Introduction

Today Internet plays a big role in every aspect of our lives and IP acted as an important pillar of Internet. Since its inception the Internet has reached almost all corners of globe and it would have not been easy without IP as a major protocol of TCP/IP suit.

The present version of IP i.e. IPv4 has played its big role in spreading Internet and Internet based applications for more than 20 years. Now it will handover the stage to its more powerful successor IPv6. In the coming sections the need of migration to IPv6 from IP4, the advantages of IPv6, challenges and migration strategy would be discussed.

Migration to IPv6 from IPv4. Is it necessary?

There are many reasons for migration from IPv4 to IPv6 and in near future it would not be an option but compulsion.

Unavailability of IPv4 address space:

The main reason for migration to IPv6 is scarcity of unique IP address for global use. To understand this problem let us have a close look in IPv6 addressing and limitations.

IPv4 address is a 32 bit binary value represented in 4 parts. Hence total number of IP addresses possible is 2^{32} i.e. roughly 4.3 billion. Again these IP addresses were originally identified as certain classes as per the table below.

Class	Range	Number of hosts in network	Remarks
A	0- 126	16.7 million	
B	128-191	65,535	
C	192-223	255	
D	224-239		Multicast group cant be used in host addressing
E	240-255		Reserved for experimental use.

Apart from class D and E there are some more pool of addresses, which are kept reserved and cannot be used for global unicast addressing. Those are 127.0.0.0 /8, 10.0.0.0 /8, 172.16.0.0 / 16 and 192.168.0.0 /24. So a large number of ip addresses are always unusable for practical purpose.

During the era of classfull addressing entire blocks of class A and B were assigned to big and medium sized companies. One of such class A may have 16.7 million of hosts. Any network having those many numbers of users is practically impossible. (E.g. MIT was assigned one such address blocks.) Huge numbers of IP addresses are wasted inside the network for such unplanned allocation. In present day ISPs provide only a part of the classfull networks to their customers as per their need by means of VLSM and CIDR. This saves a considerable number of addresses from being waste. But those large networks, which are already allotted to the organizations in early days, are still kept by them and cannot be reused.

The Internet has exponential growth trend and a huge number of IP address is required to sustain that growth Moreover Telecommunication industry is also rapidly changing from conventional circuit switched to purely packet switched networks. Big Telco's have already deployed NGN to support wide variety of services like VoIP, 3G, VoD, IPTV etc. Newer technologies like Smart Home, Remote surveillance, GPS etc are also coming in big manner. All of

such new technologies and services demand for huge number of IP addresses because all of end devices would require their own unique global IP address.

Some of the methods are often used to solve the problem of limited availability of IP addresses like proxy and Network Address Translation (NAT). None of the methods are well scalable. These may serve the purpose for general Web browsing but for real-time applications these are not a viable solution moreover these creates one-way communication and also incorporates process.

The main driving force for migration to IPv6 from IPv4he is scarcity of address but other factors are also reasonable in this regard.

Multimedia traffic handling:

IPv4 supports unicast, multicast and broadcast where the broadcast has limited significance in today's real world. Moreover broadcast may create excessive traffic in the network and other problems. The demand of today's multimedia application is better group communication procedure which IPv4 is capable but with limitations.

Routing management:

Packets are routed in IPv4 network by the destination IP address and path section is done in hop-to-hop manner. But sometimes it may be important to route packets based on the source IP address, or to select the entire routing path. Though some of the router manufacturers allow policy-based routing based on source addresses but may not be possible in cross-platform environment. Moreover IPv4as in general has no capability of source influenced routing.

Mobility:

Today’s consumer demands more mobility with their mobile devices and applications. Mobile IP routing may offer some limited mobility but are complex to implement and manage

Packet handling:

During the early ages the Internet routers were need to handle traffics in the range of Mbps. Today the Gbps limit is already touched and in near future the routers would require to work with Tbps range. So the protocols that bind the WWW should also be capable of improving the packet handling capacity of the network. But legacy IPv4 does not have any consideration towards it.

Security:

Security of communication is big concern for both network engineers and end users. But for security and encryption TCP/IPv4 has to depend on some other protocols like IPSec etc as IPv4 does not have any inbuilt security mechanism.

Advantages of IPv6 over IPv4

Bigger address space:
The IPv6 uses 128-bit long address in comparison to 32 bit in IPv4. So total number of possible unique address is 2^{128}! This is near infinite and there would be no sacristy of unique addresses for perhaps many years to come!
The ISPs assign IPv6 to their customer with a prefix length of /64 this means such network may hosts 2^{64} number of clients, more than sufficient for even the biggest organization of the world!

