2012

IPv6 - The way Forward for INDIA

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A compilation of Technical and Business Essays along with the quotes from the stakeholders.

Preface

Welcome to the compendium titled IPv6 – The way forward for India. At Internet Society Kolkata Chapter IPv6 issues, awareness and technical capacity development has been one of the core themes on which volunteer energy was used. Similarly over the next few months as well we will take an exciting journey of technical capacity development and will start moving into the north eastern states of India.

So when the world IPv6 launch date was decided and started getting momentum, a void was being felt in terms of absence of a platform / compilation wherein the vast body of knowledge is summarized and a normal Internet user can get interested in the topic of IPv6.

Definitely IPv6 has been a slow start because the momentum which is required can only be bought by the Internet users who were not included in the discussion. So the idea of compilation gathered ground wherein divergent views and works being done and more importantly the thoughts which were going inside for all the activities related IPv6 can be brought under a single umbrella.

Hence this compilation consisting of technical and business essays which are a mixture of theoretical and practical exposure of the respective authors and then a section on Quotes / Messages from the leaders from technical, business, government, civil society in multistakeholder format giving perspective to the entire debate on IPv6 and what's in store for India in the days to come.

June 6, 2012 is a big day in the history of Internet as it is expected that approximately 1% of Internet traffic will leverage IPv6. Let us all join hands together to make it a success.

Acknowledgements

Internet Society Kolkata chapter thanks to all the members and non members who have taken time out from their busy schedule and share articles and quotes which are part of the publication. Special thanks to volunteers who gathered together for making this compendium a success.

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PROLOGUE

INTRODUCTION

The United Nations Secretary General's statement at the opening ceremony of the International Telecommunications Union (ITU) Telecom 99 Conference on 9 October 1999 stated that: "People lack many things: jobs, shelter, food, health care, and drinkable water. Today, being cut off from basic telecommunications services is a hardship almost as acute as these other deprivations, and may indeed reduce the chances of finding remedies to them." The state of deprivation if considered as a parameter of difference between a developed and developing country, then proactive and corrective action is definitely required more in developing countries even in context of Internet addresses. So, when the Ministry of Communication and Information Technology for Egypt says about IPv6: "IPv6 is of particular importance to Internet users in developing countries as it offers great opportunities and opens a new era for the global Internet community", it stands ground.

EXAMPLES & ARGUMENTS

IPv6 is not just additional addresses; it provides a stage wherein the existing and new stakeholders can come together in the era of Internet of Things; leaving behind the insecurities and troubles of IPv4 and simultaneously having the flexibility to build applications with higher Quality of Service levels.

The new features of IPv6 like auto-configuration, Default IP Sec Security, End to End Trust & Mobile IPv6 configuration can be used extensively by the developing countries. For example: The public transport system can be modernized with the entire fleet connected over IP network to have a robust and intelligent transport system; The Rural Healthcare can be streamlined with patients not required to travel from small cities and towns to metros to have primary healthcare; smart grids power systems can be maintained to reduce transmission & distribution loss; and e-learning facility for individual students can be arranged. So IPv6 offers an opportunity to touch the larger public good with initiatives which otherwise have a larger cost and gestation period associated with them.

If we look at the business side of it, then RFID enabled supply chain management system, entertainment business with IPTV can be highly scaled and bring efficiency into the system. The services offered by telecommunication industry live voice, data & video are being offered through convergent platforms and switching to IPv6 enabled platforms will help in reducing

the networking costs and to this extent steps taken for transition from IPv4 to IPv6 are significant ones.

The costs of deploying IPv6 in an organization's technical infrastructure require planning, equipment upgrades, and training which is specific to the needs of the organization's individual networks. IPv6 planning should be integrated into short-, medium-, and long-term planning. Organizations that plan now can build IPv6 support into their normal network upgrade cycles and training budget with little or no additional cost.

CURRENT SITUATION IN DEVELOPING COUNTRIES

The party has begun. Global IPv6 deployment is gaining momentum, reflected by the formation of the IPv6taskforces in many countries. The Government of India is committed to IPv6 deployment and the Indian Government's roadmap requires all telecoms and ISPs to be IPv6 compliant by the end of 2012 and offer IPv6 services thereafter. Key organizations such as ISPAI and NIXI are also deploying IPv6 on their networks and are working closely with APNIC for capacity building.

ROLE OF STAKEHOLDERS

All the stakeholders like Service Provider, Industry Association & forums, Educational institutes, Government Bodies, Software developers, Equipment Providers & System Integrators and System Owners need to contribute for migration. This will help them in retaining the competitiveness in the global economy, innovate new application and services and be aligned with global internet community. "IPv6 needs to be integrated and offered as a service by all ISPs to sustain Internet growth and by the same token drive end-to-end innovation" said Dr. Vint Cerf, Internet Evangelist, Google & Honorary Chair, IPv6 Forum.

CONCLUSION

In the various discussion of Internet Governance, IP addresses have been continuously discussed as critical internet resources and if we go with the ISOC estimates that "more than 2.0 billion people of the world are already online" then the task at hand is to create opportunity for passing benefits of participating in Information Society to the remaining billions, who can be geographically located in either developing or developed country. This

will require an IPv6 enabled Internet which has been aptly described by Dr. Vint Cerf, IPv6 Forum Honorary Chairman, “Take the internet where no other network has been before”.

The basic idea for publishing this compendium is to generate the initial interest in the subject for all the stakeholders of Internet. The objective is to see increased participation in all public policy and technical issues and capacity development from the readers of this book so that India stands out in international forums in terms of contribution at the global stage.

The road to achieve it is definitely neither short nor easy but a step has been made in that direction but invariably huge amount of work remains pending to achieve the same.

This compendium tries to include relevant piece of information about IPv6 to build a comprehensive understanding and form insights.

Anupam Agrawal
Chair
Internet Society India Kolkata Chapter

BUSINESS ESSAYS

India is a large and rapidly developing economy with relatively low Internet penetration; however the percentage of Internet users is quickly expanding. The Indian telecommunications and Internet industries are among the fastest growing markets in the world. The APNIC IP distribution data demonstrates this phenomenon, in terms of IPv6 allocations. During the past three years, India has had among the highest IPv6 allocation rates in Asia and is currently experiencing the fastest growth of IPv6 allocations in the region.

APNIC reached the final block of IPv4 addresses in April 2011, which means IPv4 address space is no longer available in quantities that will sustain network growth.

APNIC reached the final block of IPv4 addresses in April 2011, which means IPv4 address space is no longer available in quantities that will sustain network growth. India's rapid Internet growth can only be sustained with IPv6. The continued increase of IPv6 requests from India is a positive step towards IPv6 deployment. (see Chart 1 "IPv6 address distribution to India (unit /32)").

Real and tangible IPv6 deployment in India

Actual IPv6 deployment in production networks must continue during the next few years, while Indian infrastructure is developing. APNIC's Research and Development team (labs.apnic.net) continuously monitors IPv6 deployment status globally by measuring end users' readiness for IPv6 (i.e. how many end users can access IPv6 online resources via their access networks from their devices). The world average of IPv6 native access ratio is 0.5. Current IPv6 native access ratio in India is 0.03. Please refer to Maps 1 and 2, created by labs.apnic.net.

IPv6 will play a critical role in Indian Internet development, providing new services and business opportunities for large-scale IP network applications - including smart phones, smart grids, Next Generation Networks, and cloud computing – all of which will drive unprecedented demand for IP addresses. This creates enormous opportunity for India.

