Internet Engineering Task Force
Internet-Draft
Intended status: Standards Track
Expires: August 5, 2018

Khaled Omar
The Road

February 5, 2018

Internet Protocol version 10 (IPv10) Specification
draft-omar-ipv10-11

Status of this Memo

Copyright Notice

Abstract

This document specifies version 10 of the Internet Protocol (IPv10), a solution that allows IPv4-only hosts to communicate with IPv6-only hosts and vice versa.

Table of Contents

1. Introduction

IP version 10 (IPv10) is a new version of the Internet Protocol, designed to allow IP version 6 [RFC-2460] to communicate to IP version 4 (IPv4) [RFC-791] and vice versa.

- Internet is the global wide network used for communication between hosts connected to it.

- These connected hosts (PCs, servers, routers, mobile devices, etc.) must have a global unique addresses to be able to communicate through the Internet and these unique addresses are defined in the Internet Protocol (IP).

- The first version of the Internet Protocol is IPv4.

- When IPv4 was developed in 1975, it was not expected that the number of connected hosts to the Internet reach a very huge number of hosts more than the IPv4 address space, also it was aimed to be used for experimental purposes in the beginning.

- IPv4 is (32-bits) address allowing approximately 4.3 billion unique IP addresses.

- A few years ago, with the massive increase of connected hosts to the Internet, IPv4 addresses started to run out.

- Three short-term solutions (CIDR, Private addressing, and NAT) were introduced in the mid-1990s but even with using these solutions, the IPv4 address space ran out in February, 2011 as announced by IANA, The announcement of depletion of the IPv4 address space by the RIRs is as follows:

  * April, 2011: APNIC announcement.
  * September, 2012: RIPE NCC announcement.
  * June, 2014: LACNIC announcement.
  * September, 2015: ARIN announcement.

- A long term solution (IPv6) was introduced to increase the address space used by the Internet Protocol and this was defined in the Internet Protocol version 6 (IPv6).

- IPv6 was developed in 1998 by the Internet Engineering Task Force (IETF).

- IPv6 is (128-bits) address and can support a huge number of unique IP addresses that is approximately equals to 2^128 unique addresses.

- So, the need for IPv6 became a vital issue to be able to support the massive increase of connected hosts to the Internet after the IPv4 address space exhaustion.

- The migration from IPv4 to IPv6 became a necessary thing, but unfortunately, it would take decades for this full migration to be accomplished.

- 19 years have passed since IPv6 was developed, but no full migration happened till now and this would cause the Internet to be divided into two parts, as IPv4 still dominating on the Internet traffic (85% as measured by Google in April, 2017) and new Internet hosts will be assigned IPv6-only addresses and be able to communicate with 15% only of the Internet services and apps.

- So, the need for solutions for the IPv4 and IPv6 coexistence became an important issue in the migration process as we cannot wake up in the morning and find all IPv4 hosts are migrated to be IPv6 hosts, especially, as most enterprises have not do this migration for creating a full IPv6 implementation.

- Also, the request for using IPv6 addresses in addition to the existing IPv4 addresses (IPv4/IPv6 Dual Stacks) in all enterprise networks have not achieve a large implementation that can make IPv6 the most dominated IP in the Internet as many people believe that they will not have benefits from just having a larger IP address bits and IPv4 satisfies their needs, also, not all enterprises devices support IPv6 and also many people are afraid of the service outage that can be caused due to this migration.

- The recent solutions for IPv4 and IPv6 coexistence are:

  Native dual stack (IPv4 and IPv6)
  Tunneling
  NAT64
  Dual-stack Lite
  464xlat
  MAP

(other technologies also exist, like lw6over4; they may have more specific use cases)

- IPv4/IPv6 Dual Stack, allows both IPv4 and IPv6 to coexist by using both IPv4 and IPv6 addresses for all hosts at the same time, but this solution does not allows IPv4 hosts to communicate to IPv6 hosts and vice versa. Also, after the depletion of the IPv4 address space, new Internet hosts will not be able to use IPv4/IPv6 Dual Stacks.

