                  Reserved IPv6 Subnet Anycast Addresses

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Abstract

   The IP Version 6 addressing architecture defines an "anycast" address
   as an IPv6 address that is assigned to one or more network interfaces
   (typically belonging to different nodes), with the property that a
   packet sent to an anycast address is routed to the "nearest"
   interface having that address, according to the routing protocols'
   measure of distance. This document defines a set of reserved anycast
   addresses within each subnet prefix, and lists the initial allocation
   of these reserved subnet anycast addresses.

1. Introduction

   IP Version 6 (IPv6) defines a new type of address, known as an
   "anycast" address, that allows a packet to be routed to one of a
   number of different nodes all responding to the same address [2, 3].
   The anycast address may be assigned to one or more network interfaces
   (typically on different nodes), with the network delivering each
   packet addressed to this address to the "nearest" interface based on
   the notion of "distance" determined by the routing protocols in use.

   The uses of anycast addresses are still evolving, but such addresses
   offer the potential for a number of important services [5, 6]. For
   example, an anycast address may be used to allow nodes to access one
   of a collection of servers providing a well-known service, without
   manual configuration in each node of the list of servers; or an

anycast address may be used in a source route to force routing
through a specific internet service provider, without limiting
routing to a single specific router providing access to that ISP.

IPv6 defines a required Subnet-Router anycast address [3] for all
routers within a subnet prefix, and allows additional anycast
addresses to be taken from the unicast address space. This document
defines an additional set of reserved anycast addresses within each
subnet prefix, and lists the initial allocation of these reserved
subnet anycast addresses.

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 [1].

2. Format of Reserved Subnet Anycast Addresses

Within each subnet, the highest 128 interface identifier values are
reserved for assignment as subnet anycast addresses.

The construction of a reserved subnet anycast address depends on the
type of IPv6 addresses used within the subnet, as indicated by the
format prefix in the addresses. In particular, for IPv6 address
types required to have 64-bit interface identifiers in EUI-64 format,
the universal/local bit MUST be set to 0 (local) in all reserved
subnet anycast addresses, to indicate that the interface identifier
in the address is not globally unique. IPv6 addresses of this type
are currently specified to be those having format prefixes 001
through 111, except for Multicast Addresses (1111 1111) [3].

Specifically, for IPv6 address types required to have to have 64-bit
interface identifiers in EUI-64 format, these reserved subnet anycast
addresses are constructed as follows:

```
|             64 bits            |      57 bits     |   7 bits   |
+-------------------------------+-----------------+------------+
|          subnet prefix         | 1111110111...111 | anycast ID |
+-------------------------------+-----------------+------------+
                                 |     interface identifier field  |
```

For other IPv6 address types (that is, with format prefixes other
than those listed above), the interface identifier is not in EUI-64
format and may be other than 64 bits in length; these reserved subnet
anycast addresses for such address types are constructed as follows:

```
|               n bits             |   121-n bits    |   7 bits   |
+----------------------------------+-----------------+------------+
|            subnet prefix         | 1111111...111111 | anycast ID |
+----------------------------------+-----------------+------------+
                                   |  interface identifier field  |
```

The subnet prefix here consists of all fields of the IPv6 address
except the interface identifier field. The interface identifier
field in these reserved subnet anycast addresses is formed from a
7-bit anycast identifier ("anycast ID"), with the remaining (highest
order) bits filled with all one's; however, for interface identifiers
in EUI-64 format, the universal/local bit in the interface identifier
MUST be set to 0. The anycast identifier identifies a particular
reserved anycast address within the subnet prefix, from the set of
reserved subnet anycast addresses.

The motivation for reserving the highest addresses from each subnet
rather than the lowest addresses, is to avoid conflicting with some
existing official and unofficial uses of the low-numbered addresses
in a subnet. For example, these low-numbered addresses are often
used for the ends of a point-to-point link, for tunnel endpoints, for
manually configured unicast addresses when a hardware token is not
available for the network interface, and even for manually configured
static addresses for the routers on a link. Reserving only 128
values for anycast identifiers (rather than perhaps 256) means that
the minimum possible size of interface identifiers in an IPv6 address
is 8 bits (including room in the subnet for unicast addresses as well
as reserved subnet anycast addresses), allowing the division between
subnet prefix and interface identifier in this case to be
byte-aligned.