Better Multimedia transmission without broadcast:
There is no concept of broadcast in IPv6 networks. It manages multimedia and other group transmission by multicasts and a new concept "anycast". These two modes can handle Multimedia in a much efficient manner.

Better address management inside network:
In IPv6 a client may be assigned an address by manual configuration, DHCPv6 and stateless auto configuration. Later is a new concept in IPv6 where an administrator does not even have to configure a DHCP server to allot IPs to the clients. Rather the clients calculate its own IP address based on some logics performed on its MAC address and prefix supplied by router. This may reduce management overhead of administrator.

Better packet handling:
IPv6 header is always of fixed length so hardware based processors may be used for packet handling. As the acid-base processor is faster and more efficient than software-based processors it improves the overall packet handling capability of the network.
In IP for network there is no method by which the maximum packet size that can be transmitted from source to destination can be determined. The transit routers are more often busy in fragmentation and assembly of packets while switching across interfaces with different MTU size. In IPv6 the new MTU discovery feature helps source to find out the optimum MTU size in the path up to destination. So the source send the packet with optimum size along the path and the transit routers do not need to fragment. This considerably reduces the overhead and process delay.

Inbuilt security and encryption:
IPv6 offers inclusion of authentication header inside the packet and encryption of payload for secure transmission. This eliminates the need of PPP-based authentication and IPSec based encryption. VPN can directly be built from the client machines itself without any need of additional hardware and software.

Challenges in IPv6 deployment in today's world.

Availability of IPv6 resources:
The Internet as grown on IP for and it is still running on it. Though some of the big names like Yahoo, Google started offering their services such as mail, web etc on IPv6 platform but the majority of the organizations have not hosted their websites, mail servers, DNS servers etc in IPv6. So even though the IPv6 address is plentiful but the Internet resources are limited in number

Network compatibility:
Since the header structures are different IPv4 and IPv6 are not interoperable. This means for successful communication between two clients both of them must be running on IPv6 and the intermediate network should also be capable of forwarding IPv6 traffic. But only some of the major ISPs around the globe have deployed Internet backbone. So the customers even after getting IPv6 prefixes from regional registries and enabling those inside their own network are like isolated islands because the upstream ISP does not offer IPv6 connectivity to the Internet.

Compatibility in legacy equipments:
Many of the legacy equipment do not support IPv6. Though some of the vendors offer free upgrades of equipment for compatibility but some of the older version of equipments may still not support it.

The present days routing protocols are not capable of routing IP six enable packets and special parts and of such protocols are to be used. For example OSPF V2 and the 54 do not support IP so we shall use OSPF V3 and in the BGP.

Lack of awareness:
There is some misconception among the user and network administrators that since IPv6 address is long, managing such an address space is difficult and completed. Those who are already running with IPv4 network failed to understand the need of migration to IPv6. The business houses and operators are still not aware of the potential of it as a positive catalyst for their business so they are reluctant to change.

Strategy for overcoming challenges.

Coexistence of both:
The networks and data centers may user both the version of IP inside the same network and infrastructure. This is known as dual stacking. In a dual stacked the network, equipments are addressed with both IPv4 and IPv6 addresses. Whenever communication is required for any of the protocols the relevant version is used. For example DNS server running on dual stack replies the IPv4 client by using conventional IPv4 and the IPv6 client by using IPv6. That dual stack router runs routing protocols for both version of IP and routes the specific version of packet by using the corresponding routing table.

Tunneling:
If the upstream ISP does not support IPv6 IPv6-IPv4-IPv6 tunnels can be created to connect two remotely located IPv6 networks. It is analogous to connecting to isolated islands by using sea bridge. The IPv6 packets are carried over IPv4 network transparently from one network to another

Compatibility:
Most of the modern operating systems like Windows XP have included IPv6 in the TCP/IP protocol stack. So almost all the clients to the running Windows XP and onward can be considered with IPv6 without any additional installation and it is same for Mac and latest versions of Linux also.
The major equipment manufacturer like Cisco, Juniper etc offer free upgrade of IOS to make the existing routers IPv6 capable.

Proxies and NAT:
Though NAT is not required in IPv6 but as a temporary migration tool NAT and Proxies can be used to connect IPv6 and IPv4 networks.

Conclusion

IPv4 is not an inferior protocol. It has played a major role for last 20 years in the growth of Internet. It has got some limitations and for that reason IPv6 has come to take its place. Though the growth of IPv6 is not very huge till now but it is growing fast. Migration to IPv6 is inevitable and in coming years all of the organization will migrate or will be forced to migrate to IPv6 for their own business interest.

IPv4 has brought revolution to the communication and IPv6 will keep doing the same for many coming decades or perhaps centuries. In coming years almost every object we see around will be IP enabled; be it a car, a microwave, a washing machine or something else . and IPv6 will provide unique identity to those.