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How Host A learns the IP address of Host B
draft-bcx-behave-learn-address-00

Abstract

This document describes how host A learns the IP address of host B in BEHAVE's "An IPv6 network to the IPv4 Internet" scenario. In this scenario, an IPv6-only host A must know the IPv6 address

representation of host B.

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1. Introduction

This document describes how host A learns the IP address of host B in BEHAVE's "An IPv6 network to the IPv4 Internet" scenario [I-D.baker-behave-v4v6-framework]. In this scenario, an IPv6-only host A must know the IPv6 address representation of host B, where host B could be an IPv4-only host or an IPv6-only host with IPv4 address representation [I-D.xli-behave-v4v6-prefix].

This document is intended to assist the IETF community to understand how host A learns the IP address of host B when an IPv4/IPv6 translator is involved. This document is not expected to be published as an RFC. This document is part of the consideration for a prefix document.

2. Host A learns IP address of host B in single address family

The host A can use one of the following methods to learn the IP address of host B in single address family (AF).

- o The user of host A gets the IP address manually.
- o The DNS resolves the IP address from a domain name.
- o The application performs referrals.

Note that the "user of host A gets the IP address manually" cannot be avoided, e.g., someone typed http://202.38.102.2 into their browser, or was re-directed there, or HTML had a link at that URI [I-D.wing-behave-nat64-referrals].

3. Convert address representation between two address families

In order to performance the communication between two address families (IPv4 and IPv6), an IPv4 host must have an IPv6 representation and an IPv6 host must have an IPv4 representation, as discussed in [I-D.xli-behave-v4v6-prefix].

There are two translation schemes named stateless translation and stateful translation and the methods to represent IPv4 in IPv6 and to represent IPv6 in IPv4 are somehow different [I-D.xli-behave-v4v6-prefix].

- o For the stateless translation, the address mapping algorithm is used both to represent IPv4 in IPv6 and IPv6 in IPv4. Note that in this case, blocks of service provider's IPv4 addresses are

mapped into IPv6 and used by physical IPv6 hosts. The original IPv4 form of these blocks of service provider's IPv4 addresses are used to represent the physical IPv6 hosts in IPv4. Note that the stateless translation supports both IPv6 initiated as well as IPv4 initiated communications.

o For the stateful translation, the address mapping algorithm is used to represent IPv4 in IPv6, while a session initiated state table is used to represent IPv6 in IPv4. Note that in this case, blocks of service provider's IPv4 addresses are maintained in the translator as the IPv4 address pools and dynamically bind to the specific IPv6 addresses. The original IPv4 form of these blocks of service provider's IPv4 addresses are used to represent the physical IPv6 host in IPv4. However, due to the dynamical binging, the stateful translation only supports the IPv6 initiated communication.

The embedded address format is used as the address mapping algorithm [I-D.xli-behave-v4v6-prefix] as shown in Figure 1.

```
0             n        63 n+31               127
|             |        |  |                    |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|  PREFIX      | IPv4 addr |  SUFFIX           |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                      |                       |
|<--- network part ---->|<---   host part   --->|
```

Figure 1: Embedded Address Format

In this algorithm, the IPv4 address is embedded in IPv6 address after the PREFIX. The PREFIX can either be LIR prefix or WKP prefix, where the LIR is the prefix in the service provider's address block, while the WKP is the prefix allocated by IANA and independent to the service provider's address blocks. The advantage of LIR is that it is part of the service provider's block and can be aggregated, while the advantage of WKP is that it can be hard coded in the network devices and in the end systems without manual configuration.

4. Host A learns IP address of host B cross address families

Assume host A is an IPv6 host and host B has an IPv4 address, then host A must know the IPv6 representation of host B derived from host B's IPv4 address.

