

Annex-A

Internet Protocol version 6 Monitory Group



Pakistan Telecom Authority

Headquarters, F-5/1, Islamabad

www.pta.gov.pk

Foreword

Internet Protocol (IP) has emerged as the most popular communication protocol in today's world. With the original scope of delivering Data packets, IP has evolved tremendously over the period and is now being utilized to offer "triple play bundled" services by telecommunication operators.

With the advent of new enriched applications and services, a rapid adoption of IP-based platforms (especially the Internet) is being observed. The situation is resulting in massive allocation of IPv4 (the present version of Internet Protocol) addresses and as a result reduce address space unique public IP addresses. To overcome this alarming situation, IETF (Internet Engineering Task Force) defined the next generation version of Internet Protocol (IPv6) in 1998.

Global IP allocation data estimates an IPv4 exhaustion point some-where in mid 2012. In view of growing importance of Internet Protocol for smooth presence of global communication, countries have started necessary work on transition of IPv6. Pakistan Telecommunication Authority (PTA) formulated a small industry group to calculate estimated depletion timeline of IPv4 in Pakistan and suggest necessary Policy and Regulatory areas to promote IPv6 adoption.

IPv6 Monitory group was formed in October 2009 to advise PTA on IPv6 and associated areas of consideration. The group has developed recommendations to contribute to the IPv6 proliferation and encouragement. This report highlights the status of IPv4 allocations, estimated depletion timeline and the principal areas of action.



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Executive Summary

Internet Protocol (IP) addresses are unique numeric identifiers that are required by every device looking to communicate over the Internet. Today, most of the Internet is addressed with IP version 4 (IPv4) but IPv4 address space is running out due to increase popularity of IP-based applications.

The new version of Internet Protocol (IPv6) arrives not only with massively large address space but some extra features of enhanced routing and security capabilities. International bodies and stakeholders are encouraging the migration of IPv4 to IPv6, cooperation between the Industry and IPv6 capacity building. International Telecommunication Union (ITU) during World Telecommunication Standardization Assembly (WTSA) 2008 passed a resolution 64 stressing the requirement of IPv6 deployment.

Pakistan Telecommunications Authority (PTA) has endeavored to serve the IT and Telecom sector of Pakistan for its growth and development while regulating and promoting new technologies and services. In October 2009, PTA formulated an IPv6 Monitory Group to provide high-level advice on the present status of IPv4 in Pakistan and to come up with appropriate suggestions stimulating the take-up of IPv6. The group was asked to work on three agenda points:

- 1. Calculate estimated depletion Time for IPv4**
- 2. Prepare policy suggestions to MoIT for under-way IPv6 consultation.**
- 3. Prepare regulatory suggestions to PTA for encouraging adoption of IPv6 by Internet Industry.**

The report attempts to wrap the required agenda items in a realistic way presenting the IPv4 addresses scenario and IPv6 implementation suggestions. The group will continue its respective working towards IPv6 research and development activities in the country, ensuring IPv6 readiness well before the estimated depletion time.

