in the OSPF TE LSA:

- Local and Remote TE Router ID sub-TLV
- Associated RA ID sub-TLV
- Inter-RA Export Upward sub-TLV
- Inter-RA Export Downward sub-TLV

Codepoints for these Sub-TLVs should be allocated from the "Types for sub-TLVs of TE Link TLV (Value 2)" registry standards action range (0-255).
10.2. Sub-TLVs of the Node Attribute TLV

This document defines the following sub-TLVs of the Node Attribute TLV advertised in the OSPF TE LSA:

- Local TE Router ID sub-TLV
- Associated RA ID sub-TLV
- Inter-RA Export Upward sub-TLV
- Inter-RA Export Downward sub-TLV

Codepoints for these Sub-TLVs should be assigned from the "Types for sub-TLVs of TE Node Attribute TLV (Value 5)" registry standards action range (0 - 32767) [RFC5786].

Note that the same values for the Associated RA ID sub-TLV, Inter-RA Export Upward sub-TLV, and Inter-RA Export Downward Sub-TLV MUST be used when they appear in the Link TLV, Node Attribute TLV, and Router Address TLV.

10.3. Sub-TLVs of the Router Address TLV

The Router Address TLV is advertised in the OSPF TE LSA [RFC3630]. Since this TLV currently has no Sub-TLVs defined, a "Types for sub-TLVs of Router Address TLV (Value 1)" registry must be defined.

The registry guidelines for the assignment of types for sub-TLVs of the Router Address TLV are as follows:

- Types in the range 0-32767 are to be assigned via Standards Action.
- Types in the range 32768-32777 are for experimental use; these will not be registered with IANA, and MUST NOT be mentioned by RFCs.
- Types in the range 32778-65535 are not to be assigned at this time. Before any assignments can be made in this range, there MUST be a Standards Track RFC that specifies IANA Considerations that covers the range being assigned.

This document defines the following sub-TLVs for inclusion in the
Router Address TLV:

- Associated RA ID sub-TLV
- Inter-RA Export Upward sub-TLV
- Inter-RA Export Downward sub-TLV

Codepoints for these Sub-TLVs should be allocated from the "Types for sub-TLVs of Router Address TLV (Value 1)" registry standards action range (0 - 32767).

Note that the same values for the Associated RA ID sub-TLV, Inter-RA Export Upward sub-TLV, and Inter-RA Export Downward sub-TLV MUST be used when they appear in the Link TLV, Node Attribute TLV, and Router Address TLV.

11. Management Considerations

11.1. Routing Area (RA) Isolation

If the RA Identifier is mapped to the OSPF Area ID as recommended in section 2.0, OSPF [RFC2328] implicitly provides isolation. On any intra-RA link, packets will only be accepted if the area-id in the OSPF packet header matches the area ID for the OSPF interface on which the packet was received. Hence, RCs will only establish adjacencies and exchange reachability information (see Section 4.0) with RCs in the same RC. Other mechanisms for RA isolation are beyond the scope of this document.

11.2 Routing Area (RA) Topology/Configuration Changes

The GMPLS Routing for ASON requirements [RFC4258] dictate that the routing protocol MUST support reconfiguration and SHOULD support architectural evolution. OSPF [RFC2328] includes support for the dynamic introduction or removal of ASON reachability information through the flooding and purging of OSPF opaque LSAs [RFC5250]. Also, when an RA is partitioned or an RC fails, stale LSAs SHOULD NOT be used unless the advertising RC is reachable. The configuration of OSPF RAs and the policies governing the redistribution of ASON reachability information between RAs are implementation issues outside of the OSPF routing protocol and beyond the scope of this document.
12. References

12.1. Normative References


12.2. Informative References


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


13. Acknowledgements

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Appendix A.  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 that 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 located between protocol controllers between control domains.

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

Link: (See Recommendation G.805.) A "topological component" that 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 that 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 bidirectional 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 Recommendation G.805.

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 B. ASON Routing Terminology

This document makes use of the following terms:

Routing Area (RA): an 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], an 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. An RA may contain smaller RAs inter-connected by links. The limit of subdivision results in an RA that contains two sub-networks interconnected by a single link.

Routing Database (RDB): a 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) or 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.

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