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Internet Protocols: Migration towards IPv6

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ABSTRACT: IP addresses are basic to the operation of the Internet, and their ease of use is vital to ensuring the future growth of the global Internet. almost 90 per cent of IPv4 addresses have already been allocated and there is a global need to deploy the new version of IP addresses, IPv6, to scale the Internet to the next level and sustain the global Internet expansion. As mobile Internet and broadband becomes more widespread, there is an urgent need for IPv6 networks and devices to be available. We are in the last few laps of IPv6 adoption / IPv4 exhaustion. Here we considered the issues like adoption of IPv6 by Internet Service Providers, the problems associated by IPv6 adoption in ISPs. This paper would outline the key issues and problems being faced by the Internet Service Provider community.

KEY WORDS: IPv6, DNS, Tunneling, MPLS6PE, IP.

I. INTRODUCTION

The Internet has quickly grown to become a basic infrastructure for economic and social activity around the world. The Internet Protocol (IP) specifies how interactions take place between one device and another through an addressing system. The Internet technical community has successfully supported the Internet's growth by managing on the technique of IPv4 Internet addresses through open and transparent policy frameworks, for all networks to have address space sufficient to meet their needs.

IPv4 and IPv6 networks are different types. IPv6 is not backward compatible with IPv4. IPv4 hosts and routers cannot directly deal or get connected with IPv6 traffic. The Internet today is almost running entirely on the platform of IPv4. There are IPv6 networks around the world but they are quite scattered. The Internet cannot switch overnight from IPv4 to IPv6. Therefore it is essential that both the concepts of IPv4 and IPv6 networks are able to talk to each other and the co-existence will be there for years to come. The most effective and popular technique of IPv6 transition mechanisms include dual stack concept, tunneling and translation.

In India, for provision of Internet Access services, there are around 337 Licensed Internet Service Providers (ISP) and 15 Unified Access Service Providers (UASP) operating on a regional basis or with Pan India License REF. 90 % of the retail Internet services are being provided by the top ten Service Providers. **Figure 1**.source- www.trai.gov.in. Technology wise Broadband Penetration in India may be seen in Figure-1 below in which only about 2.15% is Wireless as 3G and

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Broadband Wireless Access networks are still in the planning and roll out stage. The business case for IPv6 is fast



Figure 1. .Technology wise Broadband Penetration in India

developing on the basis of technical revolution namely Internet of Things by which objects and devices are being connected to large data basis and networks through the Internet using the advance features of IPv6. The application such as Radio Frequency Identification Device (RFID) in various fields like supply chain management for large retailers, e-health applications, location based services, e-governance services is going to generate astronomical demands upon the addressing system which can be fulfilled only by IPv6. [1]

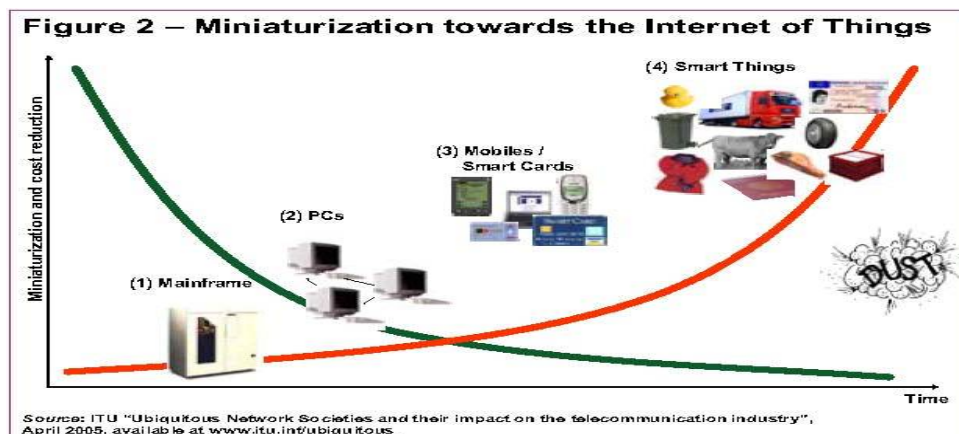


Figure 2. Miniaturization towards the Internet of Things

This paper is organized as follows. Section II deals with the IPv6 features in brief. Section III describes the various stakeholders in the IPv6 Ecosystem. Section IV describes the IPv6 transition techniques. Section V describes Migration challenges for ISPs and the path forward. The final Section VI is about the Transition techniques and steps required to be taken for catalyzing the IPv6 migration process in India.