India's mobile sector continues its dramatic growth observed during the past decade, from 10 million subscribers in 2002 to more than 350 million in 2009, surpassing the rate of fixed-line growth in 2004. Fixed-line services are currently experiencing zero and negative growth rates. [1]In the same way the mobile platform has "leap frogged" fixed-line growth, IPv6 can surpass IPv4 deployment in just a few years.

Its smaller existing base of IPv4 Internet services compared with other large economies gives India huge potential for IPv6 to be a key driver of national Internet growth moving forward. IPv6 is by far the most cost effective way to sustain the growth in Internet subscriptions in India, and it is the means by which Indian products and services can reach the global marketplace. The Indian Government announced its "National IPv6 Deployment Roadmap" in 2010, demonstrating foresight for this potential. The Roadmap provides a good starting point for the commercial deployment of IPv6 services.

APNIC's role in IPv6 deployment

APNIC will continue to focus on outreach and education activities in India, by sharing general and customized deployment information and addressing concerns and issues related to IPv6 deployment. APNIC will also work closely with the Indian Registry for Internet Names and Numbers, IRINN, to support local activities and initiatives. APNIC participated in a number of IPv6 seminars held across India, which were organized by Department of Telecommunications (DoT) and ISOC Kolkata Chapter.

One of the key business issues in deploying IPv6 is that the engineers are still learning how to use IPv6, often while building and managing existing IPv4 networks. Human capacity building is therefore essential. In 2011, APNIC held face-to-face IPv6 related training sessions in India for more than 240 engineers. APNIC also conducts monthly eLearning modules for the region, and these activities will continue to grow and expand.

APNIC also is focused on building understanding on IPv6 issues with Internet stakeholders in India including the government, network operators, and other stakeholders with

[1] India - Key Statistics, Telecommunications Market and Regulatory Overview", Peter Evans March 2012

customized IPv6 messages. For more details, please feel free to contact helpdesk@apnic.net.

In conclusion, the number of IPv6 allocations APNIC makes to ISPs in India has grown steadily during the last few years and is now accelerating rapidly. APNIC will continue to offer these services, and is committed to ensuring this supply is sustained into the distant future.

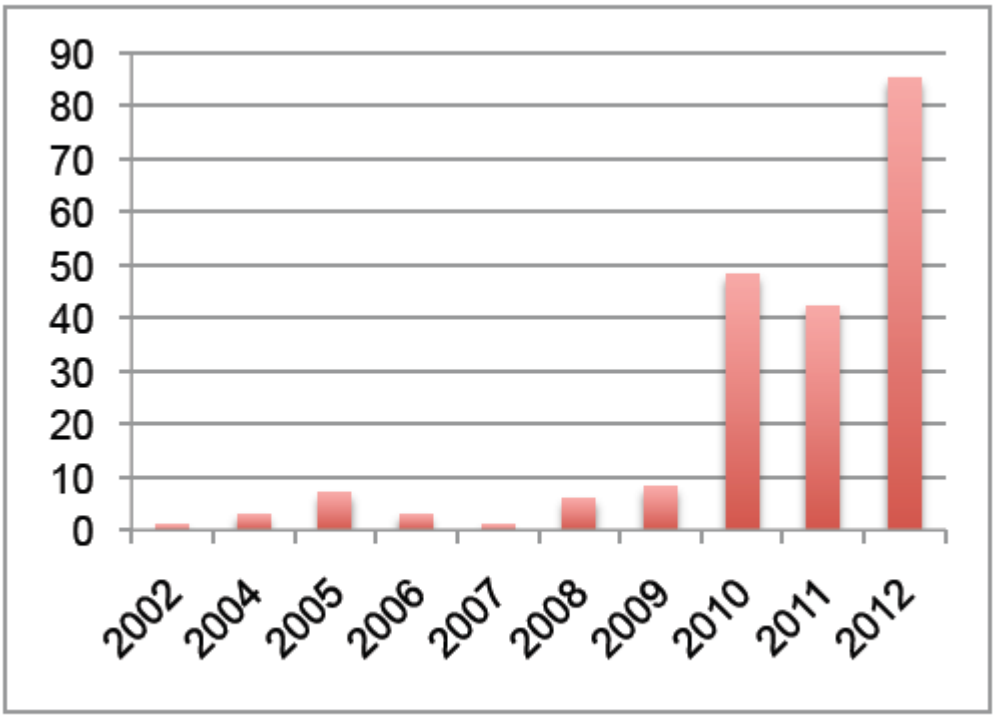
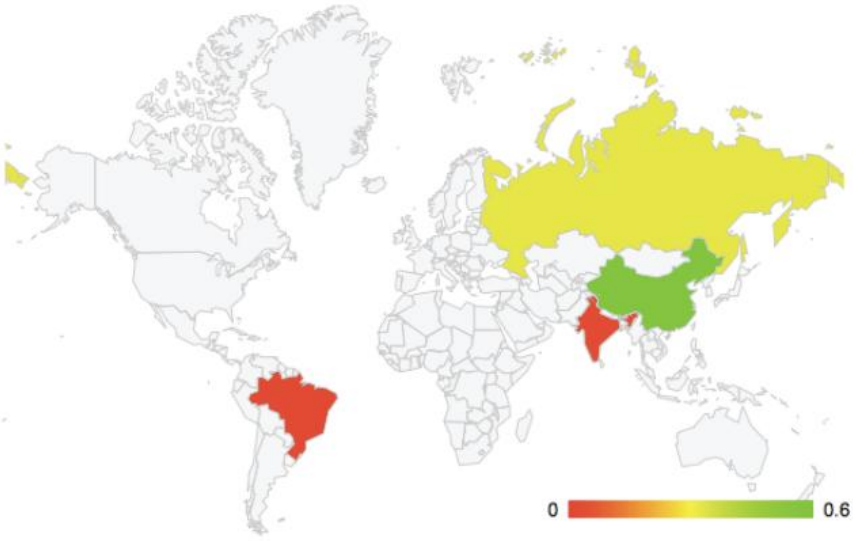
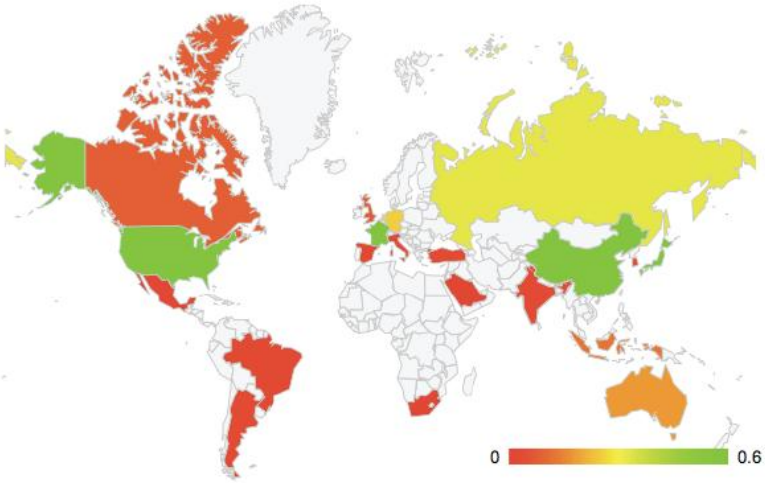


Chart 1: IPv6 address distribution to India (unit /32)



Map 1: IPv6 measurements for BRIC economies (Brazil, Russia, India, China) (http://labs.apnic.net/ipv6-measurement/Organizations/BRIC/)



Map 2: IPv6 measurements for G20 economies (http://labs.apnic.net/ipv6-measurement/Organizations/G20/)

About APNIC

APNIC is an open membership-based, not-for-profit organization that serves as the Regional Internet Registry (RIR) for the Asia Pacific. APNIC serves to ensure the fair distribution and responsible management of IP addresses and related resources within the region.

