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P. Savola
CSC/FUNET

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Multihoming Using IPv6 Addressing Derived from AS Numbers

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Abstract

In IPv6, the current IPv4 site multihoming practises have been operationally disabled, to prevent a creation of an unmanageable swamp of more specific routes. Some argue that the lack of a comprehensive site multihoming solution is hindering the deployment of IPv6. This memo presents a few proposals for end-sites with autonomous system (AS) number to be able to derive a provider independent block of addresses from the first half of the 16-bit AS-number space. This could enable a temporary IPv6 site multihoming solution for those that already employ similar mechanisms in IPv4.

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1. Introduction

A typical scenario of IPv4 site multihoming is where the site obtains an autonomous system number (ASN), and starts advertizing a block of addresses to the Internet. The addresses may be specifically obtained for this purpose, or more specific routes from an also advertised aggregate.

This site multihoming scenario has been currently prevented in IPv6 by operational procedures [6BONEOP], as it has been feared to create an unmanageable address space swamp of more specific routes.

However, currently multihoming IPv4 sites may be reluctant to start using IPv6 because no comprehensive IPv6 multihoming mechanism exists: the proposal would remove one excuse for not using IPv6.

This memo proposes a few possible approaches which could be used to derive the IPv6 address space automatically from one's AS number. These could then be advertised by the end-site to gain a temporary solution for IPv6 multihoming.

The proposed solution limits the number of multihomed sites to 2^15, that is, about 32K. In practise, this would be a lot less.

First, some background and design criteria are presented. Then, proposed different address formats are defined. Next, some operational guidelines are described. Last, requirements for current IP address registries are presented. In the appendix, a prefix filtering example and an alternative approach given.

2. Engineering Decisions

When designing the solution, the following have, and will have to be, taken into consideration:

1. Sunset strategy
2. Limited time and impact on the global routing table size
3. Discourage a rush to obtain AS numbers to exhaust the 16-bit space
4. Possibility to easily distinguish ASN-PI and other addresses
5. Easy generation of provider independent addresses
6. Fixed prefix length, enabling easy prefix filtering
7. Incentives to use the addressing for this specific purpose only

These lead to at least the following decisions:

- o Applicable to 16-bit AS numbers only, points 1-2 above
- o Applicable to AS numbers 1 - 32767 only, points 1-3
- o Direct mapping from AS number to the address, points 4-5
- o A selected prefix and length, points 4,6 above
- o Incentives (point 7) will be discussed in the next section.

2.1. Discussion

When engineering a site multihoming solution, it is important to consider the scalability of such a solution. It is unprobable that sites (by most definitions of 'site'), in contrast to major ISP's, can each use different service providers and multihome by mechanisms that require a presence or changes in the global routing table.

However, this is a relatively common practise today with IPv4, and it has been feared that unless a similar mechanism is offered, current IPv4 enterprises will be very reluctant to start using IPv6 because of the lack of a site multihoming solution.

This memo offers a way to provide a similar, or actually better -- due to control -- site multihoming mechanism for those that already have the multihoming capability today.

As the number of sites is so high, the maximal number of routes must be limited somehow. For this, the first half of 16-bit AS numbers was selected. This provides the possibility of site multihoming for all current (at the time of the writing) AS number holders, while avoiding a major rush and exhaustion of the rest of the 16-bit AS number space when new sites would also wish to obtain a way to multihome. 32-bit AS numbers [ASN4BYTE] are explicitly out of scope, as those would create an even worse scaling problem.

It seems unnecessary, except for creating administrative hurdles, to encumber RIR's with address allocation for this site-multihoming solution: therefore, an approach where addresses can be derived from a well-known prefix by combining it with one's AS number, creating provider independent addresses was chosen.

It is anticipated that this mechanism will be withdrawn when a better, scalable site multihoming solution is developed. Therefore these addresses should not be considered permanent, but rather temporary until other mechanisms can be specified.

3. ASN-PI Addressing Format

3.1. Format

The proposed addressing format is as follows:

```
| 16 bits  |   n    |  16   |     96-n bits       |
+----------+--------+-------+---------------------+
|   PRFX   |   ID   |  ASN  | site-specific parts |
+----------+--------+-------+---------------------+
```

ASN is the AS number in hexadecimal format. PRFX and ID are selected and allocated as discussed below.