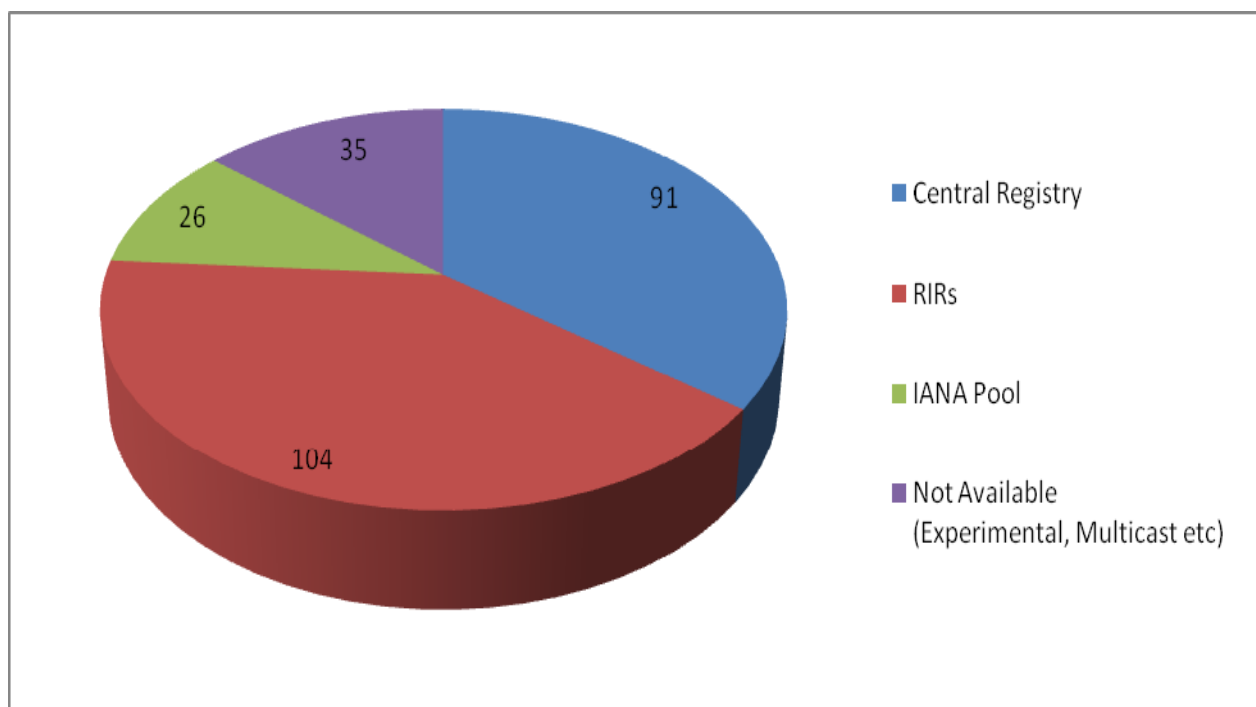


INTRODUCTION

1.1 Global IPv4 Statistics

The fourth revision of Internet Protocol known as IPv4 is the most widely deployed version. It is a 32-bit address with an address limit of 4,294,967,296 possible unique identifiers. These unique addresses are distributed globally through five RIRs (Regional Internet Registries) operating under delegation of IANA (Internet Assigned Numbers Authority).

If we look into the global IPv4 allocation with respect to total IPv4 address space, there are 256 /8 blocks (maximum possible IP blocks) of IPv4 available with IANA. Following chart depicts the status of these 256 blocks allocations as of September, 2009.



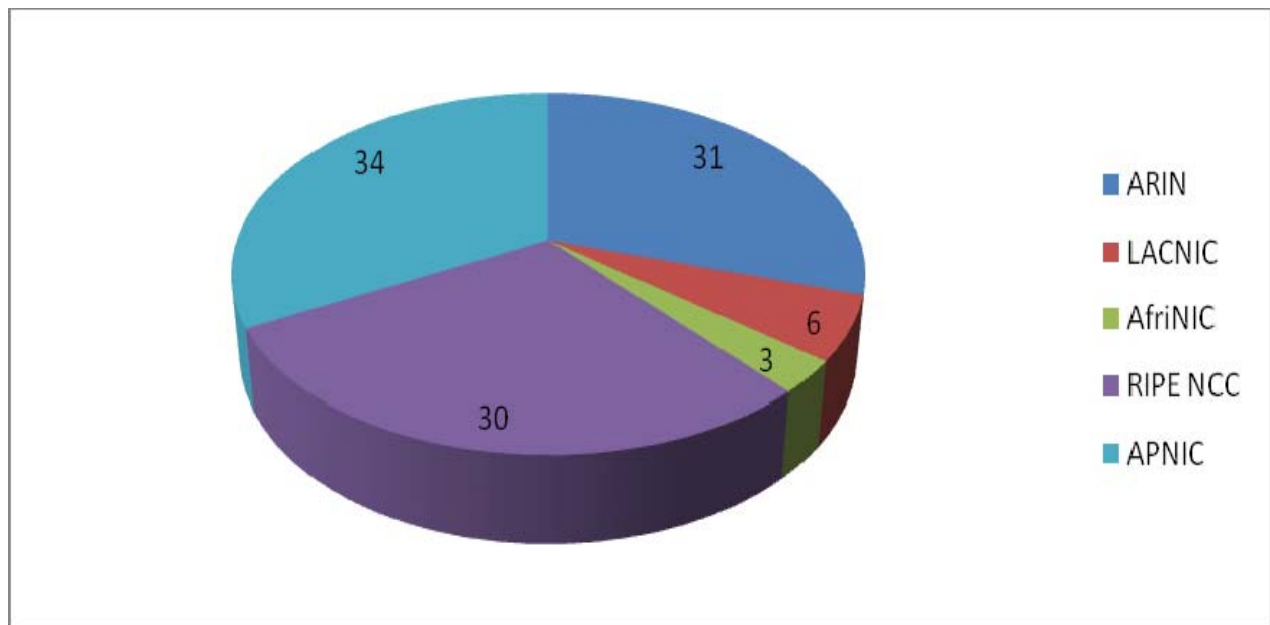
Source: Number Resource Organization (NRO)