Every device needs an IP address to connect to the global Internet, and responsible management of these addresses is essential to Internet stability, reliability, and future growth. The Internet is currently undergoing a transition from IP version 4 to IP version 6, which will support Internet growth for decades. APNIC is actively working to support a smooth and successful transition. Other key APNIC services are to maintain the public IP address registry (the Whois Database), issue digital certificates for Internet resources, and manage the critical reverse DNS infrastructure. APNIC also provides extensive Internet technical training and consulting services, particularly targeted towards IPv6 deployment in developing economies.

Business Values of IPv6 in India

IPv6 provides business value in several ways. From a cost standpoint, some features of IPv6 could reduce internal enterprise network and IT operating outlays. From a revenue viewpoint, a variety of sophisticated product plans will be enabled by the abundance of IPv6 addresses.

- Because IPv6 is the technology direction of public and private IP networks, investments in IPv6-based assets are likely to have a longer service life than expenditures on IPv4-only systems.
- Auto-configuration feature of IPv6 improves manageability and reduces network administration costs.
- The richness of IPv6 addresses allows the assignment of globally-unique IP addresses to objects within the enterprise environment, removes the need for private addressing, and consequently eliminates the capital and operating costs associated with deploying and maintaining Network Address Translation devices.
- Greater flexibility and simplicity in IPv6 address plan management comes with the elimination of IPv4 private addressing in the enterprise environment.
- Extensibility for new features arises from the massive IPv6 address space and the extensible structure of the IPv6 header.
- Intrinsic security stems from incorporation of the IP security protocol suite into the IPv6 architecture.
- Enhanced customer quality of experience can be realized by driving automation into every aspect of the enterprise environment using connected smart objects with distinctive IPv6 addresses.
- Telecommunications networks originated as a means to support communications between humans situated in different locations.

The key benefits of IPv6 in India will originate as a significance of the meeting of several contemporary technological developments.

IPv6 networks could decrease the cost of public services by reducing the transaction costs of interacting with the populace. In particular, it would facilitate timely and customized dissemination of information to citizens, and support smart digital identity cards and passports.

IPv6 networks could play a role in optimizing defense procurement and logistics management processes plus aid in real-time tracking of various military assets—including expendable resources in tactical environments.

The telecommunications industry is the backbone of the IPv6 Internet. Because telecommunications operators enjoy the role of intermediaries in the transmission of information within the IPv6 economy, they are uniquely positioned to create new market opportunities that influence their typical situation by offering new types of arbitration and house services.

IPv6 adoption in India could substantially increase the market scope and service offerings within this sector. The technology can be leveraged to develop pervasive, multimedia, multiplayer online games for leisure and education. These games can be played using a variety of ubiquitous mobile and fixed devices.

IPv6 will be a crucial component of intelligent transportation systems in India and is expected to have an immediate impact on the shipment and automotive industry. Mobile IPv6, along with GPS, automatic vehicular guidance technology, and smart speed-control systems could improve safety in the transportation industry. Dynamic tracking of vehicles could reduce costs and increase the efficiency of logistics systems.

The main benefit of IPv6 within this sector will accrue with smart grid technology, which is an initiative presently underway to modernize the electric power system using two-way communication schemes for monitoring and managing the generation, transmission, and distribution of electricity.

The IPv6 Internet could increase the efficiency and effectiveness of medical systems and decrease the cost of health care delivery. Specific applications include remote medical diagnosis, remote monitoring of patients, home-care support, remote consultation with specialists, customized treatment, and disease prevention.

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Proposed Migration Road Map of IPv6 for India

The migration over to IPv6 is a necessity in the long term, but IPv6 is not just about IP address space - there are some other advantages including long-term cost savings and better performance.IPv6 was developed to replace and improve the existing Internet Protocol (IP), the IPv4 in many ways. Among the improved areas are addressing spaces, routing efficiency, header format, auto-configuration, Quality-of-Service (QoS), security and mobility. Although IPv6 promises enhancements to IPv4 standards, its deployment is rather slow in India.

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Road Map for IPV6 deployment in India:

- Facilitate the efforts of stakeholders regarding the adoption and the deployment of IPv6, for instance through awareness-raising campaigns
- Undertaking detailed study for transition from IPv4 to IPv6 environments based on the experience gained through the networks within the country.
- Involve Internet Service Providers to get connected to IPv6 based network and initiate the services within one year.
- Making all major ISPs and major universities / research laboratories in India IPv6 aware: Implement a show case for awareness creation among all stakeholders: users, ISPs, industries, research institutes policy makers and politicians
- To participate actively in the establishment of a nationwide, vendor independent, training and education program on IPv6.

- Making at least 2 large ISPs (both in public and private sectors) ERNET and BSNL, VSNL, Satyam etc. to provide select commercial IPv6 services.

- All major Service providers (having at least 10,000 internet customers or STM-1 bandwidth) will target to handle IPv6 traffic and offer IPv6 services by August-2011

- All Central and State Government Ministries and Departments, including its PSUs, shall switch over to IPv6 services by December-2012. The transition from IPv4 to IP6 will affect many organizations and no organization can bring this change alone.

This article has been submitted by Mr. Jha Rakesh presently is full time Research Scholar at S. V. National Institute of Technology, Surat, INDIA.

TECHNICAL ESSAYS

IPv6 Background & Concepts

When we sent our first e-mail, opened first web page, or started chatting, we didn't know one day we use to operate our bank accounts, book train, bus & hotel tickets, share our real time status over Internet, and beyond that use a tiny mobile device to do all these things. Now we want to control, monitor and manage many aspects or our lives, whether it's our A.C. to be turned on remotely, or to get real time health information of our elderly parents or to track our pet dog. We know we have applications on Mobile, Cloud or Web, offering incredible services that run on Internet.

Internet is the backbone of all these services and to use Internet the devices needed to assign an address for communication. Technically we call this Internet Protocol address or IP address. The address we are using now is version 4, or IPv4. Now that we needed more devices to use Internet services, we needed more people to use Internet, this resulted in exhaustion of IPv4 addresses and now we need to switch to a new addressing scheme called IPv6. This new addressing scheme will open doors for new devices, applications & ideas to be served over Internet and will eventually benefit everyone with better applications and enhanced services.

The need of Internet Addressing

- Addressing is one of the most essential parts of Internet communication. Each device connected to Internet has got one unique address so that it can participate in the communication.
- To receive a message or to send one, one needs to have one sender and one receiver address and a set of rules and protocols for communication.
- Internet uses TCP/IP protocol to communicate among peers and IP (Internet Protocol) address for identification of devices connected to Internet. Currently we are using IPv4 (Internet Protocol version 4) addresses for the addressing needs.

