                Choosing a "Common IGP" for the IP Internet
                  (The IESG's Recommendation to the IAB)

Status of this Memo

   This memo provides information for the Internet community. It does
   not specify an Internet standard. Distribution of this memo is
   unlimited.

Special Note

   This document was originally prepared as an Internet Engineering
   Steering Group (IESG) recommendation to the Internet Architecture
   Board (IAB) in mid-summer 1991, reaching the current version by the
   date shown above. Although the document is now somewhat dated (e.g.,
   CIDR and RIP II are not mentioned), the IESG felt it was important to
   publish this along with the recent OSPF Applicability Statement [11]
   to help establish context and motivation.

Abstract

   This memo presents motivation, rationale and other surrounding
   background information leading to the IESG's recommendation to the
   IAB for a single "common IGP" for the IP portions of the Internet.

   In this memo, the term "common IGP" is defined, the need for a common
   IGP is explained, the relation of this issue to other ongoing
   Internet Engineering Task Force (IETF) routing protocol development
   is provided, and the relation of this issue to the goal for multi-
   protocol integration in the Internet is explored.

   Finally, a specific IGP is recommended as the "common IGP" for IP
   portions of the Internet -- the Open Shortest Path First (OSPF)
   routing protocol.

   The goal of this recommendation is for all vendors of Internet IP
   routers to make OSPF available as one of the IGP's provided with
   their routers.

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1. Background

   There is a pressing need for a high functionality non-proprietary
   "common" Interior Gateway Protocol (IGP) for the TCP/IP protocol
   family. An IGP is the routing protocol used within a single
   administrative domain (commonly referred to as an "Autonomous System"
   (AS).

   By "common", we simply mean a protocol that is ubiquitously available
   from all router vendors (as in "in common"). Users and network
   operators have expressed a strong need for routers from different
   vendors to have the capablity to interoperate within an AS through
   use of a common IGP.

   Note: Routing between AS's is handled by a different type of routing
   protocol, called an "Exterior Gateway Protocol" ("an EGP", of which
   the Border Gateway Protocol [2] and "The Exterior Gateway Protocol"
   [3] are examples.) The issues of routing between AS's using "an" EGP
   is not considered in this memo.

   There are two IGPs in the Internet standards track capable of routing
   IP traffic -- Open Shortest Path First (OSPF) [4] and Integrated IS-
   IS [5] (based on the OSI IS-IS). These two protocols are both modern
   "link state" routing protocols, based on the Dijkstra algorithm.
   There has been substantial interaction and cooperation among the
   engineers involved in each effort, and the protocols share some
   similar features.

   However, there are a number of technical design differences. Most
   noteably, OSPF has been designed solely for support of the Internet
   Protocol (IP), while Integrated IS-IS has been designed to support
   both IP and the OSI Connectionless Network Layer Protocol (CLNP)

simultaneously.

2. Multiple Internet Standard Routing Protocols Possible

   The Internet architecture makes a distinction between "Interior
   Gateway Protocols (IGPs)" and "Exterior Gateway Protocols (EGPs)".
   IGPs are routing protocols used within an Autonomous System (AS), and
   EGPs are routing protocols used between different AS's.

   Therefore, the Internet architecture supports the use and
   standardization of multiple IGP routing protocols. For example, it
   is perfectly reasonable for one standard routing protocol to be used
   within one AS; while a second standard routing protocol is used
   within a second AS; at the same time that a non-standard proprietary
   routing protocol is used within a third AS.

   The primary purpose for making standards is to allow
   interoperability. Setting a protocol standard in the Internet says,
   in effect, "if you wish to use this protocol, you should do it as
   specified in the standard so that you can interoperate with others
   who also wish to use this protocol." It is important to understand
   that simply specifying a standard does not, by itself, designate a
   requirement to use the standard. It is merely meant to allow
   interoperability among those who choose to follow the standard.

   Therefore, it is reasonable for both OSPF and Integrated IS-IS to be
   progressed through the Internet Standards process as appropriate
   (based on the criteria specified in [6]). In addition, it is
   possible that other IGPs may be developed and standardized in the
   future.

3. A Common IGP

   Although the Internet architecture allows for multiple standard IGP
   routing protocols, interoperability of router products from different
   vendors within a single AS would be greatly facilitated if a single
   "common" IGP were available from all router vendors. Designating a
   single common IGP would have the goal of enabling multi-vendor router
   interoperation with a modern high functionality routing protocol.