4.1. The user of host A gets the IP address manually

Assume host A has IPv6 address 2001:db8::1 and host B has IPv4 address 166.111.8.238, then the user of host A must convert this IPv4 address into its IPv6 representation [PREFIX:166.111.8.238:SUFFIX] based on the address mapping algorithm [I-D.xli-behave-v4v6-prefix]. Note that the host A or the user of host A must know the PREFIX in order to do the conversion. When the IPv4 address of host B and PREFIX of the address mapping algorithm are known to host A, the IPv6 representation of host B can be created. In addition, if the PREFIX is a WKP prefix, it can be hard coded in host A, while if the PREFIX is a LIR prefix, it can be obtained by host A via the method described in [I-D.wing-behave-learn-prefix]. For example, the user of host A will type telnet [PREFIX:166.111.8.238:SUFFIX].

4.2. The DNS resolves the IP address from a domain name

Assume host A has IPv6 address 2001:db8::1 and host B has a domain name www.edu.cn (there is an A record 202.205.109.203, but no AAAA record), then the host A will ask the DNS64 for the AAAA record of www.edu.cn. The DNS64 will get the A record 202.205.109.203 from the global domain name system and convert to the AAAA record [PREFIX: 202.205.109.203:SUFFIX] based on the address mapping algorithm [I-D.xli-behave-v4v6-prefix] [I-D.bagnulo-behave-dns64]. Note that the DNS64 must know the PREFIX.

4.3. The application performs referrals

[I-D.wing-behave-nat64-referrals] discusses the referral for SIP and BitTorrent.

In the case of SIP, "An IPv6 node SHOULD also be able to send and receive media using IPv4 addresses, but if it cannot, it SHOULD support STUN relay usage. Such a relay allows the IPv6 node to indirectly send and receive media using IPv4 [I-D.ietf-sipping-v6-transition]. Thus, all IPv6 nodes running SIP are expected to support ICE [I-D.ietf-mmusic-ice] which allows simultaneous referral of multiple IP addresses, even from different IP address families."

The BitTorrent uses HTTP URIs and DNS names, the examples in Sections 4.1 and 4.2 are also applied here.

5. Using different prefixes is considered harmful

The above examples are straightforward. However, for the stateless translation in the "the user of host A gets the IP address manually"

case and under the following condition, the situation gets very complicated.

- As discussed in Section 3, for the stateless translation, the address mapping algorithm is used both to represent IPv4 in IPv6 and IPv6 in IPv4. So when host A gets an arbitrary IPv4 address of host B, it could be used by physical IPv4 host or it could be mapped to IPv6 based on the address mapping algorithm and used by physical IPv6 host. It is clear that host A does not have the information to tell which case is applied.

- As discussed in Section 3, for the stateless translation, the PREFIX can be either LIR or WKP. So the possibilities are:

  1. Use LIR to represent IPv4 in IPv6 and use LIR to represent IPv6 in IPv4.

  2. Use WKP to represent IPv4 in IPv6 and use WKP to represent IPv6 in IPv4.

  3. Use LIR to represent IPv4 in IPv6 and use WKP to represent IPv6 in IPv4.

  4. Use WKP to represent IPv4 in IPv6 and use LIR to represent IPv6 in IPv4.

[I-D.xli-behave-v4v6-prefix] discussed why WKP cannot be used to represent IPv6 in IPv4, which means that case (2) and case (3) should not be used. This document shows that case (1) should be used and case (4) is considered harmful.

For the stateful translator, this problem does not exist, since the PREFIX is only used to present IPv4 in IPv6.

5.1. Case 1: LIR is used to both represent IPv4 in IPv6 and IPv6 in IPv4

Assume host B has IPv4 address 202.38.108.2, if the LIR is used to both represent IPv4 in IPv6 and IPv6 in IPv4, the "more specific win" routing principle will forward the packets to the right destination [I-D.xli-behave-v4v6-prefix], no matter whether it is used by IPv4 host or by IPv6 host.

- If 202.38.108.2 is used by physical IPv4 host, the routing entry covers the IPv4 address 202.38.108.2 will be [LIR::]/M, where M is the LIR prefix length, which is corresponding to the IPv4 default route. The IPv6 packets containing [PREFIX:202.38.108.2:SUFFIX] as the destination address will be forwarded to the IPv4/IPv6

translator and translated into the IPv4 packets and will be forwarded to the host B 202.38.108.2.