For example when we are connected to Internet our devices are assigned one IP address by our ISP (Internet Service Provider). Our address can be checked by many methods, the simplest one is to open this website http://www.whatismyip.com/. It shows our IP address assigned to the device. For my case this is 122.163.18.126. This address can change each time we are connected to Internet if they are dynamically allocated by our ISP. Now if we

browse web site www.isoindiakolkata.in, we are actually demanding some resources over Internet hosted in a web server which has a numeric IP address, in this case this is 92.242.132.8. So to serve this web site, computers translate theses names into numerical IP address so they can send data to the right location. These two addresses are version 4 of IP addresses and these addresses are exhausting rapidly. So if we don't have new addresses, new services, websites, applications will have difficulties in providing services over Internet and for India where Internet Penetration is very low and growing in a rapid speed, migration to IPv6 is an utter necessity for the long run.

Private Vs Unique IP Address

IP addresses are the numbers that identify devices connected to a network. If our device only needs access to a local network, it can be identified with an address that has only a local context. These are called private addresses. But when our device needs to access services on other networks or Internet, it needs to use a unique address. In some cases, this is done by translating a private address into a unique address at the border between our private network and our ISP's network. This technology is called Network Address Translation, or NAT.

NAT has the advantage of allowing multiple devices to share a single, unique address, but it also has disadvantages. One of these is that the device doing the NAT must understand the protocol being used by the devices communicating through it. If the protocol we want to use is not supported by the NAT, we cannot use it. This can cause frustration when, for instance, we are unable to use our Voice over IP (VoIP) service from a hotel or airport lounge while travelling. But there is also a second problem. If a new NAT device does not support a protocol, it will stop the people using the network it serves from also using that protocol, unless it is replaced. This stifles innovation in the services that can be provided over the Internet. Losing innovation means losing access to new services that could enrich our lives. But the variability in the protocols supported by NATs means that services often either work or break depending on the equipment used by the network operator, not by the setup on the individual user's computer.

How IP addresses are distributed?

IP address distribution is taken care by following organizations in a hierarchical fashion.

IANA – The Internet Assigned Numbers Authority (IANA) is responsible for the global coordination of the Internet Protocol addressing systems, as well as the Autonomous System Numbers used for routing Internet traffic. IANA manages the DNS root, the .net and .arpa domains, and an IDN practices resource. Internet protocols' numbering systems are managed by IANA in conjunction with standards bodies. More information: www.iana.org

ICANN - The Internet Corporation for Assigned Names and Numbers (ICANN) coordinates IP addresses across the world. Without that coordination, we wouldn't have one global Internet. In more technical terms, (ICANN) coordinates the Domain Name System (DNS), Internet Protocol (IP) addresses, space allocation, protocol identifier assignment, generic (gTLD) and country code (ccTLD) Top-Level Domain name system management, and root server system management functions. These services were originally performed under U.S. Government contract by the Internet Assigned Numbers Authority (IANA) and other entities. ICANN now performs the IANA function. More Information: www.icann.org

ICANN allocates IP address blocks to the five Regional Internet Registries (RIRs) around the world. The RIRs then allocate smaller IP address blocks to ISPs and other network operators. From there, the ISPs and other Internet operators assign the addresses to the individual Internet connections.

The RIRs

- AFRINIC (African Network Information Center) More information: www.afrinic.net
- ARIN (American Registry for Internet Numbers) More information: www.arin.net
- APNIC (Asia-Pacific Network Information Center) More information: www.apnic.net
- LACNIC (Latin American and Caribbean Network Information center) More information: www.lacnic.net
- RIPE (Réseaux IP Européens Network Coordination Centre) More information: www.ripe.net

[2]

The need for migration – Some facts

Ipv4 address space is exhausting in a rapid speed, Projected RIR Address Pool exhaustion dates are as follows:

Projected RIR Address Pool Exhaustion Dates			
SL	**RIR**	**Projected Exhaustion Date**	**Remaining Addresses in RIR Pool (/8s)**
1	APNIC	19-Apr-11	1.2052
2	RIPENCC	08-Jun-12	3.9161
3	LACNIC	08-Mar-14	4.2732
4	AFRINIC	31-May-14	4.3815
5	ARIN	30-Aug-14	5.9107

[2] www.nro.net

We have seen unprecedented increase in Internet Uses and the small address space of IPv4 is not sufficient to cater to this need. Below are some statistics

Date	Number of Users	% World Population	Information Source
December, 1995	16 millions	0.40%	IDC
December, 2000	361 millions	5.80%	Internet World Stats
December, 2005	1,018 millions	15.70%	Internet World Stats
Sept, 2010	1,971 millions	28.80%	Internet World Stats
Jun, 2011	2,110 millions	30.40%	Internet World Stats

IPv4 uses 32-bit (four-byte) addresses, which limits the address space to 4,294,967,296 (232) approx. 4 billion possible unique addresses. However, some are reserved for special purposes such as private networks (~18 million addresses) or multicast addresses (~270 million addresses). This reduces the number of addresses that can potentially be allocated for routing on the public Internet.

Advantages of IPv6 over IPv4

Subject	Ipv4	IPv6	Advantage
Address space	2^{32} addresses	2^{128} Addresses	79 Octillion times the Ipv4 address space.
Notation	Dotted Decimal Notation	Hexadecimal Notation separated by colon	Higher address space
Broadcast/ Multicast	Uses both	No broadcast and has different forms of multicast	Better bandwidth efficiency
Any cast support	Not part of the original protocol	Explicit support of Any cast	Allows new applications in mobility, data centre
Network Configuration	Mostly manual and labour intensive	Facilitate the re-numbering of hosts and routers	Lower operation expenses and facilitate migration
Security	Uses IPSec for Data packet protection	IPSec becomes the key technology to protect data and control packets	Unified framework for security and more secure computing environment.

Mobility	Uses Mobile Ipv4	Mobile Ipv6 provides fast handover, better router optimization and hierarchical mobility.	Better efficiency and scalability; Work wit latest 3G mobile technologies and beyond.

IPv6 is 128 bit long, instead of its processors Ipv4 which was only 32 bit long. The purpose is to make an addressing protocol which can scale up for the new requirements and developments. The address space of Ipv6 can be understood by the following analogy

Since IPv6 addresses are 128 bits long, the theoretical address space if all addresses were used is 2128 addresses. This number, when expanded out, is 340,282,366,920,938,463,463,374,607,431,768,211,456, which is normally expressed in scientific notation as about 3.4*1038 addresses. That's about 340 trillion, trillion, trillion addresses. It's pretty hard to grasp just how large this number is. Consider:

- This would allow every person on the planet to have their own internet as large as the current Internet
- The earth is about 4.5 billion years old. If we had been assigning IPv6 addresses at a rate of 1 billion per second since the earth was formed, we would have by now used up less than one trillionth of the address space.
- The earth's surface area is about 510 trillion square meters. If a typical computer has a footprint of about a tenth of a square meter, we would have to stack computers 10 billion high blanketing the entire surface of the earth to use up that same trillionth of the address space.

What happen to IPv5?

IPv5 never became an official protocol. Many years ago, Internet Stream Protocol (ST) was considered IP version five by industry researchers, but ST was abandoned before ever becoming a standard or widely known as IPv5. Work on ST and IPv5 is not expected to even restart.

Our New Address: IPv6

Internet Protocol version 6 (IPv6) is a version of the Internet Protocol (IP) that is designed to succeed Internet Protocol version 4 (Ipv4).

IPv6 is 128 bit number and is represented as eight groups of four hexadecimal digits, each group representing 16 bits (two octets). The groups are separated by colons (:). An example of an IPv6 address is

2001:0db8:85a3:0000:0000:8a2e:0370:7334

The hexadecimal digits are case-insensitive when used, but should be represented in lower case.