It may be clarified that the central registry represents the allocations made prior to the formation of the Regional Internet Registries (RIRs). IANA pool represents the remaining global IPv4 /8 blocks, once allocated the IANA pool is exhausted.



Though to be clear at that point in time there will still be space in each of the RIR pools, expected to be enough to last between 12 and 18 months. This is why experts predict different IPv4 exhaustion timelines for IANA and RIRs.

Going into further details, following pie highlights the respective distribution of 104 /8 blocks allocated to RIRs as of September, 2009.



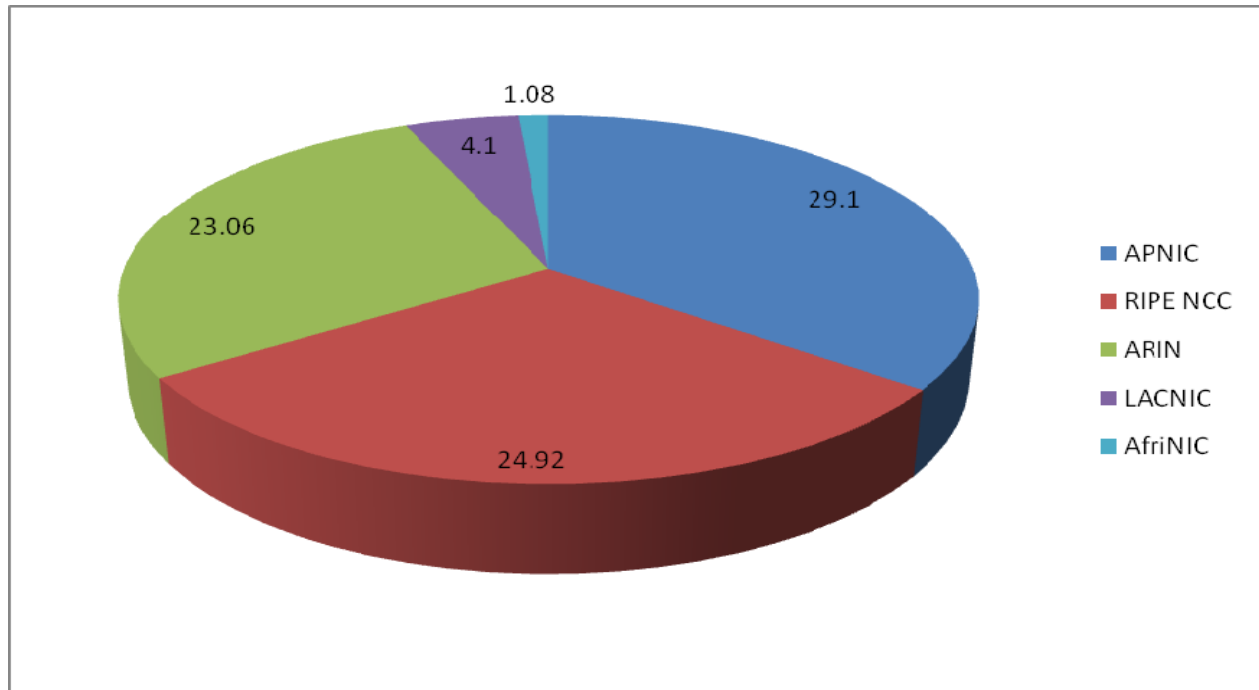
Source: Number Resource Organization (NRO)

These five RIRs are responsible for Internet Protocol addresses distribution in a particular region. Details are:

- American Registry for Internet Numbers (ARIN) for North America and parts of the Caribbean
- RIPE Network Coordination Centre (RIPE NCC) for Europe, the Middle East and Central Asia
- Asia-Pacific Network Information Centre (APNIC) for Asia and the Pacific region
- Latin American and Caribbean Internet Addresses Registry (LACNIC) for Latin America and parts of the Caribbean region
- African Network Information Centre (AfriNIC) for Africa



RIRs issue allocated address space to their customers (members) consisting of Telecommunication Companies, Internet Service Providers and others. As of September 2009, the following pie shows the status IPv4 address space issued by RIRs to their customers.