- Tunneling, allows IPv6 hosts to communicate to each other through an IPv4 network, but still does not allows IPv4 hosts to communicate to IPv6 hosts and vice versa.

- NAT-PT, allows IPv6 hosts to communicate to IPv4 hosts with only using hostnames and getting DNS involved in the communication process but this solution was inefficient because it does not allows communication using direct IP addresses, also the need for so much protocol translations of the source and destination IP addresses made the solution complex and not applicable thats why it was moved to the Historic status in the RFC 2766. Also, NAT64 requires so much protocol translations and statically configured bindings, and also getting a DNS64 involved in the communication process.

2. Internet Protocol version 10 (IPv10).

- IPv10 is the solution presented in this Internet draft.

- It solves the issue of allowing IPv6 only hosts to communicate to IPv4 only hosts and vice versa in a simple and very efficient way, especially when the communication is done using both direct IP addresses and when using hostnames between IPv10 hosts, as there is no need for protocol translations or getting the DNS involved in the communication process more than its normal address resolution function.

- IPv10 allows hosts from two IP versions (IPv4 and IPv6) to be able to communicate, and this can be accomplished by having an IPv10 packet containing a mixture of IPv4 and IPv6 addresses in the same IP packet header.

- From here the name of IPv10 arises, as the IP packet can contain (IPv6 + IPv4 /IPv4 + IPv6) addresses in the same layer 3 packet header.

3. The Four Types of Communication.

3.1) IPv10: IPv6 Host to IPv4 Host.

- IPv10 Packet:

```
         |<-------- 128-bit ------>|<------------------ 128-bit
---------------->|
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+
   | Data|   Source IPv6 Address   | Destination IPv4 Address     MAC
0000..0 |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+
                                   |<--------- 32-bit -------->| 48-bit | 48-
bit |
```

MAC ==> The sending host MAC address.

- The destination address is 128 bit, when the 1st 48-bits are zeros, the router will know that the last 32-bit is an IPv4 address and it can start forwarding the packet based on that address.

- The second 48-bit represents the sending host MAC address and this can be used for host identification.

- The last 32-bit represents the destination IPv4 address.

- Sending IPv10 host TCP/IP Configuration:

```
      IP Address:                IPv6 Address
      Prefix Length:             /length
      Default Gateway:           IPv6 Address (Optional)
      DNS Addresses:             IPv6/IPv4 Address
```

- Example of IPv10 Operation:

```
                R1 & R2 have both IPv4/IPv6 routing enabled
IPv10 Host                                                     IPv10 Host

   PC-1             R1              *            R2                PC-2
  +----+                         *   *                           +----+
  |    |             *         *       *         *               |    |
  |    |o---------o* X *o---o* IPv4/IPv6 *o---o* X *o-----------o|    |
  +----+  2001:1::1  *     *               *     *  192.168.1.1  +----+
 /    /                      *  Network  *                      /    /
+----+                         *       *                       +----+
                                 *   *
IPv6: 2001:1::10/64                *                IPv4: 192.168.1.10/24
DG  : 2001:1::1                                     DG  : 192.168.1.1

      |      128-bit    |          128-bit        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Data |    2001:1::10   | 192.168.1.10 MAC 000..0 |--->
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
       Src. IPv6 Address      Dest. IPv4 Address
```

IPv10: IPv6 host to IPv4 host

3.2) IPv10: IPv4 Host to IPv6 Host.

