Overview of the Internet Multicast Addressing Architecture
draft-ietf-mboned-addrarch-07.txt

Abstract

   The lack of up-to-date documentation on IP multicast address
   allocation and assignment procedures has caused a great deal of
   confusion. To clarify the situation, this memo describes the
   allocation and assignment techniques and mechanisms currently (as of
   this writing) in use.

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1. Introduction

Good, up-to-date documentation of IP multicast is close to non-existent. Particularly, this is an issue with multicast address allocations (to networks and sites) and assignments (to hosts and applications). This problem is stressed by the fact that there exists confusing or misleading documentation on the subject [RFC2908]. The consequence is that those who wish to learn about IP multicast and how the addressing works do not get a clear view of the current situation.

The aim of this document is to provide a brief overview of multicast addressing and allocation techniques. The term 'addressing architecture' refers to the set of addressing mechanisms and methods in an informal manner.

It is important to note that Source-specific Multicast (SSM) [RFC4607] does not have these addressing problems because SSM group addresses have only local significance; hence, this document focuses on the Any Source Multicast (ASM) model.

This memo obsoletes and re-classifies to Historic RFC 2908, and re-classifies to Historic RFCs 2776 and 2909.

1.1. Terminology: Allocation or Assignment

Almost all multicast documents and many other RFCs (such as DHCPv4 [RFC2131] and DHCPv6 [RFC3315]) have used the terms address "allocation" and "assignment" interchangeably. However, the operator and address management communities use these terms for two conceptually different processes.

In unicast operations, address allocations refer to leasing a large block of addresses from Internet Assigned Numbers Authority (IANA) to a Regional Internet Registry (RIR) or from RIR to a Local Internet Registry (LIR) possibly through a National Internet Registry (NIR). Address assignments, on the other hand, are the leases of smaller address blocks or even single addresses to the end-user sites or end-users themselves.

Therefore, in this memo, we will separate the two different functions: "allocation" describes how larger blocks of addresses are obtained by the network operators, and "assignment" describes how applications, nodes or sets of nodes obtain a multicast address for their use.

2. Multicast Address Allocation

Multicast address allocation, i.e., how a network operator might be able to obtain a larger block of addresses, can be handled in a number of ways as described below.

Note that these are all only pertinent to ASM -- SSM requires no address block allocation because the group address has only local significance (however, we discuss the address assignment inside the node in Section 3.2).

2.1. Derived Allocation

Derived allocations take the unicast prefix or some other properties of the network (e.g., an autonomous system (AS) number) to determine unique multicast address allocations.

2.1.1. GLOP Allocation

GLOP address allocation [RFC3180] inserts the 16-bit public AS number in the middle of the IPv4 multicast prefix 233.0.0.0/8, so that each AS number can get a /24 worth of multicast addresses. While this is sufficient for multicast testing or small scale use, it might not be sufficient in all cases for extensive multicast use.

A minor operational debugging issue with GLOP addresses is that the connection between the AS and the prefix is not apparent from the prefix when the AS number is greater than 255, but has to be calculated (e.g., from [RFC3180], AS 5662 maps to 233.22.30.0/24). A usage issue is that GLOP addresses are not tied to any prefix but to routing domains, so they cannot be used or calculated automatically.

GLOP mapping is not available with 4-byte AS numbers [RFC4893]. Unicast-prefix-based Allocation or an IANA allocation from "AD-HOC Block III" (the previous so-called "eGLOP" block) could be used instead as needed.

The GLOP allocation algorithm has not been defined for IPv6 multicast because the unicast-prefix-based allocation (described below) addresses the same need in a simpler fashion.

2.1.2. Unicast-prefix-based Allocation

RFC 3306 [RFC3306] describes a mechanism which embeds up to 64 high-order bits of an IPv6 unicast address in the prefix part of the IPv6 multicast address, leaving at least 32 bits of group-id space available after the prefix mapping.