Source: Number Resource Organization (NRO)

Comparing the allocated and issued address space of RIRs, we can observe that apart from AfriNIC rest of RIRs have issued 70% or more IPv4 address space. The following table presents the details:

Regional Internet Registry	Issued address space (%)
APNIC	85.5%
RIPE NCC	83%
ARIN	74.3%
LACNIC	68.3%
AfriNIC	36%

Looking at the present status of IPv4 issuance by RIRs, it is quite clear that most of them would very soon require more /8 address blocks from IANA pool.

1.2 IPv6 Benefits

Apart from its huge address space, IPv6 has been developed with a bundle of advantages over its predecessor version. The key benefits of introducing IPv6 are:

- 340 undecillion IP addresses.
- Plug and Play configuration with or without DHCP.
- Better network bandwidth efficiency using multicast and anycast without broadcast.
- Better Quality of Service support.
- Native information security framework using IPSec.
- Enhanced mobility with fast handover and better route optimization.

Summary of the comparison between both versions is given below:

Property	IP version 4	IP version 6	Advantage Summary
Address Space	32 bit in length – 4 Billion	128 bit in length – 340 Billion Billion Billion	79 Octillion times more than IPv4 address space
Security	Optional usage of IPSec for data packet protection	IPsec becomes mandatory to protect data packets	Unified framework for security with more secure communication environment
Mobility	Uses Mobile IPv4	Mobile IPv6 provides better router optimization and fast handover	Efficiency and Scalability; Work with latest 3G mobile technologies and beyond
Configuration	Manual or DHCP	Universal Plug and Play (UPnP) with or without DHCP	Low Operation Expense and reduce error
Broadcast /	Uses both	No broadcast, different	Improved bandwidth



Multicast		forms of multicast	efficiency
Anycast support	Not part of original protocol	Explicit support of anycast	Allows new applications
Network Configuration	Mostly manual and labor intensive	Facilitate the re-numbering of hosts and routers	Lower operation expenses and facilitate migration
QoS support	QoS using Diffserv	Flow classes and flow labels	More control over QoS

One of the most significant changes that IPv6 would bring to the Internet is ensuring an 'End-to-End' connectivity model. End-to-end connectivity is a principle design aspect of the Internet that allows nodes of the network to send / receive packets between each other, without requiring any intermediate network element. Presently, this principle theme is not been followed through IPv4 intermediary mechanism like NAT (Network Address Translation) are being used to exchange packets over Internet.



IPv4 – ESTIMATED DEPLETION TIMELINE

2.1 Growth of IP Communication

With the rapid convergence of communication platforms, the distinction between voice, video and data has become thin. Networks are using Internet-style technology - transmission control protocol/Internet protocol (TCP/IP). Circuit-based links are on rise both at commercial and private ends.

