CCAMP Working Group
Internet Draft
Category: Informational

Expiration Date: September 2005

John Drake (Boeing)
Chris Hopps (Cisco)
Lyndon Ong (Ciena)
Dimitri Papadimitriou (Alcatel)
Jonathan Sadler (Tellabs)
Stephen Shew (Nortel)
Dave Ward (Cisco)

March 2005

Evaluation of existing Routing Protocols against ASON routing requirements

draft-dimitri-ccamp-gmpls-ason-routing-eval-01.txt

Status of this Memo

Copyright Notice

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 an evaluation of the IETF Routing Protocols against the routing requirements for an Automatically Switched Optical Network (ASON) as defined by ITU-T.

1. Contributors

This document is the result of the CCAMP Working Group ASON Routing Solution design team joint effort.

2. 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].

3. 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].

[ASON-RR] details the routing requirements for the GMPLS routing suite of protocols to support the capabilities and functionality of ASON control planes identified in [G.7715] and in [G.7715.1]. The ASON routing architecture provides for a conceptual reference architecture, with definition of functional components and common information elements to enable end-to-end routing in the case of protocol heterogeneity and facilitate management of ASON networks. This description is only conceptual: no physical partitioning of these functions is implied.

However, [ASON-RR] does not address GMPLS routing protocol applicability or capabilities. This document evaluates the IETF Routing Protocols against the requirements identified in [ASON-RR]. The result of this evaluation is detailed in Section 5. Close examination of applicability scenarios and the result of the evaluation of these scenarios are provided in Section 6.

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

4. Requirements - Overview

The following functionality is expected from GMPLS routing protocol to instantiate the ASON hierarchical routing architecture realization (see [G.7715] and [G.7715.1]):

- Routing Areas (RAs) shall be uniquely identifiable within a carrier's network, each having a unique RA Identifier (RA ID) within the carrier's network.
- Within a RA (one level), the routing protocol shall support dissemination of hierarchical routing information (including summarized routing information for other levels) in support of an

  architecture of multiple hierarchical levels of RAs; the number of hierarchical RA levels to be supported by a routing protocol is implementation specific.
- The routing protocol shall support routing information based on a common set of information elements as defined in [G.7715] and [G.7715.1], divided between attributes pertaining to links and abstract nodes (each representing either a sub-network or simply a node). [G.7715] recognizes that the manner in which the routing information is represented and exchanged will vary with the routing protocol used.
- The routing protocol shall converge such that the distributed Routing DataBases (RDB) become synchronized after a period of time.

To support dissemination of hierarchical routing information, the routing protocol must deliver:

- Processing of routing information exchanged between adjacent levels of the hierarchy (i.e. Level N+1 and N) including reachability and upon policy decision summarized topology information.
- Self-consistent information at the receiving level resulting from any transformation (filter, summarize, etc.) and forwarding of information from one Routing Controller (RC) to RC(s) at different levels when multiple RCs bound to a single RA.
- A mechanism to prevent re-introduction of information propagated into the Level N RA's RC back to the adjacent level RA's RC from which this information has been initially received.

Note: the number of hierarchical levels to be supported is routing protocol specific and reflects a containment relationship.

Reachability information may be advertised either as a set of UNI Transport Resource address prefixes, or a set of associated Subnetwork Point Pool (SNPP) link IDs/SNPP link ID prefixes, assigned and selected consistently in their applicability scope. The formats of the control plane identifiers in a protocol realization are implementation specific. Use of a routing protocol within a RA should not restrict the choice of routing protocols for use in other RAs (child or parent).

As ASON does not restrict the control plane architecture choice used, either a co-located architecture or a physically separated architecture may be used. A collection of links and nodes such as a sub-network or RA must be able to represent itself to the wider network as a single logical entity with only its external links visible to the topology database.

5. Evaluation

This section evaluates support of existing IETF routing protocols with respect to the requirements summarized from [ASON-RR] in Section

4. Candidate routing protocols are IGP (OSPF and IS-IS) and BGP. The latter in not addressed in the current version of this document.

5.1 Terminology and Identification

- Pi is a physical node (bearer/data/transport plane) node

- Li is a logical control plane identifier that is associated to a single data plane (abstract) node i.e., the Logical Node ID

- TE Router_ID: control plane identifier that refers to the
  . RFC 3630: Router_Address (top level) TLV of the Type 1 TE LSA
  . RFC 3784: Traffic Engineering Router ID TLV (Type 134)

  Note: both [RFC3630] and [RFC3784] make use of a single stable address to populate this identifier.