A similar IPv4 mapping is described in [RFC6034], but it provides a
limited number of addresses (e.g., 1 per an IPv4 /24 block).

The IPv6 unicast-prefix-based allocations are an extremely useful way
to allow each network operator, even each subnet, to obtain multicast
addresses easily, through an easy computation. Further, as the IPv6
multicast header also includes the scope value [RFC4291], multicast
groups of smaller scope can also be used with the same mapping.

The IPv6 Embedded RP technique [RFC3956], used with Protocol
Independent Multicast - Sparse Mode (PIM-SM), further leverages the
unicast-prefix-based allocations, by embedding the unicast prefix and
interface identifier of the PIM-SM Rendezvous Point (RP) in the
prefix. This provides all the necessary information needed to the
routing systems to run the group in either inter- or intra-domain
operation. A difference from RFC 3306 is, however, that the hosts
cannot calculate their "multicast prefix" automatically, as the
prefix depends on the decisions of the operator setting up the RP,
but instead requires an assignment method.

All the IPv6 unicast-prefix-based allocation techniques provide
sufficient amount of multicast address space for network operators.

2.2. Administratively Scoped Allocation

Administratively scoped multicast address allocation [RFC2365] is
provided by two different means: under 239.0.0.0/8 in IPv4 or by
4-bit encoding in the IPv6 multicast address prefix [RFC4291].

Since IPv6 administratively scoped allocations can be handled with
unicast-prefix-based multicast addressing as described in
Section 2.1.2, we'll only discuss IPv4 in this section.

The IPv4 administratively scoped prefix 239.0.0.0/8 is further
divided into Local Scope (239.255.0.0/16) and Organization Local
Scope (239.192.0.0/14); other parts of the administrative scopes are
either reserved for expansion or undefined [RFC2365]. However, RFC
2365 is ambiguous as to whether the enterprises or the IETF are
allowed to expand the space.

Topologies which act under a single administration can easily use the
scoped multicast addresses for their internal groups. Groups which
need to be shared between multiple routing domains (even if not
propagated through the Internet) are more problematic and typically
need an assignment of a global multicast address because their scope
is undefined.

There is a large number of multicast applications (such as "Norton

Ghost") which are restricted either to a link or a site, and it is
extremely undesirable to propagate them further (beyond the link or
the site). Typically many such applications have been given or have
hijacked a static IANA address assignment. Given the fact that
assignments to typically locally used applications come from the same
range as global applications, implementing proper propagation
limiting is challenging. Filtering would be easier if a separate,
identifiable range would be used for such assignments in the future;
this is an area of further future work.

There has also been work on a protocol to automatically discover
multicast scope zones [RFC2776], but it has never been widely
implemented or deployed.

2.3. Static IANA Allocation

In some rare cases, organizations may have been able to obtain static
multicast address allocations (of up to 256 addresses) directly from
IANA. Typically these have been meant as a block of static
assignments to multicast applications, as described in Section 3.4.1.
If another means of obtaining addresses is available that approach is
preferable.

Especially for those operators that only have a 32-bit AS number and
need IPv4 addresses, an IANA allocation from "AD-HOC Block III" (the
previous so-called "eGLOP" block) is an option [RFC5771].

2.4. Dynamic Allocation

RFC 2908 [RFC2908] proposed three different layers of multicast
address allocation and assignment, where layers 3 (inter-domain
allocation) and layer 2 (intra-domain allocation) could be applicable
here. Multicast Address-Set Claim Protocol (MASC) [RFC2909] is an
example of the former, and Multicast Address Allocation Protocol
(AAP) [I-D.ietf-malloc-aap] (abandoned in 2000 due lack of interest
and technical problems) is an example of the latter.

Both of the proposed allocation protocols were quite complex, and
have never been deployed or seriously implemented.

It can be concluded that dynamic multicast address allocation
protocols provide no benefit beyond GLOP/unicast-prefix-based
mechanisms and have been abandoned.

3. Multicast Address Assignment

There are a number of possible ways for an application, node or set

of nodes to learn a multicast address as described below.

