IPv6 Migration - Suggestions for Railways

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Abstract

IPv6 is the inevitable devil that all network engineers should face. It is unfortunate that it is incompatible with IPv4. Hence, one has to plan the migration from IPv4 to IPv6 carefully without breaking user services. It is also important that while the migration phase, users should not be disturbed and their network utilization should not get affected.

In this article, we suggest a migration methodology that can be adopted by Railways for migration of Railnet from IPv4 to IPv6.

1 Introduction

IPv4 address space is getting exhausted fast. IPv6 has been in existence for more than 15 years now. When do we plan to migrate from IPv4 to IPv6? We do not see many making the move to IPv6 as of now. This is the silence before the storm. The moment IPv6 migration movement attains critical mass, we will see mass migration to IPv6 in a very short time.

IPv6 and IPv4 are not compatible. This means that we need to relearn the networking from IPv6 perspective. Training to various stakeholders will become very important and IRISET has the responsibility to equip as many railwaymen as possible with this technical knowledge and skill. These trained manpower will handhold railways to migrate Railnet and other networks from IPv4 to IPv6 when the migration boom occurs. The training that needs to be provided is required to be focused to the scheme of migration that railways will choose.

2 IPv6 Deployment Roadmap

Government of India has issued a National IPv6 Deployment Roadmap in the year 2010 and then followed it up with version II of the roadmap in 2013. It laid down the guidelines for successful migration from IPv4 to IPv6 by the governement ministries, departments and CPSEs[1]. The task force has done a great job in bringing awareness about this migration to various stakeholders in the Government of India.

[1]Central Public Sector Enterprise

The steps outlined by the task force for the smooth migration are as under:

a) Assessment

b) Plan and strategy formulation

c) Training

d) Procurement of any device if it needs replacement

e) Acquire IPv6 address

f) Pilot Testing

g) Implementation

h) Auditing & commissioning

i) Network Management

3 Current Scenario for Railnet

In Railways, Railnet is one of the major network that will need to be migrated to IPv6 in near future. The Internet from the perspective of IPv4 and IPv6 vis-a-vis Railnet can be represented as in figure 1.

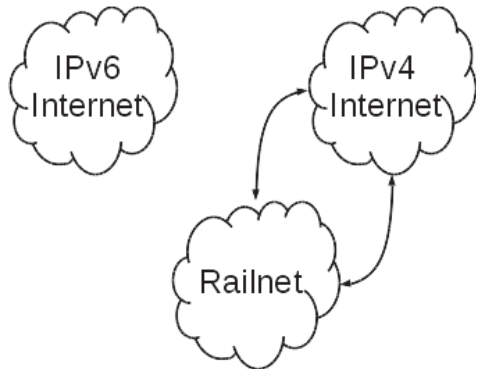

Figure 1: Railnet vis-a-vis IPv4 and IPv6

Today, two Internet viz. IPv6 Internet and IPv4 Internet both exists. Internet as we know today is largely IPv4 Internet. Many service providers are now beginning to provide their services on IPv6 Internet as well. Famous 'Google' is now available on IPv6 as well. In due course, services will migrate to

IPv6 Internet and IPv4 Internet will shrink till one fine day we will stop IPv4 completely and give it a decent burial. But this is not going to happen in a day.

It means that for a considerable amount of time, both IPv4 and IPv6 Internet will have to coexist. This also means that Railnet will have to be provided with access to both IPv4 and IPv6 Internet.

This requirement brings in many challenges as well as forces decision that need to be taken now.

4 Dual-Stack method

One option with Railways is to make all Railnet equipment including PCs, switches, routers, ADSL modems etc. dual stacked i.e. these equipment will use both IPv4 drivers as well as IPv6 drivers. This means additional workload for maintainers of the network as each device will have to be operated with IPv4 as well as for IPv6. Such a scenario is shown in the figure 2.