IPv6 designers propose using colon hexadecimal notation in which the value of each 16-bit quantity is represented in hexadecimal separated by colons:

68E6:8C64:FFFF:FFFF:0:1180:96A:FFFF

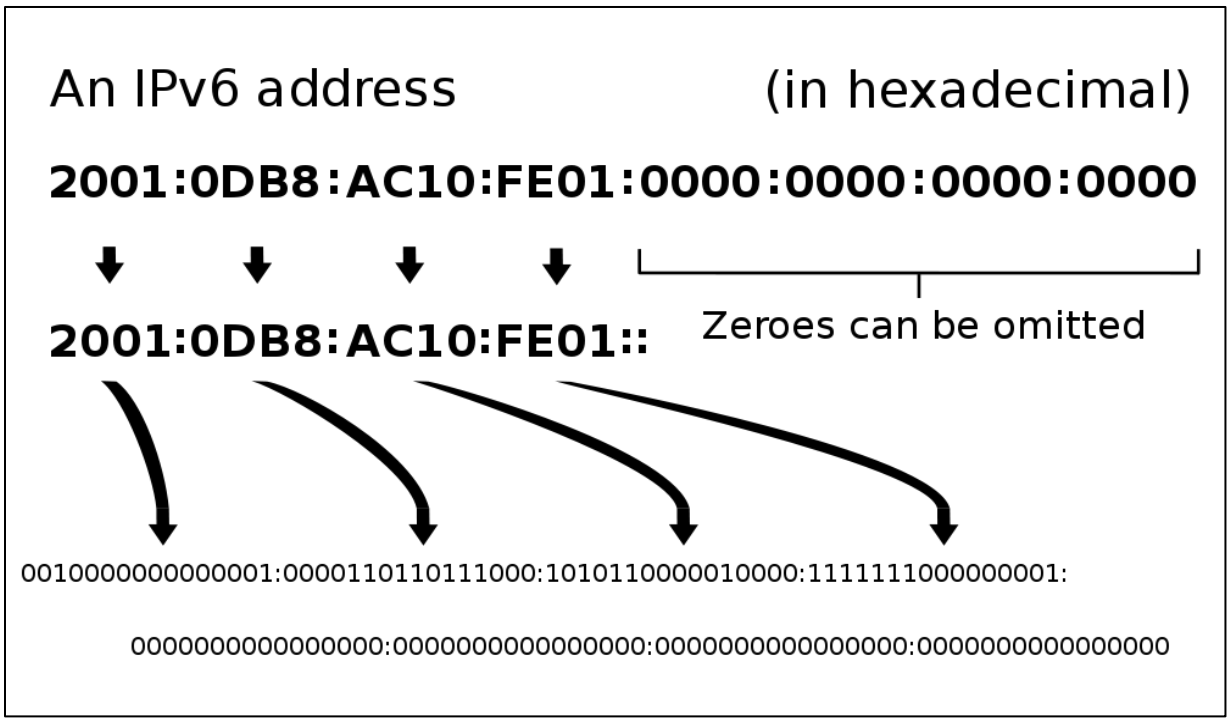
Allows for zero compression

FF05:0:0:0:0:0:0:B3

Becomes:

FF05::B3

But this can only be done once in an address



An IPv6 address consists of 128 bits. Addresses are classified into various types for applications in the major addressing and routing methodologies: unicast, multicast, and anycast networking. In each of these, various address formats are recognized by logically dividing the 128 address bits into bit groups and establishing rules for associating the values of these bit groups with special addressing features.

Unicast Addressing

A unicast address identifies a single network interface. The Internet Protocol delivers packets sent to a unicast address to that specific interface.

Anycast Addressing

An Any cast address is assigned to a group of interfaces, usually belonging to different nodes. A packet sent to an Any cast address is delivered to just one of the member interfaces, typically the nearest host, according to the routing protocol's definition of distance. Any cast addresses cannot be identified easily; they have the same format of unicast addresses, and differ only by their presence in the network at multiple points. Almost any unicast address can be employed as an Any cast address.

Unicast and anycast addresses are typically composed of two logical parts: a 64-bit network prefix used for routing, and a 64-bit interface identifier used to identify a host's network interface.

General unicast address format (routing prefix size varies)

bits	48 (or more)	16 (or fewer)	64
field	*routing prefix*	*subnet id*	*interface identifier*

The network prefix (the routing prefix combined with the subnet id) is contained in the most significant 64 bits of the address. The size of the routing prefix may vary; a larger prefix size means a smaller subnet id size. The bits of the subnet identifier field are available to the network administrator to define subnets within the given network. The 64-bit interface identifier is automatically generated from the interface's MAC address using the modified EUI-64 format, obtained from a DHCPv6 server, automatically established randomly, or assigned manually.

Multicast Addressing

A multicast address is also used by multiple hosts, which acquire the multicast address destination by participating in the multicast distribution protocol among the network routers. A

packet that is sent to a multicast address is delivered to all interfaces that have joined the corresponding multicast group. IPv6 does not implement Broadcast Addressing. Broadcast's traditional role is subsumed by multicast addressing to the all-nodes link-local multicast group ff02::1

CIDR Notation

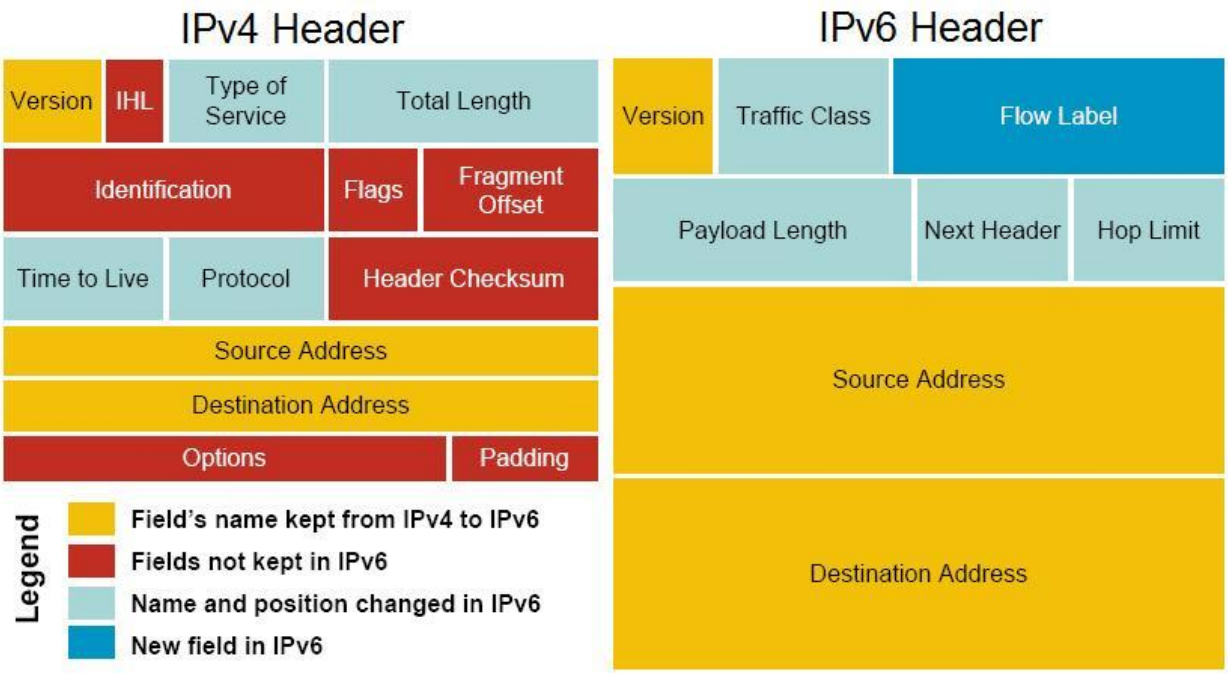
CIDR notation is a compact specification of an Internet Protocol address and its associated routing prefix. Classless Inter-Domain Routing (CIDR) is an Internet Protocol (IP) address allocation and route aggregation methodology used within the Internet addressing architecture that replaced the IPv4 class full network organization of the IP address space. It is used also for IPv6 networking, the next generation of the IP addressing architecture
Example : The IPv6 block 2001:DB8::/48 represents the IPv6 addresses
From
2001:DB8:0:0:0:0:0:0
To
2001:DB8:0:FFFF:FFFF:FFFF:FFFF:FFFF.