Any IPv6 address assignment method should be aware of the guidelines
for the assignment of group-IDs for IPv6 multicast addresses
[RFC3307].

3.1. Derived Assignment

There are significantly fewer options for derived address assignment
compared to derived allocation. Derived multicast assignment has
only been specified for IPv6 link-scoped multicast [RFC4489], where
the EUI64 is embedded in the multicast address, providing a node with
unique multicast addresses for link-local ASM communications.

3.2. SSM Assignment inside the Node

While SSM multicast addresses have only local (to the node)
significance, there is still a minor issue on how to assign the
addresses between the applications running on the same IP address.

This assignment is not considered to be a problem because typically
the addresses for these applications are selected manually or
statically, but if done using an Application Programming Interface
(API), the API could check that the addresses do not conflict prior
to assigning one.

3.3. Manually Configured Assignment

With manually configured assignment, a network operator who has a
multicast address prefix assigns the multicast group addresses to the
requesting nodes using a manual process.

Typically, the user or administrator that wants to use a multicast
address for a particular application requests an address from the
network operator using phone, email, or similar means, and the
network operator provides the user with a multicast address. Then
the user/administrator of the node or application manually configures
the application to use the assigned multicast address.

This is a relatively simple process; it has been sufficient for
certain applications which require manual configuration in any case,
or which cannot or do not want to justify a static IANA assignment.
The manual assignment works when the number of participants in a
group is small, as each participant has to be manually configured.

This is the most commonly used technique when the multicast
application does not have a static IANA assignment.

[3.4](). Static IANA Assignment

In contrast to manually configured assignment, as described above, static IANA assignment refers to getting an assignment for the particular application directly from IANA. There are two main forms of IANA assignment: global and scope-relative. Guidelines for IANA are described in [[RFC5771]()].

[3.4.1](). Global IANA Assignment

Globally unique address assignment is seen as lucrative because it's the simplest approach for application developers since they can then hard-code the multicast address. Hard-coding requires no lease of the usable multicast address, and likewise the client applications do not need to perform any kind of service discovery (but depending on hard-coded addresses). However, there is an architectural scaling problem with this approach, as it encourages a "land-grab" of the limited multicast address space.

[3.4.2](). Scope-relative IANA Assignment

IANA also assigns numbers as an integer offset from the highest address in each IPv4 administrative scope as described in [[RFC2365]()]. For example, the SLPv2 discovery scope-relative offset is "2", so SLPv2 discovery address within IPv4 Local-Scope (239.255.0.0/16) is "239.255.255.253", within the IPv4 Organization Local-Scope (239.192.0.0/14) it is "239.195.255.253", and so on.

Similar scope-relative assignments also exist with IPv6 [[RFC2375]()]. As IPv6 multicast addresses have much more flexible scoping, scope-relative assignments are also applicable to global scopes. The assignment policies are described in [[RFC3307]()].

[3.5](). Dynamic Assignments

The layer 1 of [RFC 2908]() [[RFC2908]()] described dynamic assignment from Multicast Address Allocation Servers (MAAS) to applications and nodes, with Multicast Address Dynamic Client Allocation Protocol (MADCAP) [[RFC2730]()] as an example. Since then, other mechanisms have also been proposed (e.g., DHCPv6 assignment [[I-D.jdurand-assign-addr-ipv6-multicast-dhcpv6]()]) but these have not gained traction.

It would be rather straightforward to deploy a dynamic assignment protocol which would lease group addresses based on a multicast prefix to applications wishing to use multicast. However, only few have implemented MADCAP, and it hasn't been significantly deployed. So, it is not clear if the lack of deployment is due to a currently

missing need. Moreover, it is not clear how widely for example the
APIs for communication between the multicast application and the
MADCAP client operating at the host have been implemented [RFC2771].

