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                              NAT444
                      draft-shirasaki-nat444-05

Abstract

   This document describes one of the network models that are designed
   for smooth transition to IPv6. It is called NAT444 model. NAT444
   model is composed of IPv6, and IPv4 with Carrier Grade (CGN).

   NAT444 is the only scheme not to require replacing Customer Premises
   Equipment (CPE) even if IPv4 address exhausted. But it must be noted
   that NAT444 has serious restrictions i.e. it limits the number of
   sessions per CPE so that rich applications such as AJAX and RSS feed
   cannot work well.

   Therefore, IPv6 which is free from such a difficulty has to be
   introduced into the network at the same time. In other words, NAT444
   is just a tool to make IPv6 transition easy to be swallowed. It is
   designed for the days IPv4 and IPv6 co-existence.

Status of this Memo

   This Internet-Draft is submitted in full conformance with the
   provisions of BCP 78 and BCP 79.

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   and may be updated, replaced, or obsoleted by other documents at any
   time. It is inappropriate to use Internet-Drafts as reference
   material or to cite them other than as "work in progress."

   This Internet-Draft will expire on July 8, 2012.

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1. Introduction

   The only permanent solution of the IPv4 address exhaustion is to
   deploy IPv6. Now, just before the exhaustion, it's time to make a
   transition to IPv6.

   After the exhaustion, unless ISP takes any action, end users will not
   be able to get IPv4 address.

   The servers that have only IPv4 address will continue to exist on the
   Internet after the IPv4 address exhaustion. In this situation, IPv6
   only hosts cannot reach IPv4 only hosts.

   This document explains NAT444 model that bridges the gap between the
   coming IPv6 Internet and the present IPv4 Internet.

2. Definition of NAT444 Model

   NAT444 Model is a network model that uses two Network Address and
   Port Translators (NAPTs) with three types of IPv4 address blocks.

   The first NAPT is in CPE, and the second NAPT is in Carrier Grade NAT
   (CGN) [I-D.ietf-behave-lsn-requirements]. CGN is supposed to be
   installed in the ISP's network.

```
     (The IPv4 Internet)    (The IPv6 Internet)
               |                    |
            +---------+             |
  IPv4 Global Address   |           |
            +--------+--------+     |
            |       CGN       |     |
            +--------+--------+     |
                IPv4 |             | IPv6
                  +-------------+
           Dual Stack |
        +---------------+----------------+
        |  IPv4 NAT/IPv6 Dual Stack CPE  |
        +---------------+----------------+
  IPv4 Private Address / |
  IPv6 Dual Stack        |
            +-----------+-------------+
            |IPv4/IPv6 Dual Stack host|
            +-------------------------+
```
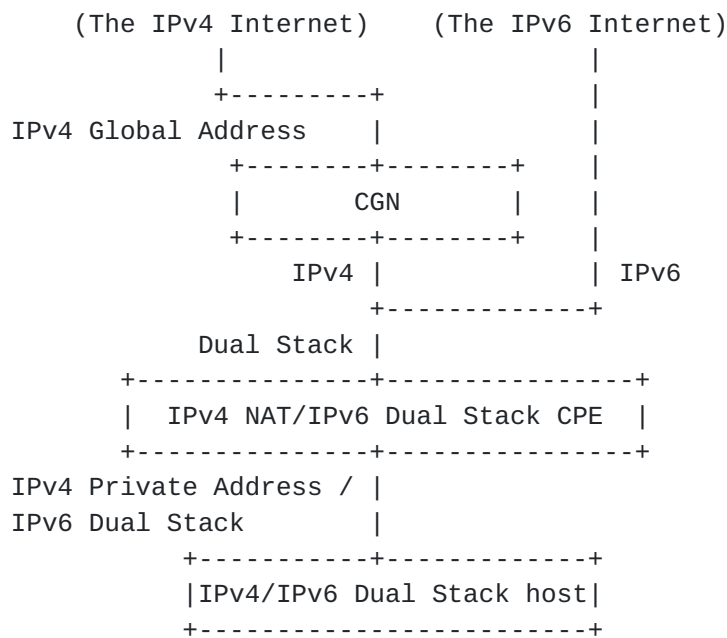
   The first IPv4 address block is Private Address [RFC1918] inside CPE.
   The second one is an IPv4 Address block between CPEs and CGN. The
   third one is IPv4 Global Addresses that is outside CGN. The ISPs

using NAT444 provide IPv6 connectivity by dual stack model.