There are multiple options for the "n" which have different consequences:

1. n = 0: total prefix length is 32 bits long, the same as current (at the time of writing) standard registry allocations

2. n = 16: total prefix length is 48 bits long, the same as the recommended prefix length for end-sites [SITELEN]

3. 0 < n < 16: some value, e.g. n=8, which would allow for sites with longer prefixes

In the final version, only one will be selected.

3.2. Discussion

n=0 seems to fail criteria point 7, above: end-sites should not need that much address space.

n=16 seems like a natural first choice, but there may be sites which need more than a /48.

Something between, say n=8, seems like a viable alternative: enough to cater for all cases, but not too many to be useful and to be distinguishable.

In all cases, currently installed prefix-length filters are likely to have to be modified -- getting new ones deployed will take some time, but the delay should be quite reasonable.

In the case of n=0, a possible allocation could be 2000::/16. In the case of n=16, possible allocations could be, for example, 2001:0::/32 or 2001:FFFF::/32. In the case of 0<n<16, a possible allocation with n=8 could be 2001:FF00::/24.

3.3. Example ASN-PI Address Assignments

As examples, using possible example allocations above, the AS number "1741" (0x6CD), would become:

n=0: 2000:6CD::/32

n=16: 2001:0:6CD::/48 or 2001:FFFF:6CD::/48

0<n<16, assume n=8: 2001:FF06:CD00::/40

4. Operational Guidelines

Every end-site with the AS-number in range 1-32767 may generate an address prefix as desribed in this memo. Routability is not guaranteed.

Networks which have received an address allocation must not use the ASN-PI addressing as described in this memo; it is meant for a specific set of end-sites only.

If the route of full prefix length is advertised with a protocol like BGP [BGP], the origin AS of the route must always equal the embedded AS number.

End-sites should advertise the maximum prefix length of the prefix, even if the whole space would not be used, so that the advertisement lengths would be uniform. This is especially the case with e.g. n=8.

An example of prefix-length filters is given in the appendix.

TBD.

4.1. Discussion

This mechanism is not meant to be used by those who have already received address allocations, or those who would be eligible for ones: it is not meant to substitute or augment address space allocated from registries.

"Proxy-announcements" e.g. by someone's ISP are not allowed. If the AS holder is incapable of advertising the addresses itself, they should be assigned addresses conventionally. Also, someone else hijacking unused addresses is also forbidden. Advertising a less specific route (e.g. an aggregate of 2000::/16, using the example above, from ISP to customers) is acceptable, though.

5. Requirements for Registries

The RIR's and other supporting registries for the AS number holder should provide for basic IP address services, such as reverse IP address delegations.

6. IANA Considerations

IANA will allocate and reserve an address prefix for this specific purpose, pending selection of the alternative approaches.

Reverse IPv6 delegations will be configured to the RIR's where respective AS number allocations have been made.

7. Evaluation of Multihoming Goals

Goals for IPv6 Site-Multihoming Architectures [GOALS] defines a set of conflicting goals ("requirements") which a solution should meet. This section briefly analyzes how those goals apply to this solution.

7.1. Capabilities

7.1.1. Redundancy

Redundancy is provided by advertisement of a single prefix over multiple providers.

7.1.2. Load Sharing

The site administators are able to control load-sharing. Outbound load-sharing works trivially. Inbound load-sharing is supported to a degree even if the ISPs would deploy prefix length limiters disallowing the use of longer prefixes for load-sharing. Using just one long advertisement with an appropriate community tagging with the transit ISPs may be able to provide similar service if not.

7.1.3. Performance

This would typically require, unless clever operational mechanisms are used like above, advertisement of more specific routes which is possible but not advisable.

7.1.4. Policy

Using the same prefix allows for policy decisions.

7.1.5. Simplicity

The solution is very simple for those deploying it.

7.1.6. Transport-Layer Survivability

With just one prefix, transport-layer survives any re-homing events.

7.1.7. Impact on DNS

There is no impact; just one address is published in the DNS.

7.1.8. Packet Filtering

Ingress filtering can be deployed.

7.2. Additional Requirements

7.2.1. Scalability

The solution is scalable, when applied only to the largest enterprises requiring such a solution.

7.2.2. Impact on Routers

No changes are required.

7.2.3. Impact on Hosts

No changes are required.

