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464XLAT: Combination of Stateful and Stateless Translation
draft-mawatari-softwire-464xlat-02

Abstract

This document describes a method (464XLAT) for IPv4 connectivity across IPv6 network by combination of stateful translation and stateless translation. 464XLAT is a simple technique to provide IPv4 access service while avoiding encapsulation by using twice IPv4/IPv6 translation standardized in [RFC6145] and [RFC6146].

Status of this Memo

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1. Introduction

The IANA unallocated IPv4 address pool was exhasuted on February 3, 2011. It is likely that each RIR's unallocated IPv4 address pool will exhaust in the near future. In this situation, it will be difficult for many networks to assign IPv4 address to end users despite substantial IPv4 connectivity required for mobile devices, smart-grid, and cloud nodes.

This document describes an IPv4 over IPv6 solution as one of the measures of IPv4 address extension and encouragement of IPv6 deployment.
The 464XLAT method described in this document uses twice IPv4/IPv6 translation standardized in [RFC6145] and [RFC6146]. It does not require DNS64 [RFC6147], but it may use DNS64. It is also possible to provide single IPv4/IPv6 translation service, which will be needed in the near future. This feature is one of the advantages, because it can be an encouragement to gradually transition to IPv6.

2. Requirements Language

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 [RFC2119].

3. Terminology

PLAT: PLAT is Provider side translator(XLAT). A stateful translator complies with [RFC6146] that performs 1:N translation. It translates global IPv6 address to global IPv4 address, and vice versa.

CLAT: CLAT is Customer side translator(XLAT). A stateless translator complies with [RFC6145] that performs 1:1 translation. It algorithmically translates private IPv4 address to global IPv6 address, and vice versa. It has also IPv6 router function that can forward IPv6 packet for IPv6 hosts in end-user network. Furthermore, it has DNS Proxy function with IPv6 transport that provides name resolution for IPv4 hosts and IPv6 hosts in end-user network. The presence of DNS64 [RFC6147] and any port mapping algorithm are not required.

4. Network Architecture

464XLAT method is shown in the following figure.

4.1. Wireline Network Architecture

```
                               ----
                              | v6 |
                               ----
                                 |
 ----      |                 .---+---.                    .-------.
| v6 |-----+                /         \                  /        \
 ----      |    ------     /   IPv6    \     ------     /   IPv4   \
           +---| CLAT |---+  Internet   +---| PLAT |---+  Internet  |
 -------   |    ------     \           /     ------     \           /
|v4p/v6 |--+                `---------'                  `----+----'
 -------   |                                                  |
 -----     |                                                -----
| v4p |----+                                               | v4g |
 -----     |                                                -----

       <- v4p -> XLAT <--------- v6 --------> XLAT <- v4g ->
```

```
  v6  : Global IPv6
  v4p : Private IPv4
  v4g : Global IPv4
```

4.2. Wireless 3GPP Network Architecture

```
                                ----
                               | v6 |
                                ----
                                  |
                              .---+---.
                             /         \
                            /   IPv6    \
                           |   Internet  |
                            \           /
 UE / Mobile Phone           `---------'
+----------------------+          |
|  ----     |          |      .---+---.              .------.
| | v6 |----+          |     /         \            /        \
|  ----     |    ------|    / IPv6 PDP  \     ------    /   IPv4   \
|           +---| CLAT |---+ Mobile Core +---| PLAT |--+  Internet  |
|           |    ------|    \    GGSN   /     ------    \          /
|           |          |     \         '                 `----+---'
|  ------   |          |      `-------'                       |
| | v4p |---+          |                                    -----
|  ------   |          |                                   | v4g |
+----------------------+                                    -----

        <- v4p -> XLAT <--------- v6 --------> XLAT <- v4g ->


  v6  : Global IPv6
  v4p : Private IPv4
  v4g : Global IPv4
```

5. Applicability

5.1. Wireline Network Applicability

When ISP has IPv6 access network infrastructure and 464XLAT, ISP can provide IPv4 service to end users.
If the IXP or another provider operates the PLAT, all ISPs have to do is to deploy IPv6 access network. All ISPs do not need IPv4 facilities. They can migrate quickly their operation to an IPv6-only environment. Incidentally, Japan Internet Exchange(JPIX) is providing 464XLAT trial service since July 2010.