- IPv10 Packet:

```
         |            128-bit               |           128-bit           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | Data| Source IPv4 Address MAC 000..0  |  Destination IPv6 Address   |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

- Sending IPv10 host TCP/IP Configuration:

```
      IP Address:                 IPv4 Address
      Subnet Mask:                /mask
      Default Gateway:            IPv4 Address
      DNS Addresses:              IPv4/IPv6 Address
```

- Example of IPv10 Operation:

```
              R1 & R2 have both IPv4/IPv6 routing enabled
IPv10 Host                                                        IPv10 Host

   PC-1             R1             *            R2                 PC-2
  +----+                         *   *                            +----+
  |    |             *         *       *         *                |    |
  |    |o---------o* X *o---o* IPv4/IPv6 *o---o* X *o-----------o|    |
  +----+  2001:1::1  *     *               *     *  192.168.1.1  +----+
 /    /                    *  Network  *                        /    /
+----+                       *       *                        +----+
                               *   *
IPv6: 2001:1::10/64              *               IPv4: 192.168.1.10/24
DG  : 2001:1::1                                  DG  : 192.168.1.1


                                   |       128-bit     |             128-
bit               |
                                   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+-+-+-+-+
                               <---|     2001:1::10    | 000..0  MAC
```

```
192.168.1.10 | Data |
                                   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+-+-+-+-+
                                    Dest. IPv6 Address        Src. IPv4 Address
```

IPv10: IPv4 host to IPv6 host

```
     3.3) IPv10: IPv6 Host to IPv6 Host.
          ------------------------------
```

- IPv10 Packet:

```
         |        128-bit        |          128-bit            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | Data|  Source IPv6 Address  |  Destination IPv6 Address   |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

- Sending IPv10 host TCP/IP Configuration:

```
      IP Address:               IPv6 Address
      Prefix Length:            /Length
      Default Gateway:          IPv6 Address (Optional)
      DNS Addresses:            IPv6/IPv4 Address
```

- Example of IPv10 Operation:

```
              R1 & R2 have both IPv4/IPv6 routing enabled
IPv10 Host                                                   IPv10 Host

   PC-1             R1             *            R2              PC-2
  +----+                         *   *                         +----+
  |    |             *         *       *         *             |    |
  |    |o---------o* X *o---o* IPv4/IPv6 *o---o* X *o---------o|    |
  +----+  2001:1::1  *     *               *     *  3001:1::1  +----+
 /    /                      *  Network  *                    /    /
+----+                         *       *                    +----+
                                 *   *
IPv6: 2001:1::10/64                *              IPv6: 3001:1::10/64
DG  : 2001:1::1                                   DG  : 3001:1::1


      |     128-bit     |      128-bit      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Data |   2001:1::10    |     3001:1::10    |--->
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
       Src. IPv6 Address  Dest. IPv6 Address
```

IPv10: IPv6 host to IPv6 host

3.4) IPv10: IPv4 Host to IPv4 Host.

- IPv10 Packet:

```
         |               128-bit           |                 128-
bit              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+
   | Data| Source IPv4 Address MAC 000..0  | Destination IPv4 Address MAC
000..0 |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+
```

- Sending IPv10 host TCP/IP Configuration:

```
      IP Address:               IPv4 Address
      Subnet Mask:              /Mask
      Default Gateway:          IPv4 Address
      DNS Addresses:            IPv6/IPv4 Address
```

- Example of IPv10 Operation:

```
              R1 & R2 have both IPv4/IPv6 routing enabled
 IPv10 Host                                                  IPv10 Host

    PC-1            R1             *            R2                PC-2
   +----+                        *   *                           +----+
   |    |            *         *       *         *               |    |
   |    |o--------o* X *o---o* IPv4/IPv6 *o---o* X *o-----------o|    |
   +----+  10.1.1.1  *     *               *     *  192.168.1.1  +----+
  /    /                 *  Network  *                         /    /
 +----+                    *       *                         +----+
                             *   *
IPv4: 10.1.1.10/24             *               IPv6: 192.168.1.10/24
DG  : 10.1.1.1                                 DG  : 192.168.1.1

      |        128-bit        |          128-bit        |
```