7.2.4. Interaction between Hosts and the Routing System

There need not be interaction.

7.2.5. Operations and Management

The site operators and managers are able to configure the multihoming parameters for the whole site, so this is extremely simple.

7.2.6. Cooperation between Transit Providers

There is no need for cooperation.

7.2.7. Multiple solutions

Multiple solutions are required. This only intends to address the case of the largest enterprises for which deploying a multi-addressing architecture throughout the infrastructure may not be feasible.

8. Evaluation of Things to Think About

A questionaire [QUES] has been published which tries to tease out the issues which surround different solution proposals. This section gives the answers.

8.1. How will your solution solve the multihoming problem?

It solves only a part of the problem: the very big enterprises. Multiaddressing is probably not an option, so they have to have either /32 allocations (via cheating the RIRs or legitimately) or something similar. This provides something similar.

8.2. Does your solution address mobility?

Mobility is not affected.

8.3. Identifiers and locators

As there is no split between the identifiers and locators, this is a moot point.

8.4. On the Wire

Similarly, there are no changes at all to the packets on the wire, so these questions are moot.

8.5. Relationship with DNS and Registries

There is no change to the relationship that would be different from IPv4 DNS. However, a related "centralized registration" point is that the RIRs have to consider when/how to hand out the "golden ASes" which are allowed to multihome using this method. This has policy concerns.

8.6. Compatibility

The solution is compatible in API level, and with old IPv6 architecture. Compatibility with IPv4 is provided by out-of-the-box transition mechanisms. Middleboxes are not a concern. There are no concerns with scoped addressing or multicast. There are no layer 2 implications, or referrals to worry about.

8.7. Legal stuff

The policy concerns wrt. who is eligible for the "multihoming prefixes" might raise some policy and legal concerns.

9. Security Considerations

This memo discusses address assignment based on AS numbers and corresponding practises. It does not have security considerations.

10. Acknowledgements

Antti Jarvenpaa, Aki Anttila and Patrick Frejborg brought up an initial idea to base site multihoming on those who have AS numbers and PI addresses. Karst Koymans noticed an error in text representation of prefix lengths.

11. References

11.1. Normative References

[GOALS] Abley, J., et al., "Goals for IPv6 Site-Multihoming Architectures", RFC3582, August 2003.

[QUES] Lear, E., "Things MULTI6 Developers should think about", draft-lear-multi6-things-to-think-about-00, work-in-progress, December 2003.

11.2. Informative References

[6BONEOP] Rockell, R., Fink, R., "6Bone Backbone Routing Guidelines", RFC2772, February 2000.

[ASN4BYTE] Vohra, Q., Chen, E., "BGP support for four-octet AS number space", draft-ietf-idr-as4bytes-06.txt, work-in-progress, December 2002.

[BGP] Rekhter, Y., Li, T., "A Border Gateway Protocol 4", RFC1771, March 1995.

[SITELEN]   IAB, IESG, "IAB/IESG Recommendations on IPv6 Address Allocations to Sites", RFC3177, September 2001.

Author's Address

Pekka Savola
CSC/FUNET
Espoo, Finland
EMail: psavola@funet.fi

A. Example of Prefix Length Filters

As an example of possible prefix length filter, one such is given (using possible example allocations above) is given in a format of a popular router configuration syntax:

```
[n=0] : ipv6 prefix-list ASN-PI permit 2000::/17 ge 32 le 32
[n=8] : ipv6 prefix-list ASN-PI permit 2001:FF00::/25 ge 40 le 40
[n=16]: ipv6 prefix-list ASN-PI permit 2001:FFFF::/33 ge 48 le 48
```

Note that /17 is used instead of /16 (and others, respectively) to accept only the first half of the 16-bit AS-number space.

B. Alternative Approach with 32-bit AS Numbers

Some argue that 32-bit AS numbers must be supported. The author believes this could have very harmful consequences in the long term, as the model is inherently unscalable. However, if so inclined, the possible addressing format could be:

```
| 16 bits  |     32 bits     |        80 bits       |
+----------+----------------+---------------------+
|   PRFX   |       ASN      | site-specific parts |
+----------+----------------+---------------------+
```

Here, 16 bit AS numbers would just be prepended with 16 bits of zero. Of course, PRFX could be shorter than 16 bits too.