                Guidelines for the use of Internet-IP addresses in the
                     ISO Connectionless-Mode Network Protocol

Status of This Memo

   This RFC suggests an addressing scheme for use with the ISO
   Connectionless Network Protocol (CLNP) in the Internet. This is a
   solution to one of the problems inherent in the use of "ISO-grams" in
   the Internet. This RFC suggests a proposed protocol for the Internet
   community, and requests discussion and suggestions for improvements.
   Distribution of this memo is unlimited.

   This memo is a revision of RFC 986. Changes were made in order to
   allow the addressing used in the CLNP in the Internet to be
   potentially useful for routing in the context of new inter- and
   intra-domain routing protocols, and in the context of large numbers
   of networks and routing domains. The addressing scheme proposed in
   this RFC allows individual routing domains to make use of internal
   routing algorithms utilizing a variety of addressing formats, while
   still providing for a common addressing approach for use by inter-
   domain routing. These features are important due to the rapid growth
   currently being experienced in the Internet.

1. Objectives

   The data communications protocols currently emerging out of the
   international standardization efforts warrant an early integration
   into the existing extensive Internet network infrastructure. The two
   possible approaches are a top-down one, where ISO applications like
   FTAM, X.400 and VTP are integrated on top of the transport function
   of the IP protocol suite, or a bottom-up approach where the whole ISO
   tower gets integrated without merging the two suites. The bottom-up
   approach may make use of the fact that the ISO-CLNP and the IP are
   very similar in function. This implies that it is reasonable to
   implement a multiprotocol function in some or all of the Internet
   gateways (potentially including part or all of the Internet
   environment). The result would be that at least large portions of
   the Internet, in particular the backbones, can become usable for full
   implementations of the ISO protocol stack.

   A major problem with this approach is that there are open issues with

regard to the ISO addressing within the CLNP. In particular, the ISO
network layer addressing standard allows a great deal of flexibility
in the assignment of addresses, and a particular address format must
be chosen. A further problem is the need for implementation and
integration of routing facilities for the ISO-compatible subset of
the Internet environment.

This paper proposed to use addresses which are considerably more
flexible than the addresses used in the current IP Internet
environment. This flexibility is necessary in order to allow some
routing domains to base their internal routing protocol on addresses
derived from the current IP addresses, to allow other routing domains
to base routing on addresses in accordance to the intra-domain
routing protocol being developed by ANSI and ISO [6], and to allow
generality for a future inter-domain routing protocol.

The addressing scheme proposed here makes use of the concept of
"routing domains" as used in ANSI and ISO. This concept is similar
to, but not identical with, the concept of "Autonomous System" used
in the Internet. Routing domains include a combination of gateways,
networks, and end systems (not just gateways), and routing domain
boundaries may be used to define associated access control and policy
routing constraints. Like autonomous systems, routing domains may be
assumed to be topologically contiguous. There is no a priori reason
why routing domains assigned for use with the ISO IP need to have any
particular relation with existing autonomous systems which have been
assigned for use with the IP. The assignment of specific routing
domain identifiers is an "assigned numbers" function which is
necessary for use of the ISO IP in the Internet, but is beyond the
scope of this document.

It is expected that this addressing scheme will be appropriate for
long term use with the ISO IP in the Internet. However, it is also
expected that in the long term, the Internet will be interconnected
with other routing domains making use of other schemes, such as
addresses assigned to commercial internets through ANSI, and
addresses assigned by national standards organizations in other
countries. This implies that, in the long term, gateways in the
Internet will need to be able to route datagrams to destinations in
other routing domains not conforming to the addressing format
proposed here. This is discussed in greater detail in section 6.

2. Introduction

The CLNP is documented in [1], but for matters of completeness the
following illustration of the CLNP header is included here as Figure
1.

The addressing part of the header is the subject of this RFC, i.e.,
the source and the destination address, respectively. These
addresses are generally discussed in [2] and [3], with this document
presenting a specific method for addressing in the Internet
environment, consistent with the international standardized NSAP
addresses.

```
                                            Octet
   +-------------------------------------+                   +--------
   |  Network Layer Protocol Identifier  |  1                :
   |-------------------------------------|                   :
   |           Length Indicator          |  2                :
   |-------------------------------------|                   :
   |    Version/Protocol Id Extension    |  3                :    Fixed
   |-------------------------------------|                   :
   |              Lifetime               |  4                :    Part
   |-------------------------------------|                   :
   |SP|MS|E/R|       Type                |  5                :
   |-------------------------------------|                   :
   |           Segment Length            |  6,7              :
   |-------------------------------------|                   :
   |              Checksum               |  8,9              :
   |-------------------------------------|                   +--------
   |  Destination Address Length Indicator | 10              :
   |-------------------------------------|                   :
   |          Destination Address        |  11 through m-1   : Address
   |-------------------------------------|                   :
   |    Source Address Length Indicator  |  m                :    Part
   |-------------------------------------|                   :
   |            Source Address           |  m+1 through n-1  :
   |-------------------------------------|                   +--------
   |          Data Unit Identifier       |  n,n+1            :
   |-------------------------------------|                   : Segment
   |            Segment Offset            |  n+2,n+3          :   ation
   |-------------------------------------|                   :
   |             Total Length            |  n+4,n+5          :    Part
   |-------------------------------------|                   +--------
   |               Options               |  n+6 through p    : Options
                                                                Part
   |-------------------------------------|                   +--------
   |                Data                 |  p+1 through z    :   Data
   +-------------------------------------+                   +--------
```

Figure 1:   PDU Header Format

3. Addresses for Use in the Internet

   This section describes the addresses used to address NSAPs in the
   Internet.