3. Behavior of NAT444 Model

The IPv6 packets from the host reach the IPv6 Internet without using
NAT functionality.

The following figure shows the behavior of the IPv4 packet from the
host to the IPv4 server via two NATs. The first NAT in CPE
overwrites the Source IP Address and Source Port from 10.0.0.2:tt to
w.w.w.w:uu. Then the second NAT in CGN overwrites them from
w.w.w.w:uu to y.y.y.y:vv. Destination IP Address and Port are not
overwritten.

```
                 +-------------+
(Port=80)    | IPv4 Server |  ^
   x.x.x.x-> +------+------+  :
                    |         :
IPv4 Global Address |         :
                    |         :
          (The IPv4 Internet):(Dst=x.x.x.x:80/Src=y.y.y.y:vv)
                    |         :
IPv4 Global Address |         :
                    |         :
   y.y.y.y->  +----+----+     :
    (Port=vv) |   CGN   |     ^
   z.z.z.z->  +----+----+     :
                    |         :
      IPv4 Address  |         :(Dst=x.x.x.x:80/Src=w.w.w.w:uu)
                    |         :
  w.w.w.w-> +-------+-------+ :
   (Port=uu) | IPv4 NAT CPE  | ^
  10.0.0.1-> +-------+-------+ :
                    |         :
IPv4 Private Address|         :
                    |         :
   10.0.0.2->  +----+----+    :(Dst=x.x.x.x:80/Src=10.0.0.2:tt)
     (Port=tt) |IPv4 Host|
               +---------+
```

The following figure explains the behavior of returning IPv4 packet
via two NATs. The first NAT in CGN overwrites the Destination IP
Address and Port Number from y.y.y.y:vv to w.w.w.w:uu. Then the
second NAT in CPE overwrites them from w.w.w.w:u to 10.0.0.2:tt.

```
                 +-------------+
      (Port=80) | IPv4 Server |   :
      x.x.x.x-> +------+------+   :
                       |         :
   IPv4 Global Address |         :
                       |         :
             (The IPv4 Internet):(Dst=y.y.y.y:vv/Src=x.x.x.x:80)
                       |         :
   IPv4 Global Address |         :
                       |         :
         y.y.y.y-> +----+----+    :
         (Port=vv) |   CGN   |    v
         z.z.z.z-> +----+----+    :
                       |         :
          IPv4 Address |         :(Dst=w.w.w.w:uu/Src=x.x.x.x:80)
                       |         :
     w.w.w.w-> +-------+-------+ :
     (Port=uu) | IPv4 NAT CPE  | v
     10.0.0.1-> +-------+-------+ :
                       |         :
   IPv4 Private Address |        :(Dst=10.0.0.2:tt/Src=x.x.x.x:80)
                       |         :
       10.0.0.2-> +----+----+    :
       (Port=tt) |IPv4 Host|    v
                 +---------+
```

4. Pros and Cons of NAT444 Model

4.1. Pros of NAT444 Model

   This network model has following advantages.

   - This is the only network model that doesn't require replacing CPEs
   those are owned by customers.
   - This network model is composed of the present technology.
   - This network model doesn't require address family translation.
   - This network model doesn't require DNS rewriting.
   - This network model doesn't require additional fragment for the
   packets because it doesn't use tunneling technology.

4.2. Cons of NAT444 Model

   This network model has some technical restrictions.

   - Some application such as SIP requires special treatment, because IP
   address is written in the payload of the packet. Special treatment
   means application itself aware double NAPT or both of two NAPTs

    support inspecting and rewriting the packets.
    - Because both IPv4 route and IPv6 route exist, it doubles the number
    of IGP route inside the CGN.
    - UPnP doesn't work with double NAPTs.