- Ri is a logical control plane identifier that is associated to a control plane "router" e.g. (advertising) Router_ID i.e.
  . RFC 2328: Router ID (32-bit)
  . RFC 1195: IS-IS System ID (48-bit)

  The Router_ID, represented by Ri and that corresponds to the RC_ID [ASON-REQ], 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. Note that, in the ASON context, arrangement considering multiple Ri's announcing routing information related to a single Li is under evaluation.

Aside from the Li/Pi mappings, these identifiers are not assumed to be in a particular entity relationship, e.g., an Ri may have multiple Li in its scope.

Note: Si is a control plane signaling function associated with one or more Li.

5.2 RA Identification

G.7715.1 notes some necessary characteristics for RA identifiers, e.g., that they may provide scope for the Ri, and that they must be provisioned to be unique within an administrative domain. The RA ID format itself is allowed to be derived from any global address space. Provisioning of RA IDs for uniqueness is outside the scope of this document.

Under these conditions, GMPLS link state routing protocols provide the capability for RA Identification.

5.3 Routing Information Exchange

We focus on routing information exchange between Ri entities (through routing adjacencies) within single hierarchical level.

Routing information mapping between levels may require specific guidelines.

The control plane does not transport Pi information as these are data plane addresses for which the Li/Pi mapping is kept (link) local - see for instance the transport LMP document [LMP-T] where such exchange is described. Example: the transport plane identifier is the Pi (the identifier assigned to the physical element) which could be for instance "666B.F999.AF10.222C", whereas the control plane identifier is the Li (the identifier assigned by the control plane), which could be for instance "1.1.1.1".

The control plane exchanges the control plane identifier information but not the transport plane identifier information (i.e. not "666B.F999.AF10.222C" but only "1.1.1.1"). The mapping Li/Pi is kept local. So, when the Si receives a control plane message requesting the use of "1.1.1.1", Si knows locally that this information refers to the data plane entity identified by the transport plane identifier "666B.F999.AF10.222C".

The control plane carries:
1) its view of the data plane link end-points and other link

connection end-points
2) the identifiers scoped by the Li's i.e. referred to as an associated IPv4/IPv6 addressing space
3) when using OSPF or ISIS as the IGP in support of traffic engineering, RFC 3477 RECOMMENDS that the Li value (referred to the "LSR Router ID") to be set to the TE Router ID value. Note that in the ASON context, there may be cases where this is not desirable. These cases are under evaluation.

5.3.1 Link Attributes

From the list of link attributes and characteristics (detailed in [ASON-RR], the Local Adaptation support information is missing as TE link attribute. GMPLS routing does not currently consider the use of dedicated TE link attribute(s) to describe the cross/inter-layer relationships. All other TE link attributes and characteristics are currently covered (see Table 1.)

However, the representation of bandwidth requires further analysis i.e. GMPLS Routing defines an Interface Switching Capability Descriptor (ISCD) that delivers information about the (maximum/ minimum) bandwidth per priority an LSP can make use of. In the ASON context, other representations are possible, e.g., in terms of a set of tuples <signal_type; number of unallocated timeslots>. The latter also may require definition of additional signal types (from those defined in [RFC 3496]) to represent contiguous concatenation i.e. STS-(3xN)c SPE / VC-4-Nc, N = 4, 16, 64, 256.

The method proposed in [GMPLS-RTG] is the most straightforward without requiring any bandwidth accounting change from an LSR

perspective. However, it introduces some lost of information. This lost of information affects the number of signals that can be used but not the range they cover. On the other hand, if additional technology specific information (such as capabilities) are advertised a finer grained resource countdown and accounting can be performed allowing for network wide resource allocation in Sonet/SDH environments.