II. IPV6 FEATURES

The most significant improvement is the increase in number of bits used for addressing, from 32 in IPv4 to 128 in IPv6, which provides more than enough globally unique IP addresses for every networked device on the planet. IPv6 provides a host of other benefits ranging from Address Auto configuration to Multicast enhancements.

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In addition to having a wider or a larger address space, IPv6 has many default features built-in which are crucial to the continued stability and growth of interactions and exchange over the Internet. These include:

1. Improved and/or cost reduced network management for large enterprises and providers suffering from dwindling IPv4 private address space;
2. Simpler and more efficient peer-to-peer and VoIP communications;
3. New protocol mechanisms (e.g. “auto-configuration”) to ease the deployment of devices on networks without a priori configuration. Sensors, smart grids, small devices, mobile and adhoc networks can all be deployed more readily and in a large scale way with IPv6;
4. Embedded security at the transport level for secure end-to-end communications and a higher (default) level of security on public networks;
5. Enhanced Quality of Service (QoS) enabling the existing consumers, enterprises and providers to use the experience superior QoS for the delay sensitive services and traffic; and
6. Embedded support for mobility for existing and future client devices (e.g. smart phones, vehicles, aircraft in flight, sensors and sensor networks).

III. IPV6 ECOSYSTEM AND STATUS

The IPv6 transition techniques can be broadly classified under the following four categories: IPv6 is not backwards compatible with IPv4, and as a reason IPv4 systems cannot use IPv6 services or communicate technically with IPv6 hosts. The transition from IPv4 to IPv6 is expected to take a significant amount of time. As long as systems require interoperability between IPv4 and IPv6, transition mechanisms are needed

The adoption of IPv6 is a function of a complex set of interactions and dependencies

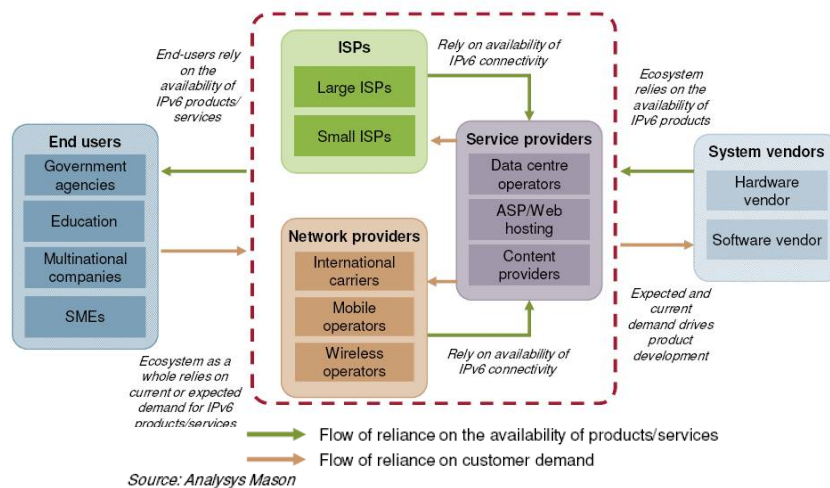


Figure 3. Adoption of IPv6.

IV. IPV6 TRANSITION TECHNIQUES

In the transition environment, three different types of hosts exist: IPv4 only, IPv6 only, and dual stack IPv4/IPv6. Transition mechanisms support interoperability between IPv4 and IPv6 hosts. Multiple transition mechanisms may be deployed with any IPv6 transition. Client capabilities, the particular transition strategy chosen, time frame, and the transition stage all impact which transition mechanisms make the most sense. Transition mechanisms fall into three categories:

- Dual stack

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- Tunneling
- Translation.

