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Abstract

This document describes several scenarios where an IP address is referred across an IPv6/IPv4 translator.
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1. Introduction

Historically, NATs (and firewalls) have been accused of "breaking referrals". Several IPv4 protocols that perform referrals are discussed, including SIP, BitTorrent, and HTTP. It is important to understand how referrals can work across an address family translator considering that existing IPv4 nodes do not understand IPv6 addresses, referrals to IPv6 nodes behind an IPv6/IPv4 translator will not cause a DNS64 query, and other factors.

This document describes how referrals work in BEHAVE’s "An IPv6 network to the IPv4 Internet" scenario. In this BEHAVE scenario, an IPv6-only host utilizes a translator and a DNS64 address rewriter to communicate to an IPv4-only host on the Internet. After this communication is established, the document examines IPv6-only host refers the IPv4-only host to a variety of other hosts that are connected to the Internet.

This document is intended to assist the IETF community to understand the scenarios where referrals across an IPv6/IPv4 translator are successful. This document is not expected to be published as an RFC. This document is part of the consideration for the IPv6 prefix [I-D.xli-behave-v4v6-prefix] [I-D.baker-behave-v4v6-framework].

2. Application Referrals Across IP Address Families

This section describes how some applications perform referrals between IPv6 and IPv4, and between IPv4 and IPv6.

2.1. SIP

A SIP call involves two the SIP signaling, sent to SIP proxies, and the media, sent directly between the SIP hosts. This is often referred to as the SIP "trapezoid", as shown in the following figure.

This section shows that IPv4 addresses can be successfully referred to both IPv4 hosts and to IPv6 hosts, if those IPv6 hosts support the IPv6 transition strategy for SIP [I-D.ietf-sipping-v6-transition]. Because an IPv6 address is not referred, the success is not dependent on the IPv6/IPv4 translator’s prefix (well-known prefix versus LIR prefix).
SIP signaling

sip-proxy.example.com-------------------------sip-proxy.example.net

/                                         \
/                                           \
/ SIP signaling                        SIP signaling \ 
/                                           \
/ Host-A-----------------------------------------Host-B

media path

Figure 1: SIP Trapezoid

It is the media path which is interesting for SIP referrals and is
the subject of this section. The SIP signaling messages are
exchanged on the upper part of the trapezoid and is not the subject
of this section. The SIP signaling messages contain SDP [RFC4566]
which conveys the IP address and UDP port of the hosts as well as
other information (e.g., audio codec).

The IPv6 transition strategy for SIP [I-D.ietf-sipping-v6-transition]
states the requirements for the IPv6 transition:

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 [I-D.ietf-behave-turn-ipv6]. Such a relay allows the IPv6
node to indirectly send and receive media using IPv4.

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. IPv4-only
endpoints do not have to support ICE, although such support assists
both hosts by choosing the most optimal path (e.g., avoiding a media
relay).

There are two documented mechanisms for SIP endpoints to communicate
across IP address families. The first mechanism uses uses media
relays (TURN servers [I-D.ietf-behave-turn]) and is described in
Section 2.1.1. The second documented mechanism uses IPv6/IPv4
translators, does not use media relays, and is described in
Section 2.1.2.

2.1.1. SIP using a Media Relay

Section 4.2 of [I-D.ietf-sipping-v6-transition] documents how an
IPv6-only SIP endpoint can use a media relay (a TURN-IPv6 server) to
exchange media with an IPv4-only SIP endpoint. This can be
accomplished using two methods.
The first method is shown in Figure 2, where the Host-A (IPv6-only) communicates with a TURN-IPv6 [I-D.ietf-behave-turn-ipv6] server directly (that is, using IPv6). In this communication, Host-A allocates a relayed-transport-address from the TURN server. This relayed-transport-address is an IPv4 address. Host-A learned Host-B’s IPv4 address via SIP signaling.