   However, designating a common IGP does not mandate the use of that
   IGP, nor would it be meant to discourage the use of other IGPs in
   situations where there may be sound technical reasons to do so.

4. Impact of Multi-protocol Topology and Integrated IP/CLNP Routing

   There are topology considerations which will affect the designation
   of a "common" Internet IGP.

The Internet requires support for a wide variety of protocol suites.
If we consider only IP and OSI CLNP, then the Internet is expected to
contain:

1. Pure IP AS's (in which IP is used but OSI CLNP is not used);

2. Pure CLNP AS's (in which CLNP is used but IP is not used);

3. Dual IP/CLNP ASs, with a common topology (i.e., all links and
   routers in the AS support IP and CLNP, and a single common
   topology is used for both protocol suites);

4. Dual, overlapping IP/CLNP ASs with differing topologies (i.e.,
   some links are dual, while some are IP-only and some are
   CLNP-only, resulting in different topologies for IP routing and
   CLNP routing).

For (1), (i.e., a pure IP environment) any IGP capable of routing IP
traffic could be used (e.g., OSPF or Integrated IS-IS).

For (2), (i.e., a pure CLNP environment) any IGP capable of routing
CLNP traffic could be used (e.g., OSI IS-IS or Integrated IS-IS).

For (3), (i.e., routing environments in which both IP and CLNP are
present in a common topology) there are two possibilities for managing
routing:

1. Separate routing protocols could be used for each supported
   protocol suite. For example, OSPF may be used for calculating
   routes for IP traffic and OSI IS-IS may be used for calculating
   routes for OSI traffic. Or Integrated IS-IS could be used for
   calculating routes for IP traffic and OSI IS-IS could be used
   for calculating routes for CLNP traffic.

   This approach of using separate routing protocols and management
   for each supported protocol family has come to be known as "Ships
   in the Night" because the two routing protocols share the
   hardware/software resources of the router without ever actually
   interacting on a protocol level.

2. "Integrated routing" could be used, in which a single routing
   protocol is used for both IP and CLNP. At this time, Integrated
   IS-IS is the only choice for "integrated routing".

For (4), (i.e., routing environments in which both IP and CLNP are
present but in an overlapping different topology) separate routing
protocols are required for the IP and CLNP environments (i.e., "Ships
in the Night"). This is equivalent to two separates cases of (1) and

(2), but it is pointed out here as a separate case for completeness.

5. Commitment to both IP and CLNP

   The IAB/IETF are committed to a timely introduction of OSI into the
   Internet. In recognition of this commitment, the IETF has an entire
   area devoted to OSI integration.

   However, while this introduction is taking place, it is essential
   that existing services based on IP be continued. Furthermore, IESG
   also feels that even after more widespread introduction of CLNP, IP
   and CLNP will continue to coexist in the Internet for quite some
   time. This view is consistent with the IAB goal of a multi-protocol
   Internet.

   Therefore, the IESG has a strong commitment to the continued support
   for IP throughout the Internet. Maintenance of this IP support
   requires selection of a common IGP suitable for support of IP, and
   requires that this selection be based on operational experience.

6. Some History

   In February 1990, the IESG recommended that the question of
   designating a "common" IGP be postponed until more information was
   available from each protocol. More than a year has now passed since
   the IESG's recommendation. There have been significant advancements
   in specification, implementation, and operational experience with
   each protocol. It is now reasonable to re-open the consideration of
   designating a "common IGP".

   At the March 1991 meeting of the IETF, the IETF Routing Area Director
   presented a set of criteria for the advancement of routing protocols
   through the Internet standards process [6]. More information
   regarding the IAB Internet Standards process can be found in [1].

   Also, at the March 1991 meeting of the IETF, the OSPF Working Group
   requested that OSPF be considered for advancement to Draft Internet
   Standard. The OSPF WG submitted four documents to the IETF to
   support its request:

   o a revised protocol specification to update [4];

   o an SNMP Management Information Base (MIB);

   o two technical reports giving a technical analysis and operational
     experience with OSPF. These reports follow the format recommended
     in [6].

These four documents have now been published as [7, 8, 9, 10]
respectively.

In summary for OSPF:

o all features of OSPF have tested (although not all features have
  been used in operation),

o OSPF has been shown to operate well in several operational
  networks containing between 10 and 30 routers,

o interoperation among routers from multiple vendors has been
  demonstrated at organized "bakeoffs".