5. Acknowledgements

    Thanks for the input and review by Shin Miyakawa, Shirou Niinobe,
    Takeshi Tomochika, Tomohiro Fujisaki, Dai Nishino, JP address
    community members, AP address community members and JPNIC members.

6. IANA Considerations

    There are no IANA considerations.

7. Security Considerations

    Each customer inside a CGN looks using the same Global Address from
    outside an ISP. In case of incidents, the ISP must have the function
    to trace back the record of each customer's access without using only
    IP address.

    If a Global Address of the CGN is listed on the blacklist, other
    customers who share the same address could be affected.

8. References

8.1. Normative References

    [RFC1918] Rekhter, Y., Moskowitz, R., Karrenberg, D., Groot, G., and
               E. Lear, "Address Allocation for Private Internets",
               BCP 5, RFC 1918, February 1996.

    [RFC4925] Li, X., Dawkins, S., Ward, D., and A. Durand, "Softwire
               Problem Statement", RFC 4925, July 2007.

    [I-D.ietf-behave-lsn-requirements]
               Perreault, S., Yamagata, I., Miyakawa, S., Nakagawa, A.,
               and H. Ashida, "Common requirements for Carrier Grade NATs
               (CGNs)", draft-ietf-behave-lsn-requirements-05 (work in
               progress), November 2011.

8.2. Informative References

[I-D.shirasaki-isp-shared-addr]
            Yamagata, I., Miyakawa, S., Nakagawa, A., Yamaguchi, J.,
            and H. Ashida, "ISP Shared Address",
            draft-shirasaki-isp-shared-addr-06 (work in progress),
            July 2011.

[I-D.shirasaki-nat444-isp-shared-addr]
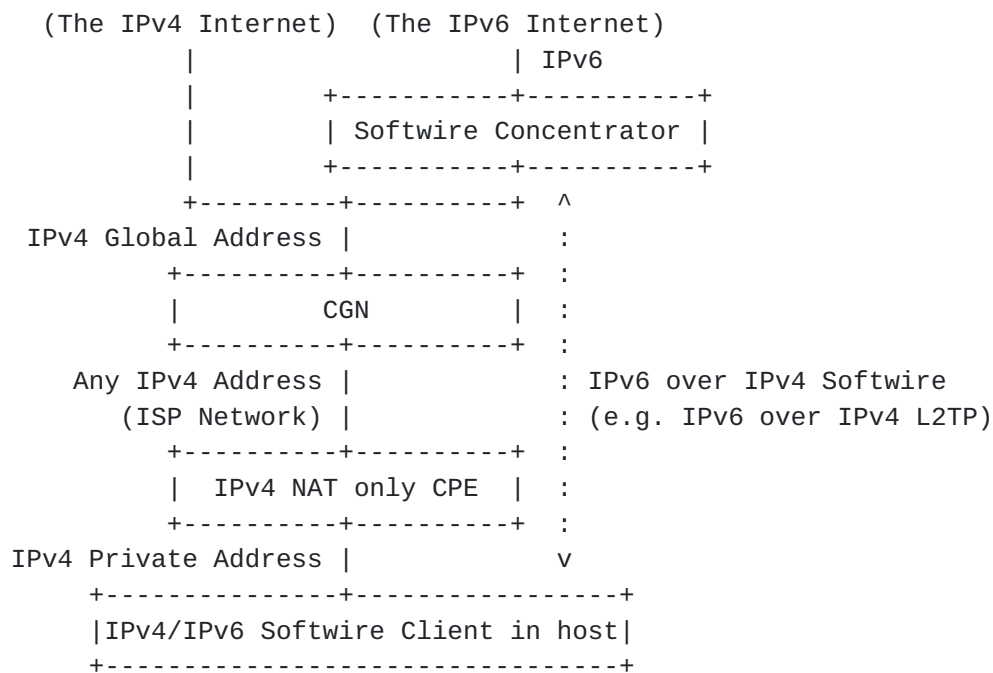   Yamaguchi, J., Shirasaki, Y., Miyakawa, S., Nakagawa, A.,
            and H. Ashida, "NAT444 addressing models",
            draft-shirasaki-nat444-isp-shared-addr-06 (work in
            progress), July 2011.