Size of a block of address

The size of a block of addresses is indicated simply by a slash (/) and the decimal size of the network prefix, without specifying which specific addresses are in the block. In our previous example: The IPv6 block 2001:DB8::/48

An address block with 48 bits in the prefix is indicated by /48. Such a block contains 2128 − 48 = 280 addresses. The smaller the size of the network prefix, the larger the block: a /21 block is 8 times larger than a /24 block.

IPv6 Header Compared to IPv4 Header



We can easily sense a simpler header in IPv6 which eventually enhances the performance of the network infrastructure capacity.

Hope this article has given you a brief introduction of IPv6 and the urgency for migration. 6th June 2012 is being celebrated as the World IPv6 launch day, and a number of websites are starting their services on IPv6. Wish you all a very successful and eventful world IPv6 launch.

The article has been compiled by Mr. Anand Raje, Director RABT Technologies Pvt. Ltd. & VP Membership of Internet Society Kolkata Chapter

IPv6 Implementation in Linux

IP version 6 (IPv6) is a new version of the Internet Protocol, designed as the successor to IP version 4 (IPv4) [RFC-791]. The changes from IPv4 to IPv6 fall primarily into the following categories.

- Expanded Addressing Capabilities,
- Header Format Simplification,
- Improved Support for Extensions and Options,
- Flow Labeling Capability,
- Authentication and Privacy Capabilities.

> A TLI API actually can be provided over sockets implementation and a socket API can be implemented on streams. Linux implements the networking subsystem based on BSD

The years 1992, 1993 and 1994 of the IPv6 History saw the birth of new possibilities. Initially IPv6 was known as IPng(next generation) protocol. The IPng protocol represents the evolution of many different IETF proposals and working groups focused on developing an IPng. It represents over three years of effort focused on this topic. By the Winter of 1992 the Internet community had developed four separate proposals for IPng. These were "CNAT", "IP Encaps", "Nimrod", and "Simple CLNP". By December 1992 three more proposals followed; "The P Internet Protocol" (PIP), "The Simple Internet Protocol" (SIP) and "TP/IX".
In the Spring of 1992 the "Simple CLNP" evolved into "TCP and UDP with Bigger Addresses" (TUBA) and "IP Encaps" evolved into "IP Address Encapsulation" (IPAE). By the fall of 1993, IPAE merged with SIP while still maintaining the name SIP. This group later merged with PIP and the resulting working group called themselves "Simple Internet Protocol Plus" (SIPP). At about the same time the TP/IX Working Group changed its name to "Common Architecture for the Internet" (CATNIP). The IPng area directors made a recommendation for an IPng in July of 1994.

The implementation of IPv6 in Linux kernel is done in the following ways: there are two major styles of network protocol management in unix. They are BSD Sockets and streams. BSD

sockets were introduced with 4.2 BSD in 1983, and streams with SVR3 in 1986. While streams provide a very nice API (Application Programming Interface) to add more protocols and device drivers, they tend to lose on performance when compared to sockets. In order to use networking protocols among other things, 4.2 BSD introduced the socket API. SVR3 also introduced another API called TLI (Transport Layer Interface). However they are independent of networking implementation inside the kernel.

A TLI API actually can be provided over sockets implementation and a socket API can be implemented on streams. Linux implements the networking subsystem based on BSD sockets. Communication using sockets follows the client server model. The server process creates a socket and listens on the socket. For a protocol such as TCP/IPv6, the client process creates a socket and connects to the server socket. Once the connection is established, the processes can send messages to each other using send or write system call. After the data has been written on the socket, the following actions take place within the kernel.

- The socket layer copies the data from the user-space to a buffer in the kernel-space and calls the protocol layer output routine.
- This routine calls the TCP output routine.
- The TCP output routine processes the TCP header and adds it to the front of the data in the buffer and calls the IPv6 output routine.
- The IPv6 output routine processes the IPv6 header and adds it to the front of the TCP header in the buffer and calls the interface layer output routine.
- The interface output routine adds the data link layer header to the front of the IP header and sends the packet to a device driver for transmission on the physical media. The input processing is different from the output processing because the input is asynchronous. The reception of a packet is triggered by an interrupt to a device driver and not by a system call issued by the process.

The actions on a packet reception are as follows:

- The kernel processes the interrupt and schedules the device driver to run.
- The device driver reads the data bytes from the device and stores the data in a buffer.
- The device driver then passes the buffer to a general interface level input routine.
- This routine determines which protocol layer should receive the packet.

- In case the packet is an IPv6 packet, the buffer is added to the input queue of IPv6 and a software interrupt is raised.
- This interrupt causes the IPv6 input process routine to run.
- This routine looks at the type of IPv6 packet and the corresponding packet processing routine is called. If the packet is a TCP packet, then the TCP input routine is called.
- The TCP input routine verifies the fields in the TCP header, and determines whether or not the process should receive the packet.
- If yes, the data along with the IP address and port number of the sender are put into the input queue of the socket of the process.

The above processes assume that the host does not forward packets. If it does, the IPv6 input routine will also decide whether the packet can be forwarded or not. If yes, the IPv6 output processing routine will be called. Otherwise all packets which are not meant for the host may be dropped.

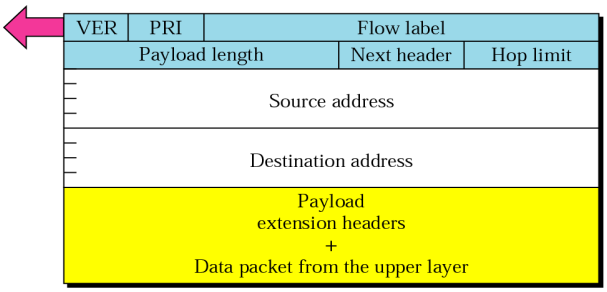
The networking architecture of Linux is fairly object oriented. It is designed to support many different communication protocols. A typical Linux kernel can be running TCP/IP, IPX, DECNET, UNIX, and many more communication protocols simultaneously. The IPv6 implementation in Linux is still under development. The current stable kernel, Linux 2.4, is missing many IPv6 extensions and does not conform to all drafts and RFCs.

This article has been submitted by Mr. INDRAJIT DE, Associate Professor, Department of Information Technology, MCKV INSTITUTE OF ENGINEERING, Liluah, Kolkata.