- If 202.38.108.2 is mapped to IPv6 and used by physical IPv6 host, the routing entry covers the IPv4 address 202.38.108.2 will be [LIR:202.38.108.0:SUFFIX]/(M+k), where M is the LIR prefix length and k is the prefix length of the service provider's IPv4 block which is mapped to IPv6. The IPv6 packets containing [PREFIX:202.38.108.2:SUFFIX] as the destination address will be forwarded to the host B [PREFIX:202.38.108.2:SUFFIX] directly.

5.2. Case 4: WKP is used to represent IPv4 in IPv6 and LIR is used to represent IPv6 in IPv4

In this case, depending on whether the IPv4 address is used by physical IPv4 host or the physical IPv6 host, the WKP or LIR should be correctly determined, since the former means representing IPv4 in IPv6 and the latter means representing IPv6 in IPv4.

- If the IPv4 address 202.38.108.2 is used by IPv4 host, the routing entry covers the address will be [WKP::]/M, where M is the WKP prefix length. Then user of host A must type in telnet [WKP:202.38.108.2:SUFFIX] to access host B.

- If the IPv4 address 202.38.108.2 is mapped to IPv6 and used by IPv6 host, the routing entry covers the address will be [LIR:202.38.108.0:SUFFIX]/(N+k), where N is the LIR prefix length and k is the prefix length of the service provider's IPv4 block which is mapped to IPv6, then the user of host A must type in telnet [LIR:202.38.108.2:SUFFIX] to access host B.

Therefore, host A must know which prefix to use. There are several methods to use, but they all have drawbacks.

5.2.1. Design a protocol to download the IPv4 address database to host A

It is possible to design a protocol to download the database of all the IPv4 blocks which are mapped to IPv6 and used by physical IPv6 hosts (in the service provider's administrative domain) to host A. However, this is not a good solution due to the complicity.

5.2.2. Add the NAT66 function to the stateless translator based on the IPv4 address database

If the IPv4/IPv6 translator can perform the NAT66 translation function, i.e. swap the prefixes between LIR and WKP, then it is possible for host A to use WKP to reach host B no matter which

address family it locates. However, in this case, the routing is not optimal. For example, host A can convert the host B's IPv4 address 202.38.108.2 to [WKP:202.38.108.2:SUFFIX]. The network will forward the packets containing [WKP:202.38.108.2:SUFFIX] as the destination address to the translator. Then the translator will check the database of all the IPv4 blocks which are mapped to IPv6 and used by physical IPv6 hosts.

- o If the destination address in the packets does not match the entry in the database, the translator will translate the IPv6 packets to IPv4 and forward the packets to host B 202.38.108.2.

- o If the destination address in the packets matches the entry in the database, the NAT66 function will swap the WKP to LIR and re-route the packets back to the IPv6 network to the host B [LIR: 202.38.108.2:SUFFIX].

However, this is not a good solution due to the nature of non-optimal routing.

5.2.3. Configure the DNS64 based on the IPv4 address database

If the DNS64 is configured with database of all the IPv4 blocks which are mapped to IPv6 and used by physical IPv6 hosts, the DNS64 can return the AAAA record with the correct PREFIX.

However, this is not a good solution due to the lack of support for "The user of host A gets the IP address manually" case.

6. Conclusions

In the unicast communication scheme, when host A needs to communicate with host B, host A must know the IP address of host B. This document describe how host A learn the IPv6 address representation of host B in BEHAVE's "An IPv6 network to the IPv4 Internet" scenario.

It clear that for the stateless translation case, the PREFIX used to represent IPv4 in IPv6 and to represent IPv6 in IPv4 must be the same and LIR must be used.

7. Security Considerations

There is no security considerations.

8. IANA Considerations

This memo adds no new IANA considerations.

9. Informative References

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