   The appropriate Authority and Format Identifier (AFI) is one octet in
   length. It specifies an ISO-6523-ICD assignment, and also that the
   Domain Specific Part (DSP) of the address is based on binary. The
   AFI octet uses the value "47". The ISO-6523-ICD format is used to
   emphasize that this is an administrative assignment. The usage of an
   ISO DCC (Data Country Code) would be possible, but could be
   misleading due to the fairly far spread geographical extent of the
   Internet.

   As required by the ISO addressing standard, the next two octets of
   the address, in this case, specify the Initial Domain Identifier.
   This two octet value is the International Code Designator (ICD)
   assigned to the Internet, "0006".

   The remainder of the NSAP address is the Domain Specific Part (DSP).
   This is assigned by the Internet administration, which is considered
   to be an addressing domain. Note that there is no particular
   relationship required between addressing domains and routing domains.
   In this case, although the Internet is considered to be a single
   addressing domain, it is expected that it will consist of multiple
   routing domains.

   The DSP of the address specifies a one octet version number, a two
   octet global area number, a two octet routing domain number, a
   variable length padding field, a variable length IGP specific part,
   and a one octet selector field.

   The version number is provided to allow for future extensions, and
   must contain the value "02".

   The global area number and routing domain number are provided to
   allow for inter-domain routing. Initially, the global area number is
   reserved and must be set to zero. The routing domain number may be
   set to the routing domain number of any gateway by which the
   associated host address is directly reachable.

   The IGP specific part of the address may contain whatever addressing
   format is used in the routing domain. Two particular formats are
   expected to be used initially, and are presented in section 4.
   Padding is used so that the entire address will always be 20 octets
   in length.

   The selector field performs the same function as the user protocol

field in the IP header. This is necessary because the ISO protocol
considers identification of the user protocol to be an addressing
issue, and therefore does not allow for the user protocol to be
specified in the protocol header independently from the address.

The assignment of specific routing domain identifiers to defined
routing domains, and the assignment of values for use in the selector
field, are functions for the Assigned Numbers authority for the
Internet [4]. The specific values to be used are outside of the
scope of this document.

In summary, a source or destination address within the ISO
Connectionless Protocol, when used in the Internet, looks as follows:

```
                                                 Octet


                 +-----------------------+
                 |          AFI          |      1
                 +-----------------------+
                 |       IDI / ICD       |      2
                 +--                 --+
                 |(specifies DoD Internet)|     3
                 +-----------------------+
                 |     Version Number    |      4
                 +-----------------------+
                 |      Global Area      |      5
                 +---                 ---+
                 |         Number        |      6
                 +-----------------------+
                 |        Routing        |      7
                 +---                 ---+
                 |         Domain        |      8
                 +-----------------------+
                 |                       |      9
                 :        Padding        :      :
                 :                       :      :
                 |                       |      n
                 +-----------------------+
                 |          IGP          |     n+1
                 :                       :      :
                 :                       :      :
                 |        Specific       |     19
                 +-----------------------+
                 |        Selector       |     20
                 +-----------------------+
```

Figure 2: ISO IP address structure

The Authority and Format Identifier (AFI) is "47" (BCD). The Initial
Domain Identifier (IDI) consists of the International Code Designator
(ICD) assigned to the Internet, and must contain the value "0006".
The Version Number must contain the value "02". The Global Area
Number must contains the value "00". The Padding field is of
variable length, but must contain the value zero.

4. Specific Values for use with the IGP specific field

In general, a particular routing domain may specify any addressing
scheme for use with the IGP specific part of the address, up to 11
octets in length (consistent with the maximum address length of 20
octets). However, it is expected that initially addresses used in
this field will consist of either the current IP addresses, or
addresses conformant with those specified in the draft ANSI proposal
for intra-domain routing.