In May 1991, the IAB approved the IETF/IESG recommendation to advance
OSPF to Draft Internet Standard.

Integrated IS-IS, as specified in [5], is currently a Proposed
Internet Standard. In July 1991, the status of Integrated IS-IS is
as follows:

o There are several separate implementations of integrated
  IS-IS under development,

o Integrated IS-IS has worked well in several multi-area operational
  networks, one containing between 20 and 30 routers,

o These recent operational results have not yet been fully
  documented. Documentation, showing satisfaction of the criteria
  given in [6] for advancing routing protocols, will be submitted
  to the IESG when Integrated IS-IS is submitted for Draft Internet
  Standard status.

7. IESG Recommendations

7.1 Regarding the Common IGP for the IP Internet

Based on the available operational experience and the pressing need
for a high functionality IGP for the IP protocol family, the IESG
recommends that OSPF be designated as the common IGP for the IP
portions of the Internet. To help ensure that this IGP is available
to all users, the IESG recommends that the IETF Router Requirements
Working Group specify OSPF as "MUST IMPLEMENT" in the document
"Requirements for Internet IP Routers".

7.2 Regarding Integrated Routing

   As mentioned above, the IESG is commited to multiprotocol
   environments, and expects usage of OSI CLNP to increase in the
   Internet over time.

   However, at this time, the IESG is not prepared to take a position
   regarding the preference of either "Ships in the Night" or Integrated
   routing for such mixed routing environments. At this time, the
   "Ships in the Night" approach is most widely used in the Internet.
   Integrated routing has the potential advantage of reducing resource
   utilization. However, additional operational experience is needed
   before any potential advantages can be fully evaluated.

   Therefore, the IESG wishes to encourage implementation of Integrated
   IS-IS so that a reasonable position can be determined based on
   operational experience. All implementers of Integrated IS-IS are
   encouraged to coordinate their activity with the IETF IS-IS Working
   Group, which is actively collecting information on such experience.

7.3 Limits of the Recommendation

   It is useful to recognize the limits of this recommendation. This
   recommendation does not take a position on any of the following
   issues:

   1. What IGP (if any) users should run inside an AS. Users are free to
      run any IGP they wish inside an AS.

   2. What IGP is technically superior, or has greater operational
      utility.

   3. What IGP any vendor should recommend to its users for any specific
      environment.

   4. What IGP should be used within a CLNP-only environment.

   Again, this recommendation is meant to designate one modern high
   functionality IGP that should be implemented by all vendors of
   routers for the IP portion of the Internet. This will enable routers
   from vendors who follow this recommendation to interoperate within a
   single IP Autonomous System.

   It is not our intent to discourage the use of other routing protocols
   in situations where there may be sound technical reasons to do so.
   Therefore, developers of Internet routers are free to implement, and
   network operators are free to use, other Internet standard routing
   protocols, or proprietary non-Internet-standard routing protocols, as

they wish.

8. References

   [1] Internet Activities Board, "The Internet Standards Process", RFC
       1310, IAB, March 1992.

   [2] Lougheed, K., and Y. Rekhter, "A Border Gateway Protocol 3 (BGP-
       3)", RFC 1267, cisco Systems, T.J. Watson Research Center, IBM
       Corp., October 1991.

   [3] Mills, D., "Exterior Gateway Protocol Formal Specification", STD
       18, RFC 904, UDEL, April 1984.

   [4] Moy, J., "OSPF Specification", RFC 1131 (Superceded by [7]),
       Proteon, October 1989.

   [5] Callon, R., "Use of OSI IS-IS for Routing in TCP/IP and Dual
       Environments", RFC 1195, DEC, December 1990.

   [6] Hinden, R., "Criteria for Standardizing Internet Routing
       Protocols", RFC 1264, BBN, October 1991.

   [7] Moy, J., "OSPF Version 2", RFC 1247, Proteon, July 1991.

   [8] Baker, F., and R. Coltun, "OSPF Version 2 Management Information
       Base", RFC 1253, ACC, Computer Science Center, August 1991.

   [9] Moy, J., "Experience with the OSPF Protocol", RFC 1246, Proteon,
       July 1991.

  [10] Moy, J., "OSPF Protocol Analysis", RFC 1245, Proteon, July 1991.

  [11] Internet Architecture Board, "Applicability Statement for OSPF",
       RFC 1370, IAB, October 1992.

9. Security Considerations

   Security issues are not discussed in this memo.

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