Link Characteristics	GMPLS OSPF
Local SNPP link ID	Link local part of the TE link identifier sub-TLV [GMPLS-OSPF]
Remote SNPP link ID	Link remote part of the TE link identifier sub-TLV [GMPLS-OSPF]
Signal Type	Technology specific part of the Interface

	Switching Capability Descriptor sub-TLV [GMPLS-OSPF]
Link Weight	TE metric sub-TLV [RFC3630]
Resource Class	Administrative Group sub-TLV [RFC3630]
Local Connection Types	Switching Capability field part of the Interface Switching Capability Descriptor sub-TLV [GMPLS-OSPF]
Link Capacity	Unreserved bandwidth sub-TLV [RFC3630] Max LSP Bandwidth part of the Interface Switching Capability Descriptor sub-TLV [GMPLS-OSPF]
Link Availability	Link Protection sub-TLV [GMPLS-OSPF]
Diversity Support	SRLG sub-TLV [GMPLS-OSPF]
Local Adaptation support	see above

Link Characteristics	GMPLS IS-IS
Local SNPP link ID	Link local part of the TE link identifier sub-TLV [GMPLS-ISIS]
Remote SNPP link ID	Link remote part of the TE link identifier sub-TLV [GMPLS-ISIS]
Signal Type	Technology specific part of the Interface Switching Capability Descriptor sub-TLV [GMPLS-ISIS]
Link Weight	TE Default metric [RFC3784]
Resource Class	Administrative Group sub-TLV [RFC3784]
Local Connection Types	Switching Capability field part of the Interface Switching Capability Descriptor sub-TLV [GMPLS-ISIS]
Link Capacity	Unreserved bandwidth sub-TLV [RFC3784] Max LSP Bandwidth part of the Interface Switching Capability Descriptor sub-TLV [GMPLS-ISIS]
Link Availability	Link Protection sub-TLV [GMPLS-ISIS]
Diversity Support	SRLG sub-TLV [GMPLS-ISIS]
Local Adaptation support	see above

Table 1. TE link Attribute in GMPLS OSPF-TE and GMPLS IS-IS-TE, respectively

5.3.2 Node Attributes

Nodes attributes include the "Logical Node ID" (as detailed in Section 5.1) and the reachability information as described in

Section 5.3.3.

5.3.3 Reachability Information

Advertisement of reachability can be achieved using the techniques described in [OSPF-NODE] where the set of local addresses are carried in a OSPF TE LSA node attribute TLV (a specific sub-TLV is defined per address family, e.g., IPv4 and IPv6). However, [OSPF-NODE] restricts to advertisement of Host addresses and not prefixes, and therefore requires enhancement (see below).

A similar mechanism does not exist for IS-IS as the Extended IP Reachability TLV [RFC3784] focuses on IP reachable end-points (terminating points), as its name indicates.

In order to advertise blocks of reachable address prefixes a summarization mechanism is additionally required. This mechanism may take the form of an prefix length (that indicates the number of significant bits in the prefix) or a network mask.

5.4 Routing Information Abstraction

G.7715.1 describes both static and dynamic methods for abstraction of routing information for advertisement at a different level of the routing hierarchy. However, the information that is advertised continues to be in the form of link and node advertisements consistent with the link state routing protocol used at that level, hence no specific capabilities are added to the routing protocol beyond the ability to locally identify when routing information originates outside of a particular RA.

The methods used for abstraction of routing information are outside the scope of GMPLS routing protocols.

5.5 Dissemination of routing information in support of multiple hierarchical levels of RAs

G.7715.1 does not define specific mechanisms to support multiple hierarchical levels of RAs, beyond the ability to support abstraction as discussed above. However, if RCs bound to adjacent levels of the RA hierarchy were allowed to redistribute routing information in both directions between adjacent levels of the hierarchy without any additional mechanisms, they would not be able to determine looping of routing information.

To prevent this looping of routing information between levels, IS-IS [RFC1195] allows only advertising routing information upward in the level hierarchy, and disallow the advertising of routing information downward in the hierarchy. [RFC2966] defines the up/down bit to allow advertising downward in the hierarchy the "IP Internal Reachability Information" TLV (Type 128) and "IP External Reachability Information" TLV (Type 130). [RFC3784] extends its applicability for the "Extended IP Reachability" TLV (Type 135). Using this mechanism, the up/down bit is set to 0 when routing information is first injected into IS-IS. If routing information is advertised from a higher level to a lower level, the up/down bit is set to 1, indicating that it has traveled down the hierarchy. Routing information that have the up/down bit set to 1 may only be advertised down the hierarchy, i.e. to lower levels. This mechanisms applies independently of the number of levels. However, this mechanism does not apply to the "Extended IS Reachability" TLV (Type 22) used to propagate the summarized topology (see Section 5.3), traffic engineering information as listed in Table 1, as well as reachability information (see Section 5.3.3).