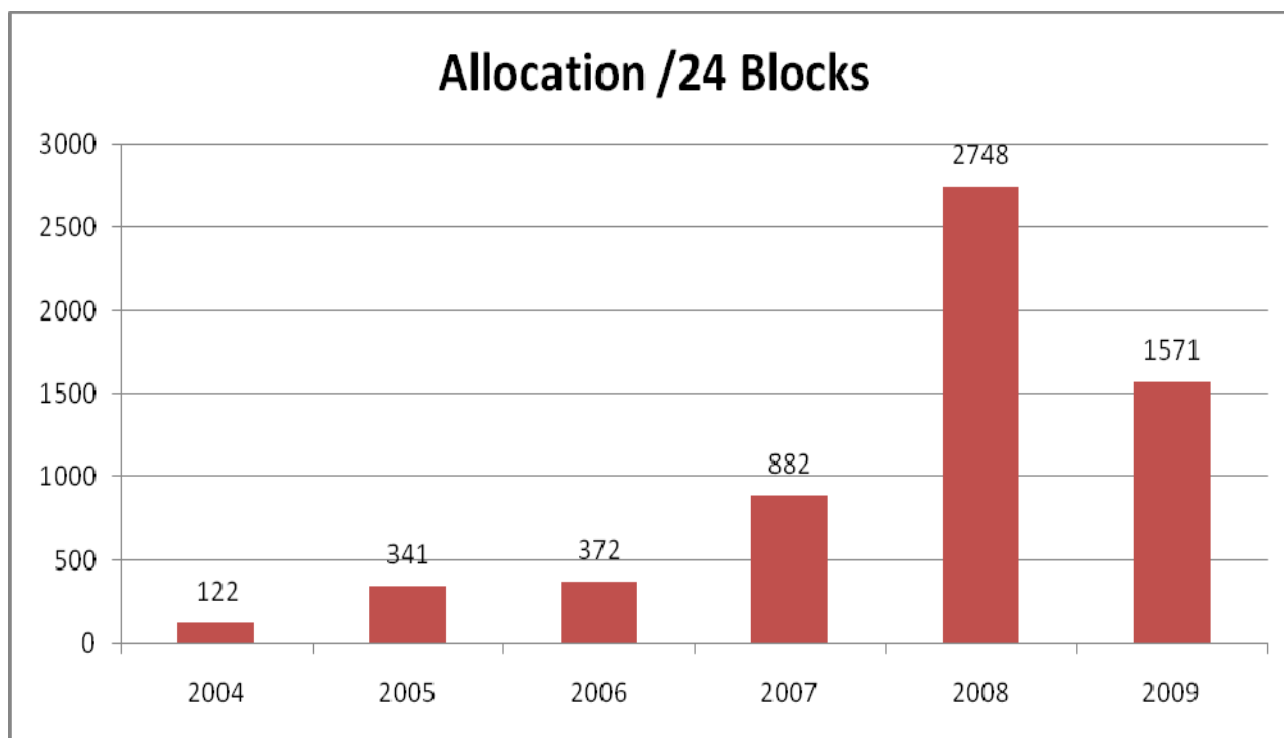
A recently announced Cisco visual networking index forecast (2008-2013) reveals that consumer broadband usage and global IP network traffic continues to climb at an overwhelming pace. According to forecast, Global IP traffic is expected to increase fivefold from 2008 to 2013, approaching 56 exabytes per month in 2013, up from approximately 9 exabytes per month in 2008.

Pakistan has observed tremendous growth in Telecommunication services during last five years. Operators have laid down resilient infrastructure for a host of IP-based services and the communication industry. Our telecom service providers have deployed NGN (Next Generation Networks) at the core-end of their networks and have started offering Triple Play (voice, video & data) services over a single connection to consumers using IP communication platforms. This trend of growing IP-based services has resulted in increase demand of Internet Protocol addresses in the country.

2.1 APNIC Statistics

According to APNIC statistics, the first ever IPv4 addresses block was allocated to Pakistan in 1993, since then IPv4 address are being allocated to APNIC members in the country. Till date, a total number of 6,839 /24 blocks have been allocated to Pakistan. This means that roughly 1.7 million IPv4 addresses are delegated to our Industry; the following graph shows the IPv4 allocation status of last five years.



