                An IPv6 Provider-Based Unicast Address Format

Status of this Memo

   This document specifies an Internet standards track protocol for the
   Internet community, and requests discussion and suggestions for
   improvements. Please refer to the current edition of the "Internet
   Official Protocol Standards" (STD 1) for the standardization state
   and status of this protocol. Distribution of this memo is unlimited.

1.0 Introduction

   This document defines an IPv6 provider-based unicast address format
   for use in the Internet. The address format defined in this document
   is consistent with the "IPv6 Addressing Architecture" [ARCH] and the
   "An Architecture for IPv6 Unicast Address Allocation" [ALLOC], and is
   intended to facilitate scalable Internet routing.

   The unicast address format defined in this document doesn't preclude
   the use of other unicast address formats.

2.0 Overview of the IPv6 Address

   IPv6 addresses are 128-bit identifiers for interfaces and sets of
   interfaces. There are three types of addresses: Unicast, Anycast,
   and Multicast. This document defines a specific type of Unicast
   address.

   In this document, fields in addresses are given specific names, for
   example "subscriber". When this name is used with the term "ID" (for
   "identifier") after the name (e.g., "subscriber ID"), it refers to
   the contents of the named field. When it is used with the term
   "prefix" (e.g., "subscriber prefix") it refers to all of the address
   up to and including this field.

The specific type of an IPv6 address is indicated by the leading bits in the address. The variable-length field comprising these leading bits is called the Format Prefix (FP).

This document defines an address format for the 010 (binary) Format Prefix for Provider-Based Unicast addresses. The same address format could be used for other Format Prefixes, as long as these Format Prefixes also identify IPv6 unicast addresses. Only the "010" Format Prefix is defined here.

3.0 IPv6 Provider-Based Unicast Address Format

This document defines an address format for the IPv6 provider-based unicast address assignment. It is expected that this address format will be widely used for IPv6 nodes connected to the Internet.

The address format defined in this document conforms to the "Architecture for IPv6 Unicast Address Allocation" [ALLOC]. Specifically, the format is designed to support aggregation of network layer reachability information at multiple levels of routing hierarchy.

For addresses of the format described in this document the address administration is organized into a three level hierarchy -- registry, provider, and subscriber. The address format defined here allows flexible address allocation at each level of the address administration hierarchy in such a way as to support a wide spectrum of demands for address allocation.

This document assumes that the Internet routing system doesn't make any assumptions about the specific structure and semantics of an IPv6 address, except for the structure and semantics of the Format Prefix part of the address, and the use of the "longest prefix match" algorithm (on arbitrary bit boundaries) for making a forwarding decision.

The address format defined in this document is intended to facilitate scalable Internet-wide routing that does not impose any constraints on connectivity among the providers, as well as among the providers and subscribers.

3.1 Provider-Based Unicast Address Structure

   For the purpose of address allocation, the address format defined in
   this document consists of the following parts: Format Prefix,
   Registry ID, Provider ID, Subscriber ID, and an Intra-Subscriber
   part. The Intra-Subscriber part definition is the responsibility of
   the subscriber and is not defined in this document. The provider-
   based unicast address format is as follows:

```
     | 3 |  5 bits  |   n bits   |   56-n bits  |       64 bits       |
     +---+----------+------------+--------------+--------------------+
     |010|RegistryID| ProviderID | SubscriberID | Intra-Subscriber   |
     +---+----------+------------+--------------+--------------------+
```
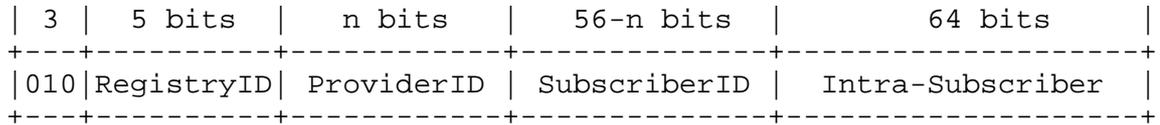
   The following sections specify each part of the IPv6 Provider-Based
   Unicast address format. In general other allocation strategies are
   possible within this framework, but the ones described in this
   document will be used to assign IPv6 provider-based addresses.

3.2 Registry ID

   With the growth of the Internet and its increasing globalization,
   much thought has been given to the evolution of the Network Layer
   address space allocation and assignment process. RFC 1466,
   "Guidelines for Management of IP Address Space", proposes a plan that
   defines distributed allocation and assignment of the IPv4 address
   space.

   As the Internet transitions to IPv6, the plan for distributed
   allocation and assignment of the IPv4 address space established in
   RFC1466 forms a base for the distributed allocation and assignment of
   the IPv6 address space.

   The Internet Assigned Number Authority (IANA) is the principal
   registry for the IPv6 address space. The IANA may allocate blocks of
   IPv6 addresses and delegate the assignment of those blocks to
   qualified Regional Registries. The IANA will serve as the default
   registry in cases where no delegated registration authority has been
   identified.

   The Registry ID of the IPv6 provider-based unicast address format is
   intended to facilitate a broad geographic address allocation and
   facilitate the operations of the distributed Regional Registries.

   The Registry ID immediately follows the format prefix part of an IPv6
   address.

At present there are three Regional Registries: INTERNIC, RIPE NCC,
and APNIC. In addition, address allocation could be done directly by
the IANA. Corresponding to this division of address allocation, this
document defines the following Registry IDs:

```
    Regional Registry                    Value (binary)
    --------------------                 --------------

    Multi-Regional (IANA)                10000
    RIPE NCC                             01000
    INTERNIC                             11000
    APNIC                                00100
```

All other values of the Registry ID are reserved by the IANA.