OSPFv2 prevents that inter-area routes which are learned from area 0 are not passed back to area 0. However, GMPLS makes use of Type 10 (area-local scope) LSA to propagate TE information [RFC3630], [GMPLS-RTG]. Type 10 Opaque LSAs are not flooded beyond the borders of their associated area. It is therefore necessary to have a means by which Type 10 Opaque LSA may carry the information that a particular routing information has been learned from a higher level RC when propagated to a lower level RC. Any downward RC from this level which receives an LSA with this information would omit the information in this LSA and thus not re-introduce this information back into an higher level RC.

5.6 Routing Protocol Convergence

Link state protocols have been designed to detect topological changes (such as interface failures, link attributes modification). Convergence period is short and involves a minimum of routing information exchange.

Therefore, existing routing protocol convergence mechanisms are sufficient for ASON applications.

6. Evaluation Scenarios

The evaluation scenarios are the following: referred to as respectively case 1), 2), 3) and 4). Additional base scenarios (being not combinations or decomposition of entities) may further complete this set in a future revision of this document.

In the below Figure 1:
- R3 represents an LSR with all components collocated.

   - R2 shows how the "router" component may be disjoint from the node

   - R1 shows how a single "router" may manage multiple nodes

```
                -------------------     -------
               |R1                 |   |R2     |
               |                   |   |       |    ------
               |  L1    L2    L3   |   |   L4  |   |R3    |
               |   :     :     :   |   |   :   |   |      |
               |   :     :     :   |   |   :   |   |  L5  |
   Control      ---+-----+-----+---     ---+---    |   :  |
   Plane           :     :     :           :       |   :  |
   ----------------+-----+-----+-----------+-------+---+--+-
   Data            :     :     :           :       |   :  |
   Plane          --     :    --          --       |  --  |
             ----|P1|--------|P3|--------|P4|------+-|P5|-+-
                  -- \   :  / --          --       |  --  |
                      \ -- /                       |      |
                       |P2|                         ------
                        --
```

   Case 1) as represented refers either to direct links between edges
   or "logical links" as per below figure (or any combination of them)

```
                   ------                        ------
                  |      |                      |      |
                  |  L1  |                      |  L2  |
                  |  :   |                      |  :   |
                  |  : R1|                      |  : R2|
   Control Plane   --+---                        --+---
   Elements          :                             :
   ------------------+-----------------------------+-------------------
   Data Plane        :                             :
   Elements          :                             :
                 ----+-----------------------------+-----
                |    :                             :     |
                |   ---            ---            ---    |
                |  |   |----------| P |----------|   |   |
             ---+--|   |           ---           |   |---+---
                |  |   |                         |   |   |
                |  | P1|-------------------------| P2|   |
                |   ---                           ---    |
                 ----------------------------------------
```

   Another case (referred to as Case 4) is constituted by the Abstract

Node as represented in the below figure. There is no internal structure associated (externally) to the abstract node.

```
                    --------------
                   |R4            |
                   |              |
                   |      L6      |
                   |       :      |
                   |    ......    |
```



```
                    ---:------:---
Control Plane          :      :
                +------+------+------+
Data Plane             :      :
                    ---:------:---
                   |P8 :      :   |
                   |  --      --  |
                 --+-|P |----|P |-+--
                   |  --      --  |
                    --------------
```

Note: the "signaling function" i.e. the control plane entity that processes the signaling messages (referred to as Si) is not represented in these Figures. More than one Si can be associated to one Ri (N:1 relationship, N >= 1) and make use of the path computation function associated to the Ri.

7. Acknowledgements

The authors would like to thank Adrian Farrel for having initiated the proposal of an ASON Routing Solution Design Team and the ITU-T SG15/Q14 for their careful review and input.

8. References

8.1 Normative References

[GMPLS-RTG] Kompella, K. (Editor) et al., "Routing Extensions in Support of Generalized MPLS," Internet Draft (work in progress), draft-ietf-ccamp-gmpls-routing-09.txt, October 2003.

[LMP-T] D.Fedyk et al., "A Transport Network View of LMP," Internet Draft (work in progress), draft-ietf-ccamp-transport-lmp-01, February 2005.