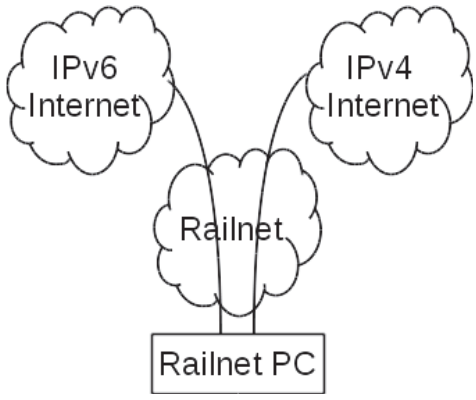

Figure 2: Railnet Dual Stack

This scheme seems simple. But it comes with its own set of problems. Let us say, we have dual-stack arrangement and we are trying to browse a website say `http://www.example.com/`. Now, the browser does a DNS resolution to get the IP address associated with the domain name. As the browser does not know if this is an IPv6 or an IPv4 site, it asks DNS server to look for an IPv6 address first. If it gets one, it uses the IPv6 Internet to complete the request. But if it does not then, it requests the DNS server to provide an IPv4 address. If an IPv4 address is returned, the browser uses the IPv4 Internet to complete the request.

As most of the Internet is now IPv4, it is clear that most of the IPv6 DNS resolution will fail. This will result into perceived high Internet latency by the users.

One may be tempted to think that the perceived web-latency problem can be overcome if the browser is programmed to try to get IPv4 address before the IPv6 address. This will work but then, most of the servers on IPv4 will make a shift to IPv6 with the same domain name an will not remove their presence from the IPv4 Internet. Thus, with the reversed order of DNS resolution, the usage of IPv6 will not increase. Further, the perception with the users will be that IPv6 network is slow. This is detrimental to the health of IPv6 Internet.

5 SIIT and NAT64

Another method for migration can be to shift to IPv6 completely and abandon IPv4. This will enable use of only IPv6 drivers in the equipment and IPv6 Internet will become available without any problem. However, IPv4 Internet will not be available. Such a scenario is shown in figure 3.

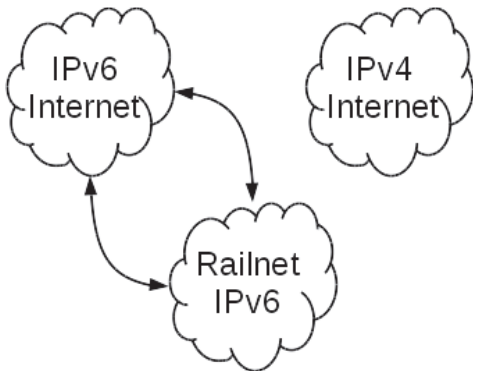

Figure 3: Railnet with IPv6 only stack

IPv4 Internet is not going away in near future. It has a lot more content available than the IPv6 Internet. Railnet users cannot be denied IPv4 Internet. Therefore, some method for accessing IPv4 Internet from a pure IPv6 network is required. Let us examine the Stateless IP/ICMP Translation (SIIT) and NAT64 (Network Address Translation six-four) method.

The requirements makes it clear that for accessing IPv4 Internet from an only-IPv6 Railnet, network address translation has to be done. The model required network is shown is figure 4.

IPv6 Railnet gets connected to IPv4 Internet through a translator that translate packet headers from IPv6 to IPv4 and vice-versa. NAT64 (pronounced NAT-six-four) provides such a translation

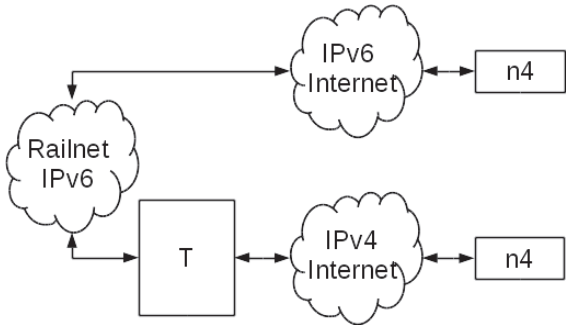

Figure 4: IPv6 Railnet Model

mechanism.

The whole IPv4 network address space of 32 bits can be represented as a /96 i.e. $(128 - 32)$ IPv6 address. Let us take an example to understand this concept. The example network is shown is figure 5.

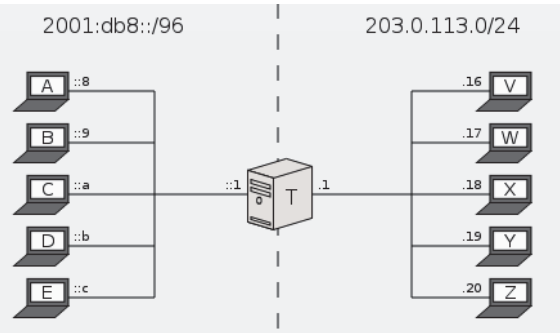

Figure 5: NAT64 Example Network

In figure 5, T, the NAT64 translator connects to both IPv4 and IPv6 network. The following are the salient features of this scheme to make it work.