An entirely different approach is Session Announcement Protocol (SAP)
[RFC2974]. In addition to advertising global multicast sessions, the
protocol also has associated ranges of addresses for both IPv4 and
IPv6 which can be used by SAP-aware applications to create new groups
and new group addresses. Creating a session (and obtaining an
address) is a rather tedious process which is why it isn't done all
that often. It is also worth noting that the IPv6 SAP address is
unroutable in the inter-domain multicast.

A conclusion about dynamic assignment protocols is that:

1. multicast is not significantly attractive in the first place,

2. most applications have a static IANA assignment and thus require
    no dynamic or manual assignment,

3. those that cannot be easily satisfied with IANA or manual
    assignment (i.e., where dynamic assignment would be desirable)
    are rather marginal, or

4. that there are other gaps why dynamic assignments are not seen as
    a useful approach (for example, issues related to service
    discovery/rendezvous).

In consequence, more work on rendezvous/service discovery would be
needed to make dynamic assignments more useful.

4. Summary and Future Directions

This section summarizes the mechanisms and analysis discussed in this
memo, and presents some potential future directions.

4.1. Prefix Allocation

   A summary of prefix allocation methods for ASM is shown in Figure 1.

```
+-------+-------------------------------+--------+--------+
| Sect. | Prefix allocation method      | IPv4   | IPv6   |
+-------+-------------------------------+--------+--------+
| 2.1.1 | Derived: GLOP                 |  Yes   | NoNeed*|
| 2.1.2 | Derived: Unicast-prefix-based |  No    | Yes    |
|  2.2  | Administratively scoped       |  Yes   | NoNeed*|
|  2.3  | Static IANA allocation        | Yes**  |  No    |
|  2.4  | Dynamic allocation protocols  |  No    |  No    |
+-------+-------------------------------+--------+--------+
*  = the need satisfied by IPv6 unicast-prefix-based allocation.
** = mainly using the AD-HOC block III (former "eGLOP")
```

                                Figure 1

   o Only ASM is affected by the assignment/allocation issues.

   o With IPv4, GLOP allocations provide a sufficient IPv4 multicast
      allocation mechanism for those that have 16-bit AS number. IPv4
      unicast-prefix based allocation offers some addresses. IANA is
      also allocating from the AD-HOC block III (former "eGLOP") with
      especially 32-bit AS number holders in mind. Administratively
      scoped allocations provide the opportunity for internal IPv4
      allocations.

   o With IPv6, unicast-prefix-based addresses and the derivatives
      provide a good allocation strategy and this also works for scoped
      multicast addresses.

   o Dynamic allocations are too complex and unnecessary a mechanism.

4.2. Address Assignment

A summary of address assignment methods is shown in Figure 2.

```
+--------+-------------------------------+----------+----------+
| Sect.  | Address assignment method     | IPv4     | IPv6     |
+--------+-------------------------------+----------+----------+
|  3.1   | Derived: link-scope addresses |   No     |   Yes    |
|  3.2   | SSM (inside the node)         |   Yes    |   Yes    |
|  3.3   | Manual assignment             |   Yes    |   Yes    |
|  3.4.1 | Global IANA/RIR assignment    |LastResort|LastResort|
|  3.4.2 | Scope-relative IANA assignment|   Yes    |   Yes    |
|  3.5   | Dynamic assignment protocols  |   Yes    |   Yes    |
+--------+-------------------------------+----------+----------+
```

Figure 2

o Manually configured assignment is typical today, and works to a
   sufficient degree in smaller scale.

o Global IANA assignment has been done extensively in the past.
   Scope-relative IANA assignment is acceptable but the size of the
   pool is not very high. Inter-domain routing of IPv6 IANA-assigned
   prefixes is likely going to be challenging and as a result that
   approach is not very appealing.

o Dynamic assignment, e.g., MADCAP has been implemented, but there
   is no wide deployment. Therefore, either there are other gaps in
   the multicast architecture or there is no sufficient demand for it
   in the first place when manual and static IANA assignments are
   available. Assignments using SAP also exist but are not common;
   global SAP assignment is unfeasible with IPv6.

o Derived assignments are only applicable in a fringe case of link-
   scoped multicast.