Use of the Multi-regional Registry ID permits flexibility in address
assignments which are outside of the geographical regions already
allocated. The IANA will be responsible for managing address space
registration under the Multi-Regional Registry ID.

It is expected that the IANA, and any designated Regional Registries,
allocate addresses in conformance with this overall scheme. Where
there are qualifying Regional Registries established, primary
responsibility for allocation from within that block will be
delegated to that registry.

A Regional Registry may have more than one block of addresses
allocated to it (as a result the Registry would have multiple
Registry IDs associated with it).

3.3 Provider ID and Subscriber ID

This document leaves the organization of the Provider ID and
Subscriber ID portions of address up to individual registries.
Particularly the registry needs to define how much address space is
given to providers and their subscribers. There are several issues
which must be addressed when doing this. These include:

    o There will likely be a mixture of providers of different sizes.
    o Small providers will grow to become large providers.
    o Large providers will lose customers and become small providers.
      In extreme cases, the registry will require them to return some
      of their address space to the registry.
    o Organizations which need to be multi-homed to more than one
      provider will request a Provider ID assignment.

It is important that a registry design its Provider ID space to allow
flexibility and at the same time use the address space efficiently.

3.3.1 Provider ID

   The value of the Provider ID associated with an address block a
   registry allocates to a particular provider uniquely identifies this
   provider within the registry.

   This document assumes that some subscribers may decide to acquire
   their address space directly from a registry, thus making their
   addresses independent of the provider(s) they are directly attached.

3.3.2 Subscriber ID

   The structure and assignment strategy of Subscriber ID's is specified
   by each provider.

   A (direct) provider may decide to group its subscribers into regions.
   This grouping may be useful when the (direct) provider is attached to
   another (indirect) provider at multiple points, as it allows the
   direct provider to exert a certain degree of control over the
   coupling between the attachment points and flow of the traffic
   destined to a particular subscriber (see Section 5.3.1 of [ALLOC]).

   To accommodate such a grouping the (direct) provider may allocate
   some small number of high-order bits of the Subscriber ID as a
   Subscriber-Region ID. The purpose of a Subscriber-Region ID is to
   identify a group of subscribers that are within a close topological
   proximity to each other (from the provider's point of view), and thus
   could be reachable through a particular attachment point between the
   (direct) provider and other (indirect) provider(s).

3.4 Intra-Subscriber Part

   This document leaves the organization of Intra-Subscriber portion of
   the address up to individual subscribers.

   The provider-based unicast address format described in this document
   leaves 64 bits for the local portion of the address. The editors of
   this document recommend that subscribers use IPv6 auto-configuration
   capabilities [AUTO] to generate addresses using link-specific
   addresses as Interface ID such as 48 bit IEEE-802 MAC addresses. In
   this case 16 bits are left for the Subnet ID. This should sufficient
   (e.g., 65,535 subnets) for all but the largest of subscribers. This
   is shown as follows:

```
      |             64 bits            |  16 bits  |     48 bits       |
      +-------------------------------+-----------+------------------+
      |         Subscriber Prefix      | Subnet ID |   Interface ID   |
      +-------------------------------+-----------+------------------+
```
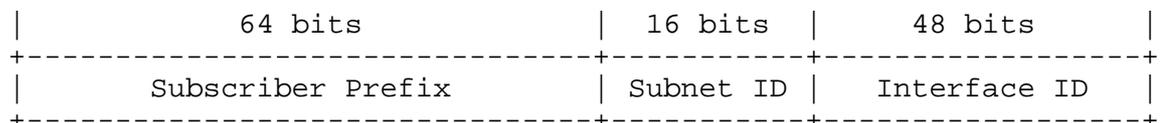
   Subscribers who need additional subnets (and who desire to continue
   to use 48 bit IEEE-802 MAC addresses for Interface ID's) can be
   accommodated by having the provider assign them a block of subscriber
   prefixes. Alternatively, an extremely large subscriber could be
   assigned its own Provider ID which would give it additional bits of
   address space to create its own local address hierarchy.

4.0 National Registries

   A Regional Registry may allocate blocks of address space to several
   National Registries. The National Registry then becomes the entity
   that allocates address space to individual providers within the
   country served by the National Registry.

   To create National Registries the Regional Registry may add a layer
   of hierarchy in the Provider ID field to create National Registries.
   The resulting Provider Prefix is as follows:

```
| 3 |  5 bits  |  n bits  |  m bits  |  56-n-m   |    64 bits     |
+---+----------+----------+----------+-----------+----------------+
|010|RegistryID| National | Provider | Subscriber |Intra-Subscriber|
|   |          |RegistryID|    ID    |    ID      |                |
+---+----------+----------+----------+-----------+----------------+
```

   This document assumes that within each regional registry there will
   be a relatively small number of national registries. The size of the
   National-Registry ID should be related to the number of countries in
   the region administrated by the regional registry and the number of
   providers expected to be in each country.

5.0 Acknowledgments

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   Scott Bradner (Harvard), Brian Carpenter (CERN), Geoff Huston
   (AANET), and Tony Li (cisco) for their review and constructive
   comments.

6.0 References

   [ALLOC] Rekhter, Y., Li, T., "An Architecture for IPv6 Unicast
           Address Allocation", RFC 1887, December 1995.

   [ARCH] Hinden, R., "IP Version 6 Addressing Architecture",
           RFC 1884, December 1995.

   [AUTO] Thompson, S., "IPv6 Stateless Address Autoconfiguration",
           RFC 1972, August 1996.

7.0 Security Considerations

   Security issues are not discussed in this memo.

8.0 Editors' Addresses

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