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Data | 10.1.1.10 MAC 000..0  | 192.168.1.10 MAC 000..0 |--->
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
          Src. IPv4 Address        Dest. IPv4 Address
```

IPv10: IPv4 host to IPv4 host

Important Notes:

- IPv4 and IPv6 routing must be enabled on all routers, so when a router receives an IPv10 packet, it should use the appropriate routing table based on the destination address within the IPv10 packet.
- That means, if the received IPv10 packet contains an IPv4 address in the destination address field, the router should use the IPv4 routing table to make a routing decision, and if the received IPv10 packet contains an IPv6 address in the destination address field, the router should use the IPv6 routing table to make a routing decision.
- All Internet connected hosts must be IPv10 hosts to be able to communicate regardless the used IP version, and the IPv10 deployment process can be accomplished by ALL technology companies developing OSs for hosts networking and security devices.

When the source or destination is an IPv4 address, the IPv4 address is located in the last 32 bits.

When the source is IPv4 and the destination is IPv6, the sending host will consider the destination IPv6 address as an IPv4 address not on the same subnet, meaning it should send this frame to the default gateway (router).

Once the router receives the frame, it removes the frame header and trailer and look for the destination IPv6 address, then the router start to take a routing decision by checking its IPv6 routing table and start sending the packet to the next hop through the IPv6 network.

Similarly, when the source is IPv6 and the destination is IPv4, the sending host will consider the destination IPv4 address as an IPv6 address not on the same subnet, meaning it should send this frame to the default gateway (router)

Once the router receives the frame, it removes the frame header and trailer and look for
the destination IPv4 address, then the router start to take a routing decision by checking
its IPv4 routing table and start sending the packet to the next hop through the IPv4 network.

```
   S    D
  IPv4-IPv6    --->  IPv6  --->   IPv6 Network  --->      IPv6
 Sending Host       Router                            Destination Host


                                                              S    D
     IPv4        <---  IPv4 Network  <---  IPv4  <---   IPv6-IPv4
Destination Host                          Router       Sending Host
```

4. IPv10 Packet Header Format.

- The following figure shows the IPv10 packet header which is almost the same as the IPv6 packet header:

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Version| Traffic Class |           Flow Label                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Payload Length        |  Next Header  |   Hop Limit   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+                                                               +
|                                                               |
+                         Source Address                        +
|                                                               |
+                                                               +
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+                                                               +
|                                                               |
+                      Destination Address                      +
|                                                               |
+                                                               +
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

```
Version              4-bit Internet Protocol version number.

                     - 0100 : IPv4 Packet
                              (Src. and dest. are IPv4).
                     - 0110 : IPv6 Packet
                              (Src. and dest. are IPv6).
                     - 1010 : IPv10 Packet
                              (Src. and dest. are IPv4/IPv6).


Traffic Class        8-bit traffic class field.

Flow Label           20-bit flow label.
```

```
   Payload Length       16-bit unsigned integer.  Length of the payload,
                        i.e., the rest of the packet following
                        this IP header, in octets.  (Note that any
                        extension headers [section 4] present are
                        considered part of the payload, i.e., included
                        in the length count.)

   Next Header          8-bit selector.  Identifies the type of header
                        immediately following the IP header.

   Hop Limit            8-bit unsigned integer.  Decremented by 1 by
                        each node that forwards the packet. The packet
                        is discarded if Hop Limit is decremented to
                        zero.