4.3. Future Actions

o Multicast address discovery/"rendezvous" needs to be analyzed at
   more length, and an adequate solution provided. See
   [I-D.ietf-mboned-addrdisc-problems] and
   [I-D.ietf-mboned-session-announcement-req] for more.

o The IETF should consider whether to specify more ranges of the
   IPv4 administratively scoped address space for static allocation
   for applications which should not be routed over the Internet
   (such as backup software, etc. -- so that these wouldn't need to
   use global addresses which should never leak in any case).

o The IETF should consider its static IANA allocations policy, e.g.,
   "locking it down" to a stricter policy (like "IETF Consensus") and
   looking at developing the discovery/rendezvous functions, if
   necessary.

5. Acknowledgements

Tutoring a couple of multicast-related papers, the latest by Kaarle
Ritvanen [RITVANEN] convinced the author that updated multicast
address assignment/allocation documentation is needed.

Multicast address allocations/assignments were discussed at the
MBONED WG session at IETF59 [MBONED-IETF59].

Dave Thaler, James Lingard, and Beau Williamson provided useful
feedback for the preliminary version of this memo. Myung-Ki Shin,
Jerome Durand, John Kristoff, Dave Price, Spencer Dawkins, and Alfred
Hoenes also suggested improvements.

6. IANA Considerations

This memo includes no request to IANA.

IANA considerations in sections 4.1.1 and 4.1.2 of obsoleted and now
Historic [RFC2908] were never implemented in IANA registry. No
update is necessary.

(RFC-editor: This section may be removed prior to publication;
alternatively, the second paragraph may be left intact.)

7. Security Considerations

This memo only describes different approaches to allocating and
assigning multicast addresses, and this has no security
considerations; the security analysis of the mentioned protocols is
out of scope of this memo.

Obviously, especially the dynamic assignment protocols are inherently
vulnerable to resource exhaustion attacks, as discussed e.g., in
[RFC2730].

8. References

8.1. Normative References

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Appendix A. Changes

(To be removed prior to publication as an RFC.)

A.1. Changes between -06 and -07

o Update uni-based-mcast and iana updates references to point to
   RFCs.

A.2. Changes between -05 and -06

o Editorial updates.

o Obsolete only RFC2908; the rest only move to Historic.

o Category is Informational instead of BCP (in line with the routing
   architecture.

o Move 3171bis and v4-uni-based to Normative references in order to
   make sure we don't go forward until they're resolved.

o Resolve pending issues per IETF75 discussion, in particular major
   changes to eGLOP and IANA policy discussions.

A.3. Changes between -04 and -05

o Editorial updates. These and the following are from Spencer
   Dawkins.

o New text explicitly stating that GLOP for v6 is not needed and
   GLOP for 4byte ASNs isn't (and likely won't be) defined.

o Expand reasons for filtering difficulties with global IANA
   assignments for local apps, and that it would be easier if these
   were done from the local pool.

o Explicitly mention dynamic allocations protocols' lack of benefit
   and abandonment.

[A.4](#). **Changes between -03 and -04**

   o S/scope-relative/administratively scoped/ and expand Static IANA
      Assignment section to two subsections; mainly from Dave Price.

   o Mention the routing challenges of IPv6 IANA assigned prefixes in
      [section 4.2](#)

[A.5](#). **Changes between -02 and -03**

   o Reword architectural implications of Static IANA and editorial
      improvements; mainly from John Kristoff.

[A.6](#). **Changes between -01 and -02**

   o Mention the mechanisms which haven't been so successful: eGLOP and
      MZAP.

   o Remove the appendices on multicast address discovery (a separate
      draft now) and IPv4 unicast-prefix-based multicast addressing.

   o Add a note on administratively scoped address space and the
      expansion ambiguity.

   o Remove the references to [draft-ietf-mboned-ipv6-issues-xx.txt](#)

   o Minor editorial cleanups.

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