[OSPF-NODE] R.Aggarwal, and K.Kompella, "Advertising a Router's Local Addresses in OSPF TE Extensions," Internet Draft, (work in progress), draft-ietf-ospf-te-node-addr-01.txt, July 2004.

[RFC2026] S.Bradner, "The Internet Standards Process -- Revision 3", BCP 9, RFC 2026, October 1996.

[RFC2328] J.Moy, "OSPF Version 2", RFC 2328, April 1998.

[RFC2119] S.Bradner, "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC3477] K.Kompella et al. "Signalling Unnumbered Links in Resource ReSerVation Protocol - Traffic Engineering (RSVP-TE)", RFC 3477, January 2003.

[RFC3630] D.Katz et al. "Traffic Engineering (TE) Extensions to OSPF Version 2", RFC 3630, September 2003.

[RFC3667] S.Bradner, "IETF Rights in Contributions", BCP 78, RFC 3667, February 2004.

[RFC3668] S.Bradner, Ed., "Intellectual Property Rights in IETF Technology", BCP 79, RFC 3668, February 2004.

[RFC3784] H.Smit and T.Li, "Intermediate System to Intermediate System (IS-IS) Extensions for Traffic Engineering (TE)," RFC 3784, June 2004.

[RFC3946] E.Mannie, and D.Papadimitriou, (Editors) et al., "Generalized Multi-Protocol Label Switching Extensions for SONET and SDH Control," RFC 3946, October 2004.

8.2 Informative References

[ASON-RR] W.Alanqar et al. "Requirements for Generalized MPLS (GMPLS) Routing for Automatically Switched Optical Network (ASON)," Work in progress, draft-ietf-ccamp-gmpls-ason-routing-reqts-04.txt, May 2004.

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

[G.7715] ITU-T Rec. G.7715/Y.1306, "Architecture and

Requirements for the Automatically Switched Optical Network (ASON)," June 2002.

[G.7715.1] ITU-T Draft Rec. G.7715.1/Y.1706.1, "ASON Routing Architecture and Requirements for Link State Protocols," November 2003.

[G.8080] ITU-T Rec. G.8080/Y.1304, "Architecture for the Automatically Switched Optical Network (ASON)," November 2001 (and Revision, January 2003).

9. Author's Addresses (to be completed)

Lyndon Ong (Ciena Corporation)
PO Box 308
Cupertino, CA 95015 , USA
Phone: +1 408 705 2978
EMail: lyong@ciena.com

Dimitri Papadimitriou (Alcatel)
Francis Wellensplein 1,
B-2018 Antwerpen, Belgium
Phone: +32 3 2408491

EMail: dimitri.papadimitriou@alcatel.be

Jonathan Sadler
1415 W. Diehl Rd
Naperville, IL 60563
EMail: jonathan.sadler@tellabs.com

Stephen Shew (Nortel Networks)
PO Box 3511 Station C
Ottawa, Ontario, CANADA K1Y 4H7
Phone: +1 613 7632462
EMail: sdshew@nortelnetworks.com

Appendix 1: 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.

Intellectual Property Statement

The IETF takes no position regarding the validity or scope of any Intellectual Property Rights or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; nor does it represent that it has made any independent effort to identify any such rights. Information on the procedures with respect to rights in RFC documents can be found in BCP 78 and BCP 79.

Copies of IPR disclosures made to the IETF Secretariat and any assurances of licenses to be made available, or the result of an attempt made to obtain a general license or permission for the use of such proprietary rights by implementers or users of this specification can be obtained from the IETF on-line IPR repository at http://www.ietf.org/ipr.

The IETF invites any interested party to bring to its attention any copyrights, patents or patent applications, or other proprietary rights that may cover technology that may be required to implement this standard. Please address the information to the IETF at ietf-ipr@ietf.org.

Disclaimer of Validity

This document and the information contained herein are provided on an "AS IS" basis and THE CONTRIBUTOR, THE ORGANIZATION HE/SHE REPRESENTS OR IS SPONSORED BY (IF ANY), THE INTERNET SOCIETY AND THE INTERNET ENGINEERING TASK FORCE DISCLAIM ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Copyright Statement

Acknowledgment

Funding for the RFC Editor function is currently provided by the Internet Society.