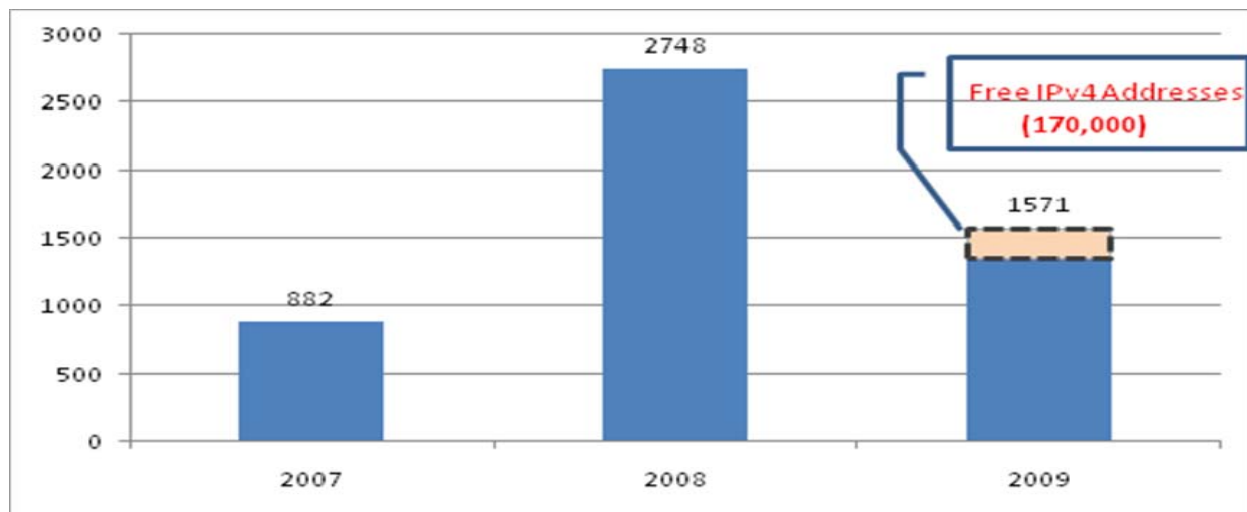


Source: APNIC

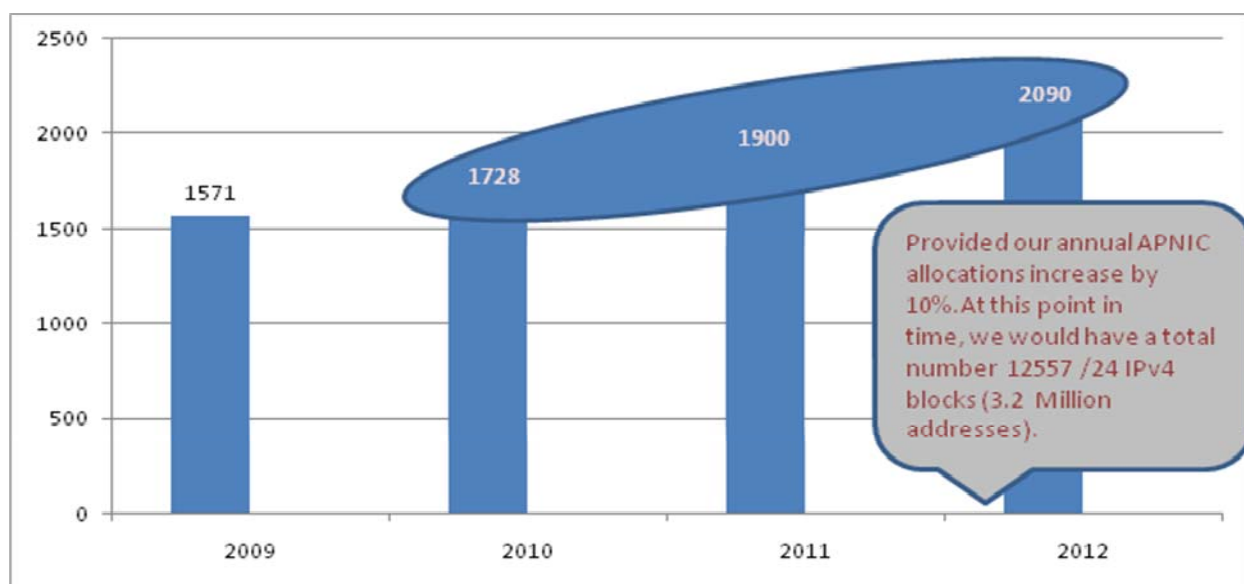
If we analyze the scenario of IP addresses allocations in Pakistan, it will be interesting to note that approx 88% of the total IPv4 address space has been assigned during last five years. This shows the increase supply and demand of IP-based communication in the country. A massive increase in IPv4 allocation can be observed from 2007 to 2008 where the assigned space jumped to 2748 /24 blocks in 2008 from 882 /24 blocks in 2007. It means that during 2008 our Industry requested approx 0.7 Million IPv4 addresses from APNIC. This is a reason why in 2009 the allocated space has reduced to 1571 /24 blocks. Operators did have a large pool of free IP addresses available; thus the requirement for more blocks was reduced.

It may also be noted here that these statistics elaborate the allocated IP address space to Pakistan and doesn't highlights other details like how many of these 1.7 Million IP addresses have been assigned and how many free IPv4 addresses are available presently. However, general views of experts reveal that we are left with approx 10% of total assigned space, means that we have around 170,000 free IPv4 addresses.





On the basis of available statistics, if we predict the future of IPv4 allocations, usage and availability in Pakistan. It can be stated that on the basis of increasing deployment and utilization of IP-based services, our members at APNIC would demand for more IPv4 block allocations in next 2-3 years. Let's foretell that for the next 3 years (till 2012 which is the estimated global RIR depletion timeline), our APNIC members make an average of 10% annual increased allocation of IPv4. Although with the present extension of IP services, future IPv4 allocations are expected to be on a higher side for next 2-3 years. The prediction made would result in approx 12557 /24 blocks in total by 2012. In simple figures, we would have a total number of approx 3.2 Million IPv4 addresses assigned by 2012.