   Source Address       128-bit address of the originator of the packet.
```

```
                                    |     32-bit    |  48-bit |      48-bit
|
    +-+-+-+-+-+-+-+-+-+-+-+-+         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+
    |   IPv6 Address      |   OR    | IPv4 Address  |   MAC   |   00000......0
|
    +-+-+-+-+-+-+-+-+-+-+-+-+         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+
    |      128-bit        |         |                 128-bit
|
```

```
   Destination Address  128-bit address of the intended recipient of the
                        packet (possibly not the ultimate recipient, if
                        a Routing header is present).
```

```
                                    |     32-bit    |  48-bit |      48-bit
|
    +-+-+-+-+-+-+-+-+-+-+-+-+         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+
    |   IPv6 Address      |   OR    | IPv4 Address  |   MAC   |   00000......0
|
    +-+-+-+-+-+-+-+-+-+-+-+-+         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+
    |      128-bit        |         |                 128-bit
|
```

5. Advantages of IPv10.

1) Introduces an efficient way of communication between IPv6 hosts and IPv4 hosts.

2) Allows IPv4 only hosts to exist and communicate with IPv6 only hosts even after the depletion of the IPv4 address space.

3) Adds flexibility when making a query sent to the DNS for hostname resolution as IPv4 and IPv6 hosts can communicate with IPv4 or IPv6 DNS servers and the DNS can reply with any record it has (either an IPv6 record Host AAAA record or an IPv4 record Host A record).

4) There is no need to think about migration as both IPv4 and IPv6 hosts can coexist and communicate to each other which will allow the usage of the address space of both IPv4 and IPv6 making the available number of connected hosts be bigger.

5) IPv10 support on "all" Internet connected hosts can be deployed in a very short time by technology companies developing OSs (for hosts and networking devices, and there will be no dependence on enterprise users and it is just a software development process in the NIC cards of all hosts to allow encapsulating both IPv4 and IPv6 in the same IP packet header.

6) Offers the four types of communication between hosts:

   - IPv6 hosts to IPv4 hosts (6 to 4).

   - IPv4 hosts to IPv6 hosts (4 to 6).

   - IPv6 hosts to IPv6 hosts (6 to 6).

   - IPv4 hosts to IPv4 hosts (4 to 4).

6. IPv10 with DNS.

```
                           DNS Server
                             +----+
 Host AAAA Record            |    |         Host A Record
                 /   ^       |    |      ^  \
                /   /        |    |       \  \
               /   /         +----+        \  \
         IPv6 /   /     IPv4/IPv6 Address   \  \ IPv4
         (2) /   /                           \  \
            /   / PC-2                  PC-1  \  \
           /   /  (1)                          \  \
          V   /                                 \  V
 IPv10 Host                                         IPv10 Host
    PC-1                                                PC-2
   +----+                                              +----+
   |    |                                              |    |
   |    |                                              |    |
   +----+                                              +----+
  /    /   <--------------------------------------->  /    /
 +----+                  IPv10 Packets               +----+
                              (3)
IPv4-Only Host                                      IPv6-Only Host
```

Step-1 ==> PC-1 needs to communicate with PC-2, it sends a query to the DNS server (with either IPv4 or IPv6 address) to resolve the hostname PC-2.

Step-2 ==> The DNS server has a AAAA record for PC-2, and reply with PC-2's IPv6 address.

Step-3 ==> PC-1 can now communicate with PC-2 using IPv10 packets.

Similarly, PC-2 can communicate with PC-1 using the same method.

Security Considerations

The security features of IPv10 are described in the Security Architecture for the Internet Protocol [RFC-2401].

Acknowledgments

The author would like to thank S. Krishnan, W. Haddad, L. Howard, C. Huitema,
T. Manderson, JC. Zuniga, A. Sullivan, , A. Petrescu, K. Thomann, S. Bortzmeyer,
J. Linkova, and T. Herbert for the useful inputs and discussions about IPv10.

Author Address

Khaled Omar Ibrahim Omar
The Road
6th of October City,
Giza, Egypt
Passport ID no.: A19954283

Phone: +2 01003620284
E-mail: eng.khaled.omar@hotmail.com

References

[RFC-2401] Stephen E. Deering and Robert M. Hinden, "IPv6 Specification", RFC 2460, December 1998.

IANA Considerations

IANA must reserve version number 10 for the 4-bit Version Field in the Layer 3 packet header for the IPv10 packet.

Full Copyright Statement