Figure 2: SIP using IPv6-capable Media Relay

The second method is shown in Figure 3. This method is not mentioned in Section 4.2 of [I-D.ietf-sipping-v6-transition] because NAT-PT was deprecated at the time and IPv6/IPv4 translation was not yet on the horizon. So it is discussed in this document. In this method, Host-A (IPv6-only) communicates across an IPv6/IPv4 translator to a TURN server. This TURN server might be IPv4-only. Host-A allocates a relayed-transport-address IPv4 IPv4 address from the TURN server and uses that IPv4 address to communicate with Host-B. Host-A learned Host-B’s IPv4 address via SIP signaling.

Figure 3: SIP using IPv6/IPv4 Translator and IPv4 Media Relay

In both Figure 2 and Figure 3 Host-A (IPv6-only) obtains the IPv4 address of Host-B via SIP signaling and uses that address for any later referrals. Media is exchanged between Host-A and Host-B through the TURN server, which functions as a media relay.

The following sections detail what occurs when Host-A refers Host-B’s IP address to different hosts. These hosts are connected to the Internet in different ways: to the IPv6 internet (both with and without an IPv6/IPv4 translator) and to the IPv4 network. In a SIP
referral, Host-A sends a SIP message through SIP proxies to another host. As with most SIP messages, this SIP message contains an SDP [RFC4566] bodypart. The SDP has the IP address and UDP port of Host-B which is used to exchange media with Host-B.

Note that, prior to the referral, Host-A does not know (and cannot learn) how other hosts are connected to the Internet.

2.1.1.1. Referring to IPv4-only host (Host-D)

In both methods above, Host-A knows Host-B’s IPv4 address.

If Host-A (IPv6-only) refers Host-B’s IPv4 address to an IPv4-only host, the referral will be successful.

2.1.1.2. Referring to IPv6-only or dual-stack host with Translator (Host-B)

If Host-A (IPv6-only) refers Host-B’s IPv4 address to an IPv6-only host, the referral will succeed if Host-A’s SIP stack understands IPv4 addresses and can obtain an IPv4 address from a media relay (similar to shown in Figure 3).

As part of the IPv6 transition, IPv6-only SIP implementations need to understand IPv4 addresses, as already required (SHOULD) by IPv6 transition strategy for SIP [I-D.ietf-sipping-v6-transition].

Thus, this referral is also successful.

2.1.1.3. Referring to IPv6-only or dual-stack host without Translator

If Host-A (IPv6-only) refers Host-B’s IPv4 address to an IPv6-only host, the referral will succeed if Host-A’s SIP stack understands IPv4 addresses and can obtain an IPv4 address from a media relay (similar to shown in Figure 2).

As part of the IPv6 transition, IPv6-only SIP implementations need to understand IPv4 addresses, as already required (SHOULD) by IPv6 transition strategy for SIP [I-D.ietf-sipping-v6-transition].

Thus, this referral is also successful.

If Host-A (IPv6-only) refers Host-B’s IPv4 address to a dual-stack host, it will succeed because the dual-stack host will be able to successfully use Host-B’s IPv4 address.
2.1.2. SIP without a Media Relay

Section 6.2 of [I-D.ietf-sipping-nat-scenarios] describes an IPv6-only SIP endpoint using an IPv6/IPv4 translator to exchange media with an IPv4-only SIP endpoint. To do this, the IPv6-only SIP endpoint implements ICE [I-D.ietf-mmusic-ice] and is configured with a STUN server on the IPv4 side of the IPv6/IPv4 translator (that is, on the IPv4 Internet).

This section analyzes how such an IPv6-only SIP endpoint, exchanging media across an IPv6/IPv4 translator with an IPv4-only SIP endpoint, would refer the synthesized IPv6 address to another SIP endpoint.

[[Editor’s note: which of the two diagrams, below, is clearer?]]