Dual Stack:

Out of several IPv6 transition mechanisms, dual stacking is one important mechanism that allows hosts and routers to simultaneously run both IPv4 and IPv6 stacks. The IPv6 and IPv4 stacks function independent of each other while running on the same sets of IP devices. This technique is applicable for Services providers who have equipments that support IPv6 all across the network.

IPv6 over IPv4 tunneling:

This is one of the simplest coexistence mechanisms where the IPv6 packet is encapsulated into an IPv4 packet and routed across the network as an IPv4 packet [3]. This mechanism can be very rapidly deployed just by creating tunnels in the edge of the networks and is most suitable for IPv4 based enterprise / service provider backbones. This technique is applicable for Service Provider that do not support MPLS and have legacy equipments in the path that do not support IPv6.

IPv6 over MPLS 6PE:

MPLS 6PE enables IPv6 islands to communicate with each other over an MPLS/IPv4 core network using MPLS LSPs (Label Switched Path). This method relies on BGP extensions in the IPv4 network Provider Edge Routers (6PE) to exchange IPv6 reachability information along with an MPLS label for each IPv6 address prefix announced. MPLS 6PE is the preferred option for IPv6 transition for those service providers that have an MPLS based backbone network. This technique is applicable for Service Provider that support MPLS and have legacy equipments in the path that do not support IPv6 in the Core network.[6]

Translation:

Translation consists of transforming IPv4 or IPv6 packets into the other protocol so they can be routed or transmitted across a network. Network Address Translation—Protocol Translation (NAT-PT) allows IPv6 and IPv4 devices to communicate via an intermediate translation device. Transport Relay Translator (TRT) is another mechanism to allow IPv6 hosts to communicate with IPv4 hosts through an intermediary. Translation mechanisms (IPv4 to IPv6 and IPv6 to IPv4) introduce new methods to construct networks and systems and thus enlarge the set of possible attacks against those networks and systems. This is the least preferred method in IPv6 migration / transition [7].

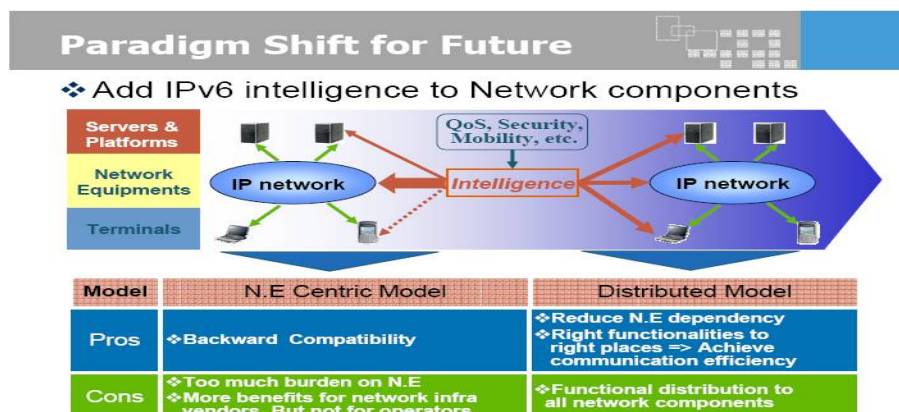


Figure.3.1 Source-CST-Report

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V. IPV6 MIGRATION CHALLENGES FOR ISP

In India, the process for migration from IPv4 to IPv6 was initiated by the Telecom Regulatory Authority of India (TRAI). ISPs providing Pan Indian Services have already upgraded their backbone transport networks to be IPv6 ready. It was also stated that until customers begin demanding, most ISPs have no incentive to incur any major additional costs. However, due to the anticipated shortage of IPv4 resources, Department of Telecom, Government of India launched informative awareness programs across the country for all the stakeholders during 2009. The efforts by the Government culminated finally in form of a National IPv6 Deployment Roadmap have been issued by DoT in June, 2010 for enabling IPv6 migration in the networks of Telecom Service Providers. Nine Working Groups have been established by DoT comprising of representatives from the various organizations like major ISPs, smaller ISPs, various associations, vendors to All major Telecom Service Providers. Telecom Service Providers in India are now planning for the deployment of IPv6 in their networks in India under the active monitoring of Department of Telecommunications (DoT), facilitate the process.