1. A thinks V's address is 64:ff9b::203.0.113.116.
2. T will pretend that IPv4 Internet is a IPv6 network with network address 64:ff9b::/96.
3. When T receives a packet for 64:ff9b::A.B.C.D, it changes the IPv6 header of the packet with an IPv4 header with source address as the IPv4 interface address of T and destination as A.B.C.D Thus the packet gets routed in the IPv4 network. T maintains the state and when data is returned back, it looks into its state table and changes the IPv4 header to IPv6 header with the correct source and destination address and sends the data back to the IPv6 network.

This scheme looks simple and good. However, manual mapping of IPv6 and IPv4 addresses for the whole of Internet may not be feasible. We need further technological help. Welcome DNS64.

6 DNS64

So we plan to use a NAT64 in an only-IPv6 network to access the IPv4 Internet. We then need a mechanism that will convert the IPv4 address of a resource into an appropriate IPv6 address as per the translation scheme.

DNS64 (DNS six-four) is that mechanism. DNS64 returns an IPv6 address for every domain name that is queried. In case the queried domain has an IPv6 address, the same is returned. This communication can then happen in a normal way routing packets to the connected IPv6 network. In case, a resource does not have a IPv6 address but an IPv4 address, it creates the IPv6 address for the resource using the pre-configured IPv6 prefix and returns the same. The communication now happens through the translator.

7 Services in IPv6 Railnet

When Railnet will be only-IPv6, we need to understand how the services will be hosted on Railnet. Nowadays most of the services are accessed using HTTP and hence we will limit our discussion to HTTP services only.

Railnet can host services on IPv6. Railnet user and IPv6 users can access it directly without any problem. For making these services available to IPv4 users, we may utilize a reverse proxy on the IPv4 network that will proxy the request to the IPv6 Railnet. This scheme is shown in figure 6.

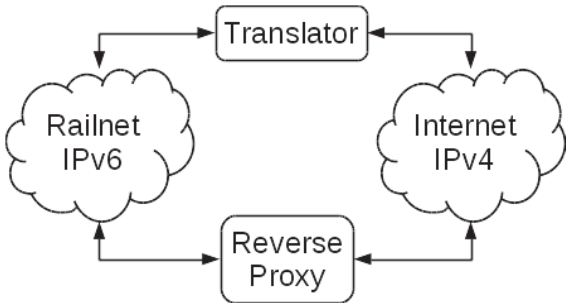

Figure 6: Accessing Services on IPv6 Railnet

8 Conclusion

This article discusses the dual-stack and SIIT/NAT64/DNS64 method for migration to

IPv6. While dual-stacking seems to be simple, it increases the load on a network professional and complicates the network management at the LAN level. Hence, this scheme is not recommended for Railnet.

The SIIT/NAT64/DNS64 method is recommended for the migration to IPv6 as it keeps the local LAN network management simple by having a single TCP/IP driver. The Translators, NAT64 and DNS64 can be deployed at the overall network level at the gateways and can be managed by Railtel Corporation of India Limited (RCIL) that manages the gateway firewalls today.

Railnet can have a Translator, NAT64 and DNS64 at all its Internet gateways in redundancy. RCIL can provide the IPv6 address blocks and Railway Board can plan the IPv6 allocation for all the zones and divisions. It is also recommended that Railway Board commissions IRISET to setup such a gateway in coordination with RCIL to study the scheme and make a lab setup for training Railwaymen about the scheme. This will prepare Railway personnel for the migration and will also allow IRISET and RCIL to study problems that may arise if any.

References

[1] *IP/ICMP Translation Algorithm.* RFC 7915, 2016.

[2] *Sateful NAT: Network Address and Protocol TRanslatrion from IPv6 Clients to IPv4 Servers.* RFC 6146, 2011.

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[4] *DNS64: DNS Extension for Network Address Translation from IPv6 Clients to IPv4 Servers.* RFC 6147, 10-Oct-2017.

[5] *JOOL.* http://www.jool.mx, 10-Oct-2017.

The information / views expressed in this paper is of the authors and are based on their experience. Comments / observations may be sent to the author at rakeshirsse@gmail.com.

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