In the following diagram all of the hosts belong to different ISPs:

```
+---+---+     +-----+-----+
|  IPv6   |     |  IPv6     |
| Service |     | Service   |
| Provider|     | Provider  |
+-----6/4--+-6/4-----+
          
IPv6     IPv6

+-----+     +-----+
| IPv6 |     | IPv4   |
| Internet|     | Internet|
+-----+     +-----+
            
Host-F    Host-C Host-D
IPv6-only IPv4-only IPv4-only

Host-E
dual-stack
```
In the following diagram all of the hosts belong to different ISPs:

```
IPv6 Internet : IPv4 Internet
   |
   Host-A-------6/4 Translator     Host-C
IPv6-only     : IPv4-only
   |
   Host-B-------6/4 Translator     Host-D
IPv6-only     : IPv4-only
   |
   Host-F     
IPv6-only     :
   |
   Host-E
dual-stack
```

In the following scenarios, Host-A (IPv6-only) is communicating with Host-C through the IPv6/IPv4 translator device. Host-A knows Host-C’s synthetic IPv6 address (because it is sending traffic to it) and Host-C’s IPv4 address (because it received Host-C’s IPv4 address in SIP signaling). The following scenarios describe how referrals to other nodes would function.

Note that, prior to the referral, Host-A does not know (and cannot learn) how other hosts are connected to the Internet.

2.1.2.1. Referring to IPv4-only host (Host-D)

If Host-A refers to Host-D (IPv4-only), only the IPv4 address can be successfully referred. The IPv6 address cannot be successfully referred (no matter if well-known prefix or LIR prefix).

Thus, this referral is successful.

2.1.2.2. Referring to IPv6-only or dual-stack host with Translator device (Host-B)

If it refers to Host-B (IPv6-only, using a different IPv6/IPv4 translator device) or to a dual-stack host (not shown) with an IPv6/IPv4 translator device in the service provider, the IPv4 referral is also successful. It is successful because the IPv6-only host (with a IPv6/IPv4 translator device) or the dual-stack host both have to be able to communicate with IPv4 hosts, as required by IPv6 transition strategy for SIP [I-D.ietf-sipping-v6-transition].
2.1.2.3. Referring to IPv6-only or dual-stack host without Translator device (Host-F)

If it refers to Host-F (IPv6-only, with no IPv6/IPv4 translator device), the referral fails because Host-F cannot communicate with any IPv4 hosts. This failure is expected, because not only would a referral fail, but two hosts in two different IP address families cannot initiate their own communication -- they need an address family translator (or media relay) or one host needs to be dual-stack.

If it refers to Host-E (dual-stack), the IPv4 address can be successfully referred.

2.2. BitTorrent

BitTorrent trackers use HTTP URIs and DNS names. Thus, if an IPv6-only host running a web browser can connect to an IPv4-only web site using a translator (e.g., using IPv6/IPv4 translator and DNS64), that same IPv6-only host running a BitTorrent client can connect to an IPv4-only BitTorrent tracker. While some BitTorrent trackers are beginning to track IPv6 addresses of BitTorrent peers, most trackers only track IPv4 peers. Most content is only available on IPv4.

When an IPv6-only BitTorrent peer obtains IPv4 addresses from its tracker, it cannot use those IPv4 addresses. To do so, the BitTorrent client software would need to prefix the IPv4 address with the prefix of a IPv6/IPv4 translator that will perform the necessary address family translation on behalf of the IPv6-only BitTorrent client. This could be done with updates to BitTorrent clients to prefix the IPv4 address with the IPv6 prefix of a IPv6/IPv4 translator which will both authorize and route the communication to the IPv4 BitTorrent peer. BitTorrent clients do not perform this function today.

2.3. SMTP

A minority of SMTP [RFC5321] clients and SMTP servers support 551 to redirect mail to another host,

551 User not local; please try <forward-path>.

If the <forward-path> includes an IPv4 address literal, the IPv6 host will need to know how to formulate an IPv6 packet that will traverse its IPv6/IPv4 translator.
3. Security Considerations

It is anticipated that an ISP would not allow non-customers to utilize the ISP’s IPv6/IPv4 translator device.

4. IANA Considerations

There are no IANA considerations for this document.

5. Acknowledgements

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6. References

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