Gaining Security by shifting from IPV4 to IPV6

These Every computer in this world is recognised by its I.P. (Internet Protocol) Address. All the machines in this universe need unique identification. In IPV4, the typical format of I.P. address is dotted-decimal notation (202.45.1.18). In IPV6 the format changes to (ABCD:0012:00FF:AB99:76AF:DA76:CD74:39AD). Does this give more security? How long will this take for a common man to migrate from IPV4 to IPV6? What are the pros and cons? One obvious change would be the massive number of IP addresses being available to the mankind. But are we prepared? Since there is a huge domain space in IPV6, one needs to exploit the methodology using this domain space for more security. Can we have strong authentication, privacy, secrecy, integrity and non-reputation, and protection again the replay action? As on today millions of users are using IPV4. For them, changing over to IPV6 cannot be done overnight. It may take a couple of years for the global awareness and translation from IPV4 to IPV6. By introducing the new protocol IPV6 we may solve some of the old problems associated with IPv4; but would we be introducing totally new ones? Will the life (and devices) become more complicated? Or will lead to safer and more secure Internet transactions? Only time can tell.

IPv6, the latest version of the Internet Protocol, has a 128-bit (16 bytes or 32 hexadecimal digits) address space, a revised header format, new options, an allowance for extension, support for resource allocation, and increased security measures. IPV6 looks like a string of 8, 4-digit hexadecimal numbers separated by a colon. The number of machines which can be uniquely identified would be (2)128. This is a real massive number. The number of machines in this universal would not exceed in your and my life-time.



(Header Image courtesy: Data Communication and Networking by Behrouz A Forouzon; Tata McGraw-Hill Publishing Co. Ltd.)

An IPv6 datagram is composed of a base header and a payload. Extension headers add functionality to the IPv6 datagram. Three strategies used to handle the transition from version 4 to version 6 are dual stack, tunneling, and header translation.

This paper restricts to the security in IPV6 as compared to the security in IPV4.

2.0 THE SECURITY ISSUES

Port Scanning: Black hat hackers use port scanners to detect open ports on a network node which are associated with well-known vulnerabilities. They then exploit these ports to gain access to the network. Scanning an IP address of only 32 bits is a relatively simple and quick, which means possible to cover every address within a couple of minutes. However, to scan a whole 128 bit IPv6 address would literally take hundreds of thousands of years. Therefore, IPv6 makes the option of port scanning nearly impossible, but not completely.

IPSec: One main security feature of IPv4 was IPSec. In brief IPSec provides secure data communication and key exchange. For IPv4 networks IPSec is optional. However, within IPv6 networks IPSec has become mandatory to increase IPv6 security.

3.0 THE MAIN NEW POINTS OF IPV6 SECURITY ARE:

- Authentication Extension header: This validates the message sender and ensures the integrity of data
- Encrypted Security Pay Load: This is the extension that provides confidentiality and guides against eavesdropping.

3.1 Authentication header (AH): (RFC 2402)

The IP Authentication Header (AH) is used to provide connectionless integrity and data origin authentication for IP datagrams and to provide protection against replays using incremented the Sequence Number.

3.2 Limitations of Authentication header (AH)

Some IP header fields may change in transit. Therefore the value of these fields, when the packet arrives at the receiver, may not be predictable by the sender. The values of such fields cannot be protected by AH.

3.3 IP Encapsulating Security Payload (ESP)

The primary difference between the authentications provided by ESP and AH is the extent of the coverage. Specifically, ESP does not protect any IP header fields unless those fields are encapsulated by ESP (tunnel mode)

3.4 The Integrity Check Value (ICV)

The fields in the AH format and are included in the Integrity Check Value (ICV) computation.

3.5 Security Parameters Index (SPI)

The SPI is an arbitrary 32-bit value that, in combination with the destination IP address and security protocol (AH), uniquely identifies the Security Association for this datagram. The set of SPI values in the range 1 through 255 are reserved by the Internet Assigned Numbers Authority (IANA) for future use;

3.6 Sequence Number enable the anti-replay service for a specific SA.

Authentication Data This is a variable-length (* x 32) field that contains the Integrity Check Value (ICV) for this packet. Padding is included to ensure that the length of the AH header is an integral multiple of 32 bits (IPv4) or 64 bits (IPv6).

3.7 Authentication Header Processing

Authentication Header Location: AH may be employed in two ways: transport mode or tunnel mode. In transport mode, AH is inserted after the IP header and before an upper layer protocol, e.g., TCP, UDP, ICMP, etc. or before any other IPsec headers that have already been inserted. Tunnel mode AH may be employed in either hosts or security gateways. In tunnel mode, AH protects the entire inner IP packet, including the entire inner IP header. The position of AH in tunnel mode, relative to the outer IP header, is the same as for AH in transport mode.

3.8 Authentication Algorithms

The authentication algorithm employed for the ICV computation is specified by the SA.

3.9 The Security Architecture document.

In transport mode, the sender inserts the AH header after the IP header and before an upper layer protocol header. In tunnel mode, the outer and inner IP header/extensions can be inter-related in a variety of ways. The construction of the outer IP header/extensions during the encapsulation process is described in the Security Architecture document.

3.10 Security Association Lookup

AH is applied to an outbound packet only after an IPsec implementation determines that the packet is associated with an SA that calls for AH processing. The process of determining what, if Any, IPsec processing is applied to outbound traffic is described in the Security Architecture document.

3.11 Sequence Number Generation:

The sender's counter is initialized to 0 when an SA is established. The sender increments the Sequence Number for this SA and inserts the new value into the Sequence Number Field. Thus the first packet sent using a given SA will have a Sequence Number of 1. If anti-replay is enabled (the default), the sender checks to ensure that the counter has not cycled before inserting the new value in the Sequence Number field.

3.12 Integrity Check Value Calculation:

The AH ICV is computed over:

- IP header fields that are either immutable in transit or that are predictable in value upon arrival at the endpoint for the AH SA
- The AH header (Next Header, Payload Len, Reserved, SPI, Sequence Number, and the Authentication Data (which is set to zero for this computation), and explicit padding bytes (if any))
- The upper level protocol data, which is assumed to be immutable in transit

3.13 Mobility

As IPv6 supports stateless auto-configuration this means that devices can become mobile with the ability to leaving old and enter new networks seamlessly. When entering a new network the device will have two IPv6 addresses, one temporary and one real address. The temporary address is stored within the IPv6 header. This second temporary address can easily be exposed to spoofing attacks. Network administrators should be fully aware of this feature.

4.0 IP-BASED SECURITY TODAY: "INSIDERS V/S OUTSIDERS"

IP security for enterprises today is primarily boundary focused. It employees a convenient set of assumptions that all "insiders" are good and all "outsiders" are bad, it is far from reality. Operational experience has proven that attacks on enterprise resources and assets are just as likely (and probably more likely) to occur from internal sources than from the Internet. In fact, internal-based attacks are considered potentially more devastating since the majority of them go unnoticed, and due to limited internal monitoring and logging, it is normally unlikely to fully understand the extent of the compromise. Not all insiders are "good" and not all outsiders are "bad".
Conventional firewalls rely on:

- The notions of restricted topology and
- Controlled entry points to function.

More precisely, they rely on the assumption that everyone on one side of the entry point--the firewall is to be trusted, and that anyone on the other side is, at least potentially, an enemy. The vastly expanded Internet connectivity in recent years has called that assumption into question. Which part can be called "inside" and which part can be called "outside" – It is all distributed.