Appendix A.   Example IPv6 Transition Scenario

   The steps of IPv6 transition are as follows.

   Step 1: Enabling softwire client in host

   ISP provides IPv6 connectivity to customers with softwire [RFC4925].
   ISP installs CGN and softwire concentrator in its network. A
   softwire client in host connects to the IPv6 internet via ISP's
   concentrator. ISP can use existing IPv4 equipments. Customers can
   just use existing CPE.

```
      (The IPv4 Internet)  (The IPv6 Internet)
               |                     | IPv6
               |         +-----------+-----------+
               |         | Softwire Concentrator |
               |         +-----------+-----------+
             +---------+----------+  ^
    IPv4 Global Address |          :
            +----------+----------+  :
            |          CGN        |  :
            +----------+----------+  :
        Any IPv4 Address |          : IPv6 over IPv4 Softwire
           (ISP Network) |          : (e.g. IPv6 over IPv4 L2TP)
            +----------+----------+  :
            |   IPv4 NAT only CPE  |  :
            +----------+----------+  :
    IPv4 Private Address |          v
        +---------------+-----------------+
        |IPv4/IPv6 Softwire Client in host|
        +---------------------------------+
```

   Step 2: Enabling softwire client in CPE

A customer enables softwire client in CPE. A softwire client in CPE
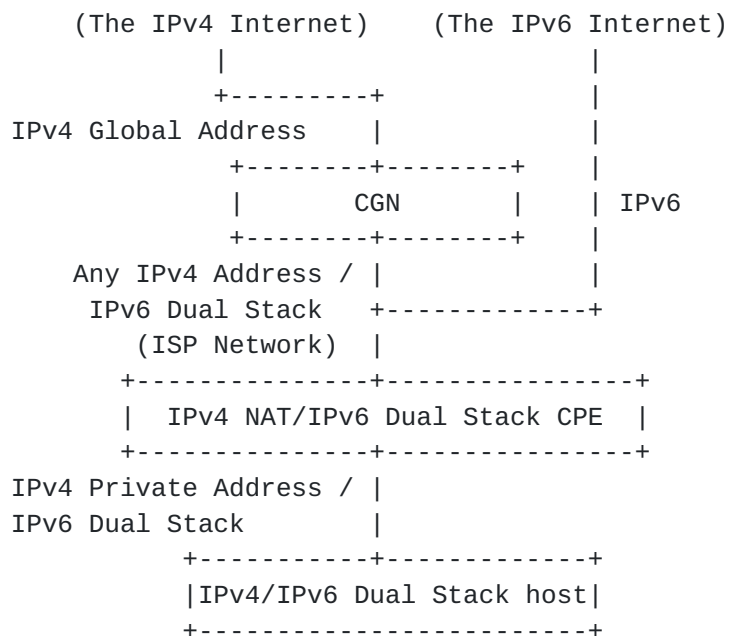connects to the IPv6 internet via ISP's concentrator. A Customer's
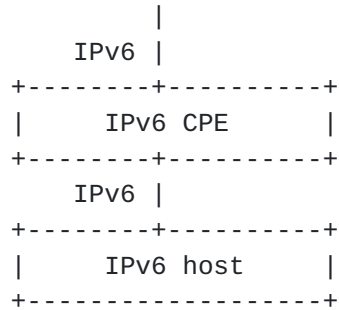network is now dual stack.

```
      (The IPv4 Internet)    (The IPv6 Internet)
                |                   | IPv6
                |            +----------+-----------+
                |            | Softwire Concentrator |