5.2. Wireless 3GPP Network Applicability

In pre-release 9 3GPP networks, GSM and UMTS networks must signal and support both IPv4 and IPv6 PDP attachments to access IPv4 and IPv6 network destinations. This is generally not operationally viable since much of the network cost is derived from the number of PDP attachments, both in terms of licenses from the network hardware vendors and in terms of actual hardware resources required to support and maintain the

PDP signaling and mobility events. This has been one of the operational challenges of bringing IPv6 to mobile networks, it simply costs more from the network provider perspective and does not result in any new revenues, since customers are not willing to pay for IPv6 access. Now that both global and private IPv4 addresses are scarce to the extent that it is a substantial business risk and limiting growth in many areas, the mobile network providers must support IPv6 address which solve the IP address scarcity issue, but it is not feasible to simply turn on additional IPv6 PDP network attachments since that does not solve the near-term IPv4 scarcity issues and at it also increases cost. The most logical path forward is to replace IPv6 with IPv4 and replace the common NAT44 with NAT64 and DNS64. Extensive live network testing with hundreds of friendly-users has shown that IPv6-only network attachments for mobile devices covers over 90% of the common use-cases in Symbian and Android mobile operating systems. The remaining 10% of use-cases do not work because the application requires an IPv4 socket or the application references an IPv4-literal. 464XLAT in combination with NAT64 and DNS64 allows 90% of the applications to continue to work with single translation while at the sametime facilitating legacy IPv4-only applications by providing a private IPv4 address and IPv4 route on the host for the applications to reference and bind to. Traffic sourced from the IPv4 interface is immediately routed the NAT46 CLAT function and passed to the IPv6-only mobile network and destine to the PLAT NAT64.

6. Implementation Considerations

6.1. IPv6 Address Format

IPv6 address format in 464XLAT is presented in the following format.

```
+----------------------------------------------+---------------+
|              XLAT prefix(96)                 |    IPv4(32)   |
+----------------------------------------------+---------------+
```

Source address and destination address have IPv4 address embedded in the low-order 32 bits of the IPv6 address. The format is defined in Section 2.2 of [RFC6052]. However, 464XLAT does not use the Well-Known Prefix "64:ff9b::/96".

6.2. DNS Proxy Implementation

CLAT perform DNS Proxy for IPv4 hosts and IPv6 hosts in end-user network. It MUST provide name resolution with IPv6 transport. It does not need DNS64 [RFC6147] function.

6.3. IPv6 Fragment Header Consideration

In the 464XLAT environment, the PLAT and CLAT SHOULD include an IPv6 Fragment Header, since IPv4 host does not set the DF bit. However, the IPv6 Fragment Header has been shown to cause operational difficulties in practice due to limited firewall fragmentation support, etc. Therefore, the PLAT and CLAT may provide a configuration function that allows the PLAT and CLAT not to include the Fragment Header for the non-fragmented IPv6 packets. At any rate, both behaviors SHOULD match.

6.4. Auto Prefix Assignment

Source IPv6 prefix assignment in CLAT is via DHCPv6 prefix delegation or another method. Destination IPv6 prefix assignment in CLAT is via some method. (e.g., DHCPv6 option, TR-069, DNS, HTTP, [I-D.ietf-behave-nat64-discovery-heuristic], etc.)

7. Deployment Considerations

Even if the Internet access provider for consumers is different from the PLAT provider (another Internet access provider or Internet exchange provider, etc.), it can implement traffic engineering independently from the PLAT provider. Detailed reasons are below.

1. The Internet access provider for consumers can figure out IPv4 source address and IPv4 destination address from translated IPv6 packet header, so it can implement traffic engineering based on IPv4 source address and IPv4 destination address (e.g. traffic monitoring for each IPv4 destination address, packet filtering for each IPv4 destination address, etc.). The Tunneling methods do not have such a advantage, without any deep packet inspection for visualizing the inner IPv4 packet of the tunnel packet.

2. If the Internet access provider for consumers can assign IPv6 prefix greater than /64 for each subscriber, this 464XLAT method can separate IPv6 prefix for native IPv6 packets and XLAT prefix for IPv4/IPv6 translation packets. Accordingly, it can identify the type of packets ("native IPv6 packets" and "IPv4/IPv6 translation packets"), and implement traffic engineering based on IPv6 prefix.

This 464XLAT method have two capabilities. One is a IPv6 -> IPv4 -> IPv6 translation for sharing global IPv4 addresses, another is a IPv4 -> IPv6 translation for reaching IPv6 only servers from IPv4 only clients that can not support IPv6. IPv4 only clients will remain for a while.

8. Security Considerations

To implement a PLAT, see security considerations presented in Section 5 of [RFC6146].

To implement a CLAT, see security considerations presented in Section 7 of [RFC6145]. And furthermore, the CLAT SHOULD perform Bogon filter, and SHOULD have IPv6 firewall function as a IPv6 router. It is useful function for native IPv6 packet and translated IPv6 packet. The CLAT SHOULD check IPv6 packet received from WAN interface. If the packet is invalid prefix (i.e., it is not XLAT prefix), then SHOULD silently drop the packet. In addition, the CLAT SHOULD check IPv4 packet after the translation. If the packet is not match private IPv4 address of LAN, then SHOULD silently drop the packet.

9. IANA Considerations

This document has no actions for IANA.

10. Acknowledgements

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