IPv4 Annual /24 Block Allocation - Prediction



This means that while the global IPv4 depletion would take place at RIRs end, we would still be having some good percentage of available IPv4 addresses to be utilized. Assuming the same number of free addresses as we have by today (10% of the total space), we may have around 320,000 free IPv4 addresses available for further allocation by the end of 2012. These 320,000 addresses would be enough to cater our National requirements for at least one and a half year. Basis on these analysis, we can predict that **full depletion IPv4 addresses in Pakistan would happen somewhere in mid-2014. By full depletion it means that not a single operator in the country would have any free IPv4 address to assign.**

Projected IANA Pool Exhaustion – September 2011

Projected APNIC Pool Exhaustion – November 2012

Projected Full Depletion of IPv4 for Pakistan – July 2014

2.3 IPv6 activities in Pakistan

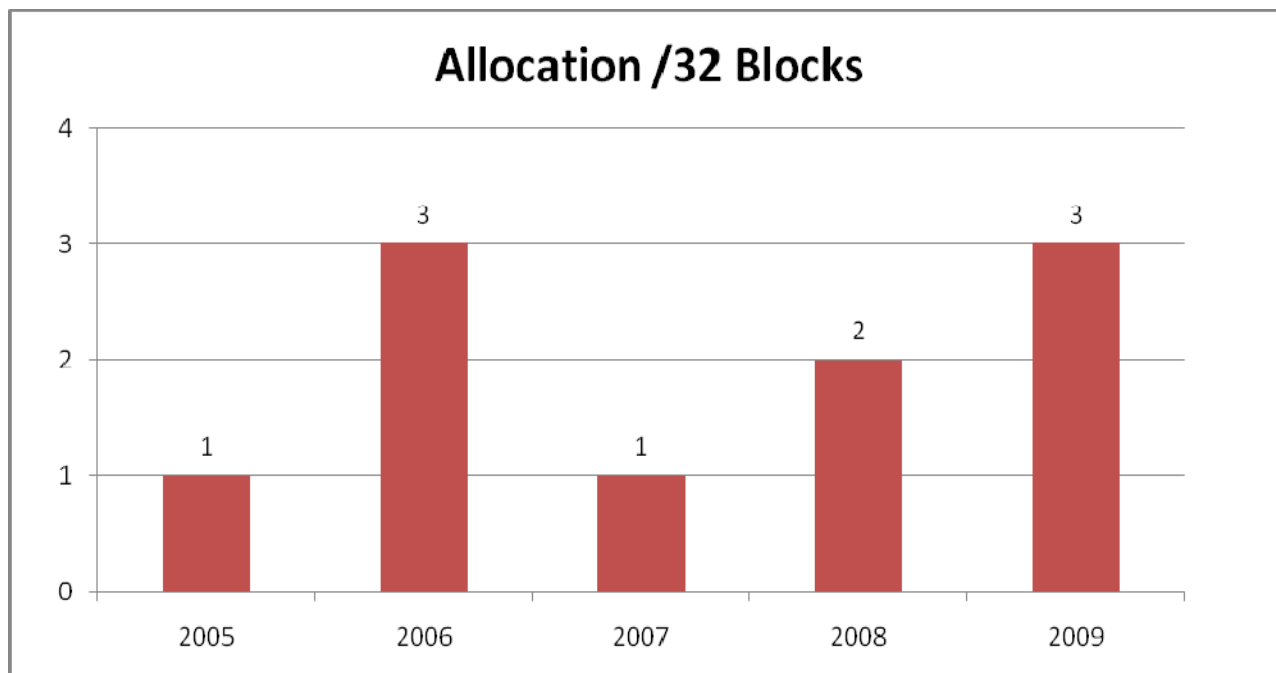
IPv6 initiatives in Pakistan started off in 2006 when three local ISPs (CYBERNET, SUPERNET and DANCOM) decided to get their v6 prefix from APNIC. These ISPs had their initial IPv6 deployment within their own network and established Pakistan IPv6 Task Force (Pkv6TF) to further increase the pace of IPv6 activities in the country.