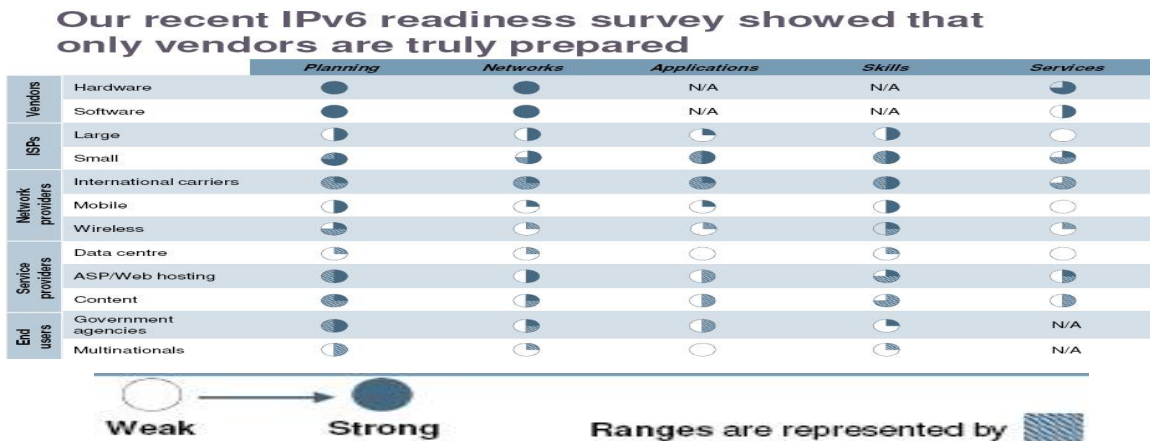


Figure4.IPv6 Readiness survey

Government of India in capacity of being Licensor of Telecom Services. The allocation of IPv6 resources in India has also grown over the period as is evident from Ref.: [4].

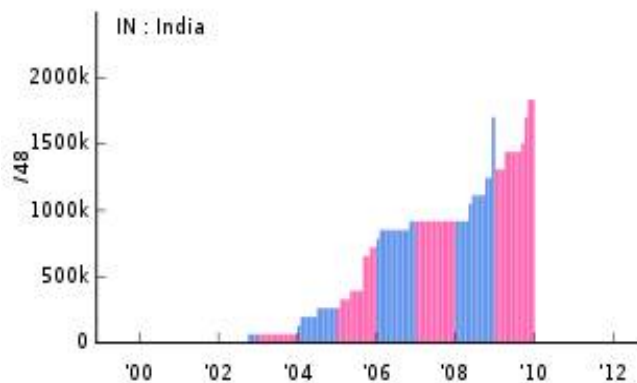


Figure 5. Allocation of IPv6 in India

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The challenges involved in the migration process for a typical Service Provider network in India can be identified as:

- a) Dimensioning and Assessing the Network and Market – This involves assessing the impact of IPv6 migration on the service provider's infrastructure, hardware including CPEs, software, applications etc. On the customer side it means impact on their hosts, servers and applications. It also means assessment of the market for IPv6 by the Service Provider.
- b) Network assessment dimension (for core network, access network, user device) – The equipments in the different parts of the network have to be checked for upgrade, the cost of upgrade and also the planning for a phased upgrade without disturbing the commercial traffic on the network.
- c) DNS/NMS – The DNS servers have to be converted to dual stack. DNS must be able to handle AAAA records for IPv6 in addition to the A records. The NMS needs to be evolved before IPv6 implementation. In dual stack networks both IPv4 and IPv6 have to be managed in optimized and effective way.
- d) Security assessment – The network has to be protected against threats. It needs to be checked for support of IPv6 based standard, reflexive and ACL. To check for IPsec, OSPFv3, encryption. The firewall should support both IPv4 and the IPv6 packets. The system also needs to be checked for other security features built for IPv4 and whether they will work with IPv6.
- e) OSS/BSS challenge – This includes checking of customer portal (web portal, helpdesk), AAA/LDAP support, Mediation/billing, VCM/COM etc., OM/IM, legal interception, FCAP etc.
- f) Other challenges like customer readiness/awareness, investment, operational cost, training and human resources. Path Forward: Suggested IPv6 Deployment Strategy/Design [8].