As with all IPv6 anycast addresses [3], these reserved subnet anycast
addresses are allocated from the IPv6 unicast address space. All
reserved subnet anycast addresses as defined in this document are
reserved on all links, with all subnet prefixes. They MUST NOT be
used for unicast addresses assigned to any interface.

3. List of Reserved Subnet Anycast Addresses

   Currently, the following anycast identifiers for these reserved
   subnet anycast addresses are defined:

```
   Decimal    Hexadecimal      Description
   -------    -----------      -----------
     127         7F            Reserved
     126         7E            Mobile IPv6 Home-Agents anycast [4]
     0-125       00-7D         Reserved
```

   Additional anycast identifiers are expected to be defined in the
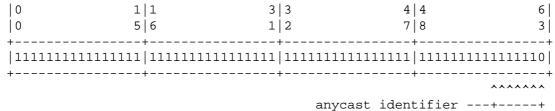   future.

4. Examples

   To illustrate the construction of reserved subnet anycast addresses,
   this section details the construction of the reserved Mobile IPv6
   Home-Agents subnet anycast address [4]. As noted in Section 3, the
   7-bit anycast identifier for the Mobile IPv6 Home-Agents anycast
   address is 126 (decimal) or 7E (hexadecimal).

   For IPv6 addresses containing a format prefix indicating that
   interface identifiers are required to be 64 bits in length and are
   required to be in EUI-64 format (currently format prefixes 001
   through 111, except for 1111 1111 [3]), the reserved Mobile IPv6
   Home-Agents subnet anycast address consists of the 64-bit subnet
   prefix followed by the 64-bit interface identifier shown below:

```
|0               1|1               3|3               4|4               6|
|0               5|6               1|2               7|8               3|
+----------------+----------------+----------------+----------------+
|1111110111111111|1111111111111111|1111111111111111|1111111111111110|
+----------------+----------------+----------------+----------------+
        ^                                            ^^^^^^^
        +--- universal/local bit       anycast identifier ---+-----+
```

   For other IPv6 address types, the interface identifier may be other
   than 64 bits in length and is not in EUI-64 format. In this example,
   assume that the length of the interface identifier is 64 bits, to
   allow clear comparison with the example given above (although
   interface identifiers of lengths other than 64 bits follow the same
   general construction of the interface identifier shown here).   In
   this case, the reserved Mobile IPv6 Home-Agents subnet anycast
   address consists of the 64-bit subnet prefix followed by the 64-bit
   interface identifier shown below:

```
|0               1|1               3|3               4|4               6|
|0               5|6               1|2               7|8               3|
+----------------+----------------+----------------+----------------+
|1111111111111111|1111111111111111|1111111111111111|1111111111111110|
+----------------+----------------+----------------+----------------+
                                                     ^^^^^^^
                                          anycast identifier ---+-----+
```

5. IANA Considerations

   This document defines a set of reserved subnet anycast addresses,
   based on a set of anycast identifiers within each subnet prefix in
   the IPv6 unicast address space. As future needs arise, new anycast
   identifiers may be defined. Such anycast identifiers MUST be
   reserved within all subnet prefixes, and so the assignment of these
   anycast identifiers requires centralized administration. New values
   SHOULD be assigned in descending numerical order and are expected to
   be assigned only with IESG approval.

6. Security Considerations

   The use of any type of reserved anycast addresses poses a security
   concern only in allowing potential attackers a well-known address to
   attack. By designating certain services to be located at specific
   reserved anycast addresses, an attacker may more profitably focus an
   attack against such a specific service. Any such attack, however, is
   best dealt with in each service that uses a reserved anycast address.

   RFC 1546, which originally proposed the idea of anycasting in IP,
   also points out a number of security considerations with the use of
   anycasting in general [6].

References

   [1] Bradner, S., "Key words for use in RFCs to indicate requirement
       levels", BCP 14, RFC 2119, March 1997.

   [2] Deering, S. and R. Hinden, "Internet Protocol Version 6 (IPv6)
       Specification", RFC 2460, December 1998.

   [3] Hinden, R. and S. Deering, "IP Version 6 Addressing
       Architecture", RFC 2373, July 1998.

   [4] David B. Johnson and Charles Perkins, "Mobility Support in IPv6",
       Work in Progress.

   [5] Steve King et al, "The Case for IPv6", Work in Progress.

   [6] Partridge, C., Mendez, T. and W. Milliken, "Host Anycasting
       Service", RFC 1546, November 1993.

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