The Task Force is an independent, locally self-funded activity associated with leading IPv6 experts, organizations and vendors globally. The activities of IPv6 task force are limited to 6Core Project at the moment.

6Core stands for "IPv6 National Core of Pakistan" which is the First IPv6 based project initiated by ISPs of Pakistan. The 6Core is a test-bed network formulized by these ISPs to kick start IPv6 research activities.



2.4 IPv6 Allocation Statistics



Source: APNIC

This shows an appealing scenario of IPv6 allocations in Pakistan where operators have started acquiring the IPv6 blocks since 2005. Although we don't see any utilization of IPv6 address in production but certainly limited test-based configuration is taking place. Below is the table providing details of IPv6 block allocations to Pakistan alongwith the operator name.

Operator	Prefix
Cyber Net	2001:4538::/32
Super Net	2001:fe8::/32
Cybersoft Technologies	2401::/32
Telenor Pakistan	2402:e000::/32
Link Dot Net	2404:148::/32
PTCL	2404:7000::/32
WorldCall	2406:7000::/32
Micronet Broadband	2407:d000::/32



IPv6 – SUGGESTED POLICY & REGULATORY MEASURES

3.1 Role of Government

There is a general perception that market forces may be left responsible to drive the transition from IPv4 to IPv6, questioning why and how Government should be involved for this important change over of global IP addressing.

If we look around the countries who are leading the way towards IPv6 deployment, a common approach is observed which involves all stakeholders, including the operators, technical community, academia, public authorities and civil society. Malaysia is one of such examples where the Government established the National IPv6 Council in 2004 to provide leadership and strategic planning. IPv6 is identified as one of 8 key infrastructure projects for MyICMS 886 (Malaysian Information, Communications and Multimedia Services 886) strategy under the Ninth Malaysian Plan (RMK-9, 2006-2010). Ministry of Energy, Water and Communications ministry issued a comprehensive 'National Strategic IPv6 Roadmap' taking in account the role and responsibilities of all stakeholders.

Government has a pivotal position to increase the awareness, introduce R&D activities and encourage IPv6 deployment. Governments could kick start measures to engage different stakeholders such as establishing test beds, providing incentives; an ideal scenario of deploying IPv6 inside Government's network and services to act as a catalyst for promotion of IPv6 inside private sector.

3.2 Role of Regulator

High-speed Internet broadband is quickly becoming commonplace worldwide and many national regulators have pledged to improve the access and usage of next-generation broadband networks. Since generally, the telecommunication regulator looks after the Internet industry issues, its role for promoting IPv6 transitional activities become even more significant.



Taking an example of such regulatory interventions for IPv6 transition, in 2006, the Telecom Regulatory Authority of India (TRAI) issued its recommendations on transition from IPv4 to IPv6. Salient feature of the document included:

- Definition of IP address mentioned in ISP license to be amended to enable 128 bits to be used as needed for IPv6 based addressing.
- National Internet Registry (NIR) in the country should be established within the framework of APNIC, the Regional Internet Registry.
- Expanding the existing IPv6 test bed of ERNET to make it countrywide and accessible to all interested parties.
- Upgrading NIXI as a national test bed for IPv6 and interconnection among its various nodes to provide access to all the ISPs.

Regulator under its vision of promoting competition and facilitating the Internet industry could play an active leading role towards encouragement of IPv6 adoption by operators, devising strategies for native IPv6 connectivity at International links, offering relative regulatory relaxations to enable IPv6 arrangements within networks and carry on necessary consultative process with the industry on IPv6 issues and challenges.

Based on the respective role of policy maker and regulator, following set of recommendations is proposed by 'IPv6 Monitory Group' through this report.



Recommendations

- i. Increase IPv6 awareness and capacity building by organizing seminars and training programs for university students and professionals.
- ii. Establish a National Internet Registry (NIR) to overlook the IP and DNS management issues in the country.
- iii. Provide some profit incentives to Internet Industry for encouraging them to adopt IPv6 based Infrastructure. These incentives could include reduction in regulatory fee and tax rebates.
- iv. Upstream Internet connectivity providers may be asked to enable IPv6 readiness in their networks.
- v. Necessary funding may provided through agencies like National ICT R&D Fund Co to establish IPv6 research labs for academic institutions.
- vi. An exclusive 'National IPv6 Roadmap' may be devised catering future strategy for IPv6 transition.