IPv6 implementation would be carried out in 3 phases - Providing IPv6 at the access level, running IPv6 within the core infrastructure, interconnecting with other IPv6 service providers. Various migration strategies would include deploying IPv6 over IPv4 tunnels, deploying IPv6 using dual stack backbones. Since the networks of large Telecom Service Providers are mostly Multi Protocol Label Switching (MPLS) based therefore the IPv6 will have to be deployed over the MPLS backbones. This is also the fastest up gradation because it requires fewer backbone infrastructure upgrades and lesser configuration of core routers. It is also a very cost-effective strategy. There are different methods for deployment of IPv6 over MPLS backbones [9][10]

- a) IPv6 using tunnels on the CE (Customer edge) routers
- b) IPv6 over a circuit transport over MPLS
- c) IPv6 on the provider edge (PE) routers (known as 6PE) – this is also the best alternative implementation.

IPv6 Deployment Options

Today's popular scenario in the SP networks consists of the following:-

- a) Core – It is either Native IPv4 or MPLS with associated services
- b) Services – These are MPLS L2/L3 VPNs, QoS or L2TPv3, QoS, Multicast..., Data Centre, Consumer Services etc.

If an ISP has to be successful in integration, all the above have to be IPv6 compliant. Various deployment options in the SP core are-

- a) For Native IPv4 environments
 - Tunnel IPv6 in IPv4
 - Enabling dual-stack
 - Native IPv6 with dedicated network resources
- b) For MPLS environments
 - IPv6 Provider Edge solutions
 - IPv6 MPLS VPN solutions

Since most of the service providers have an MPLS environment therefore the IPv6 PE (also called 6PE) solution is most appropriate.

For the Service Providers that do not support MPLS and have legacy equipments that do not support IPv6, the preferred co-existence mechanism would be IPv6 over IPv4 tunneling.

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This is one of the simplest coexistence mechanisms where the IPv6 packet is encapsulated into an IPv4 packet and routed across the network as an IPv4 packet. This mechanism can be very rapidly deployed just by creating tunnels in the age of networks and is more suitable for IPv4 based Enterprise/Service Provider backbones [5].

VI. CONCLUSION

The type of IPv6 Transition techniques deployed by an ISP will largely depend upon the size of the network, services provided and the anticipated demand for IPv6 based services. It is recommended that the larger ISPs i.e. those having Pan Indian License with portfolio of enterprise services will have to resort to combination of transition techniques including using IPv6 over MPLS 6PE and Dual Stack at the edge of their network. In case of the smaller regional ISPs, Dual Stack transition mechanism is recommended as the same is observed to be most popular across various regions in the world.

The IPv6 migration in India has been hampered due to the considerations of cost implications, lack of user demand, lack of vendor support, technical problems etc. It is recommended that Government of India should persistently follow up with all the stakeholders like Service Providers, Vendors, Content Providers, Government Enterprise Networks in order to ensure the timely IPv6 readiness for the Internet community in India. It is recommended that the Government should ensure IPv6 readiness as per targeted time frame of December, 2011 of all Service Providers by issuing appropriate Regulations.

IPv6 technology delivers an array of business benefits and is not limited to an inexhaustible pool of IP addresses. It is also important to note that IPv6 migration is non-disruptive and allows for a peaceful coexistence of IPv4 and IPv6. It is clearly evident that we are now in the penultimate phase of IPv6 adoption and it is essential for businesses to start taking steps towards IPv6 transition if not done already and Smart Phones.

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