                |            +----------+-----------+
              +---------+-----------+  ^
  IPv4 Global Address     |            :
          +---------+-----------+  :
                |         CGN         |  : IPv6 over IPv4 Softwire
          +---------+-----------+  : (e.g. IPv6 over IPv4 L2TP)
        Any IPv4 Address |            :
          (ISP Network)  |            v
        +--------------+------------------+
        |IPv4 NAT/IPv6 Softwire client in CPE|
        +--------------+------------------+
  IPv4 Private Address / |
  IPv6 Dual Stack        |
          +----------+------------+
          |IPv4/IPv6 Dual Stack host|
          +------------------------+
```
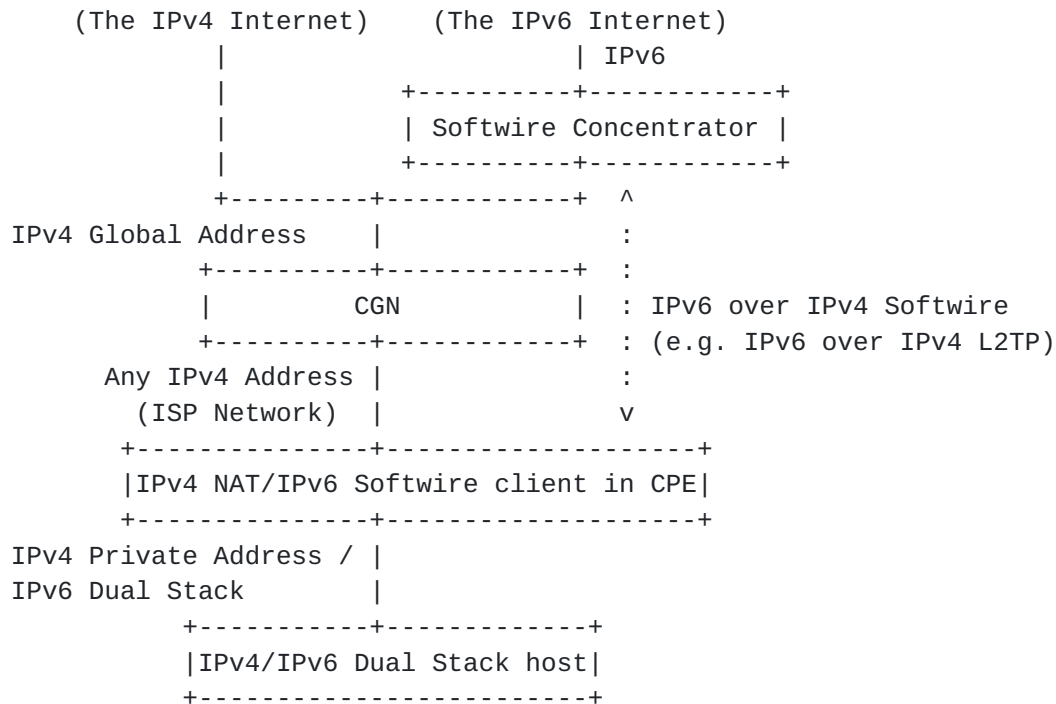
Step 3: Moving on to dual stack

ISP provides dual stack access to CPE. A CPE uplink is now dual
stack.

```
      (The IPv4 Internet)    (The IPv6 Internet)
                |                   |
            +---------+             |
  IPv4 Global Address     |             |
          +--------+--------+    |
                |         CGN        |  | IPv6
          +--------+--------+    |
        Any IPv4 Address / |         |
          IPv6 Dual Stack   +-------------+
            (ISP Network)  |
        +--------------+---------------+
        |   IPv4 NAT/IPv6 Dual Stack CPE  |
        +--------------+---------------+
  IPv4 Private Address / |
  IPv6 Dual Stack        |
          +----------+------------+
          |IPv4/IPv6 Dual Stack host|
          +------------------------+
```

Step 4: Moving on to pure IPv6

IPv6 transition completes.

```
(The IPv6 Internet)
         |
    IPv6 |
+--------+----------+
|     IPv6 CPE      |
+--------+----------+
    IPv6 |
+--------+----------+
|     IPv6 host     |
+------------------+
```


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