For end systems which are members of routing domains using the IP
addresses for internal routing, the addresses will look as follows:

```
                                                Octet

                    +-----------------------+
                    |          AFI          |     1
                    +-----------------------+
                    |       IDI / ICD       |     2
                    +--                   --+
                    |(specifies DoD Internet)|    3
                    +-----------------------+
                    |     Version Number    |     4
                    +-----------------------+
                    |      Global Area      |     5
                    +---                 ---+
                    |         Number        |     6
                    +-----------------------+
                    |        Routing        |     7
                    +---                 ---+
                    |         Domain        |     8
                    +-----------------------+
                    |                       |     9
                    :        Padding        :     :
                    :                       :     :
                    |                       |    15
                    +-----------------------+
                    |       Four Octet      |    16
                    +---                 ---+
                    |        Internet       |    17
                    +---                 ---+
                    |          DoD          |    18
                    +---                 ---+
                    |        Address        |    19
                    +-----------------------+
                    |        Selector       |    20
                    +-----------------------+
```

            Figure 3: ISO IP Address with Encoded DoD IP Address

     For end systems which are members of routing domains using the
     address format specified in the draft ANSI proposal for intra-domain
     routing [6], the addresses will look as follows:

```
                                                 Octet

              +-----------------------+
              |         AFI           |    1
              +-----------------------+
              |      IDI / ICD        |    2
              +--                   --+
              |(specifies DOD Internet)|   3
              +-----------------------+
              |    Version Number     |    4
              +-----------------------+
              |     Global Area       |    5
              +---                 ---+
              |        Number         |    6
              +-----------------------+
              |       Routing         |    7
              +---                 ---+
              |        Domain         |    8
              +-----------------------+
              |                       |    9
              +---                 ---+
              |       Padding         |   10
              +---                 ---+
              |                       |   11
              +-----------------------+
              |                       |   12
              +---    LOC-AREA     ---+
              |                       |   13
              +-----------------------+
              |                       |   14
              :          ID           :    :
              :                       :    :
              |                       |   19
              +-----------------------+
              |       Selector        |   20
              +-----------------------+
```

Figure 4: ISO IP Address with Encoded ANSI-format Address

5. Devices Attached to PDNs

   Otherwise isolated end systems, which are attached to the Internet
   only indirectly via public data networks, and simple LANs which are
   similarly attached only via Public Data Networks, may make use of a
   separate address format based on their X.121 address. Such addresses
   may, for example, use the ISO-X.121 address format discussed in [3].
   These addresses will need to be handled for routing purposes in much
   the same way as addresses in routing domains which have been

interconnected to the Internet, but which use other address formats,
such as those specified by national standards bodies.

6. Migration to Future Routing Protocols

Initially, routing of ISO datagrams in the Internet may make use of
the first 8 octets of the address (AFI, ICD, version, global area
number, and routing domain number) as a flat field identifying the
routing domain. This implies that if EGP is initially used for
routing between routing domains, a new version of EGP may be required
to carry 8 octet routing domain numbers instead of 3 octet network
numbers.

There are currently several efforts underway to determine the
requirements for inter-autonomous system routing, and to define a new
protocol. One of the requirements of inter-autonomous system routing
is the need to be able to deal with a very large Internet. It is
anticipated that during the lifetime of the addressing scheme
described in this RFC the number of networks in the Internet will
grow to the point where it is no longer feasible for any gateway to
maintain separate routes to every network in the Internet. Allowing
inter-domain routing to be done by routing domain number instead of
network number is therefore a necessary step in the long term.

It is difficult to anticipate the rate at which the number of routing
domains may grow. For example, during a period of time in which the
number of networks grows by a factor of 100, it is not clear whether
the number of routing domains may also be expected to grow by a
factor of 100, or by some lesser amount. It is possible that the
number of routing domains will also grow to a point where it is not
feasible for a single gateway to maintain separate routes to each.
In order to prepare for this eventuality, we have provided for a
"global area" field.

In the long term, it will be necessary for gateways to route to
destinations which are in routing domains utilizing other addressing
formats, specified by other organizations such as ANSI, ECMA, etc.
In this case, it will not be possible to ensure that the first 8
octets of the address specifies the routing domain. In the long
term, it will therefore be necessary to route based on variable
length routing domain identifiers. It may be assumed that future
inter-domain routing protocols will allow for specification of either
(1) an address mask, specifying which part of an address is relevant
for specifying those destinations which are reachable via a
particular domain; or (2) a length field, specifying how many leading
octets in a particular address are relevant. Specification of the
details of such a routing protocol is beyond the scope of this
document.

References

    [1]   ISO, "Protocol for Providing the Connectionless-Mode Network
          Services", RFC-926, ISO, December 1984.

    [2]   ANSI, "Guidelines for the Specification of the Structure of the
          Domain Specific Part (DSP) of the ISO Standard NSAP Address",
          RFC-982, ANSI Working Document X3S3.3/85-258, April 1986.

    [3]   ISO, Draft International Standard 8348/DAD2, "Information
          Processing Systems -- Data Communications -- Network Service
          Definition, Addendum 2 Covering Network Layer Addressing", RFC-
          941, April 1985.

    [4]   Reynolds, J. and J. Postel, "Assigned Numbers", RFC-1010,
          USC/Information Sciences Institute, May 1987.

    [5]   Callon, R. and H. W. Braun, "Working Draft -- Guidelines for the
          use of Internet-IP addresses in the ISO Connectionless-Mode
          Network Protocol," RFC-986, June 1986.

    [6]   ISO TC97/SC6/WG2 working document, "Intermediate System to
          Intermediate System Intra-Domain Routing Exchange Protocol".