4.1 Security benefits associated with IPv6

4.1.1 Secure Architectures: Transitioning to IPv6 provides agencies a chance to significantly modify and enhance their enterprise architecture around the capabilities of IPv6.

It affords the opportunity to implement new security architectures that could significantly improve an agency's overall security posture.

4.1.2 Ubiquitous Security Layer: Numerous security protocols have been and are being developed within the IETF to support greater security capabilities within IP, such as IP security (IPsec). While many of these will operate with both IPv4 and IPv6, current entrenched deployments of IPv4 make spending the resources necessary to modify the equipment and architectures to implement them unlikely. In addition, IPSec is considered a mandatory part of IPv6.

4.1.3 Node and Topology Hiding: One of the weaknesses in IPv4 is the ability for malicious entities to quickly scan and identify nodes on the Internet. Once a hacker has access to an organization's subnet, it is a fairly quick and simple process to identify all of the nodes and focus on the ones with the greatest weakness. IPv6 provide a significant advantage due to the sheer number of potential addresses on a single subnet. There are 264 or 18,446,744,073,709,551,616 potential IPv6 nodes on each subnet, making typical network scanning virtually impossible.

4.1.4 New Capabilities: The IPv6 foundation enables the development and deployment of new capabilities and delivers inherent security benefits from utilizing an established and approved framework. Currently, as new services are required for the Internet, inventive companies are identifying issues and design workarounds.

While this is great from a service delivery standpoint, many of these workarounds exploit or create new security vulnerability. However, developers and users are left with little recourse to implement their requirement.

5.0 (NAT) NETWORK ADDRESS TRANSLATION

This section provides an overview of NAT and its relationship to IPv6. A more detailed analysis of NAT functionality regarding IPv6 can be found in RFC 4864.

- NAT enables a user to have a large set of address internally and one address, or a small set of address, externally. The traffic inside can use the large set giving flexibility to large number of devices; the traffic outside can use the small set giving uniqueness and more security.

- NAT has played a critical role within the Internet community and throughout enterprises across the globe. NAT is commonly utilized as a standard method of operation in nearly every federal, state, and local agency. While NAT has been extremely valuable in many regards, it has also created numerous challenges in developing scalable solutions and end-to-end services. NAT has been a major point of discussion in the IPv6 community about how to remove NAT and replace its functionality and perceived benefits with other mechanisms within the IPv6 protocols.
- Thus, IPv6 will provide an environment that can be focused on security and also provide the flexibility for quickly delivering new services.
- Unique Identification: Significant security issues on the Internet stem today from the use of NAT and private IPv4 address space. It is virtually impossible to obtain a level of assurance based on IP addresses. Most users sit behind one or more NAT or similar devices that prevent the direct association of an IP address to a specific user or node.

6.0 FUTURE SERVICES

With the changes in IPv6 structure and tremendously increased address space, architectures and services can be developed to prevent address spoofing and establish the necessary association to support true network-level access control and authentication.

6.1 Groups having common Interests: IPv6 makes it easy for nodes to have multiple IPv6 addresses on the same network interface. This can create the opportunity for agencies to establish overlay or group-networks on top of other physical IPv6 networks. Thus, department, groups, or other users and resources can belong to one or more groups with each having its own established security policies. That way, security can become more granular and easier to implement based on grouping common requirements.

6.2 High Availability: One of the major strengths of IPv6 will be the ability to quickly setup and modify networks on the fly. This ad-hoc capability will allow not only nodes on the network, but also entire networks to become much more resistant to denial-of-service scenarios. When deployed in mesh configurations, nodes and potentially networks could quickly identify and establish new routes as existing or preferred routes are disrupted.

6.3 Developing an IPv6 Security Plan

As agencies transitions to IPv6, security will be a major concern across not only its core networks, but also across the entire enterprise. While IPv6 provides the foundation for the development and implementation of a more secure enterprise, agencies must be concerned with potential issues the new protocol may create. Examples of these issues may include:

- Poorly implemented IPv6 stacks
- Few network protection devices/tools support IPv6
- New attacks
- Poorly implemented IPv6 routing protocols
- Inconsistent IPv4/IPv6 security features
- Few IPv4 network management tools ported to IPv6
- Organizations not leveraging new security features
- New/existing applications unable to leverage new IPv6 features to solve mission issues

One of the critical steps agencies must take in the IPv6 transition process is the development of an IPv6 Security Plan. The IPv6 security plan should not be developed in isolation, but should be a close, collaborative effort between the agency's IPv6 transition team and the agency's Information Security (IS) team, and should comply with agency-established IS policy and procedures. The objective of the IPv6 Security Plan is to facilitate the insertion of IPv6 while maintaining the security posture of the agency's IT infrastructure as required by Federal Information Security Management Act (FISMA).

The development of the IPv6 Security Plan should include a core understanding of all of the components necessary to secure the agency's enterprise during the transition,

When IPv4 was developed, it was with little thought to security at the packet layer – the IPv4 approach was: "do security somewhere else". Security was not inherent in the design of the IPv4 protocol. IPv6 rearranges that thinking – it builds in the potential for security at the packet layer, with IPSec as a mandatory element of the IPv6 standard. (IPsec is a suite of protocols for securing communications by authenticating and encrypting IP packets in a data stream.)

However, this does not mean IPv6 is automatically more secure. IPSec must also be implemented in networks, and its widespread adoption depends upon the development of suitable Public Key Infrastructures.

IPv6 also has capabilities to secure the conversations between routers and hosts in a subnet, which represent some additional security. So, while IPv6 has the potential to be vastly more secure than IPv4, which will yet depend upon widespread implementation and usage of its features.

Conclusion: This article aims to highlight a few security issues with the IPv6 protocol. Although significant improvements are made with the new protocol if it is far from solving all problems and difficulties. In fact by introducing the new protocol we are solving some of the old problems with IPv4 while introducing totally new ones. Ultimately the new protocol creates as many problems as it solves. Therefore, becomes no more secure than IPv4. Only the future will tell if the new protocol will offer greater security as we start the migration period.

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IPv6 Features – Creating the Road Forward

In the area of communications, the Internet protocol is the wellknown protocol that is responsible for moving/routing packets of data from node to node across the Internet. The current version of the Internet protocol driving the Internet is IPv4 (Internet protocol version 4), which is a very old protocol designed initially for working in a closed educational environment. It has only a 32-bit address space, which can cater to just 4.3 billion independent nodes. However, due to various reasons, only about 25 percent of this address space could be utilized. With the coming of mobile revolution, next-generation networks, 3G and 4G, in the near future all networks and devices will communicate using the Internet protocol, which means tremendous demand for IP addresses.

It was evident in the early 1990s that the IPv4 address space would not last long and therefore the Internet Engineering Task Force (IETF) sat down to deliberate on the next version of the Internet protocol. IPv6 was designed from scratch to make it more feature rich and robust so that it could serve the commercial world for a long time to come. IPv6 is documented in several RFCs (request for comments) starting from RFC 2460.
Although IPv6 is the successor of IPv4, both protocol versions are different and IPv6 is not backward compatible with IPv4. Therefore, there are several techniques designed by the Internet community to make IPv4 and IPv6 work together like dual stack, tunneling, and translation, in which dual stack is likely to be the most preferred option for transition from IPv4 to IPv6.

IPv6 is not just about addresses but it has been designed to provide several advantages over current IPv4. Therefore, IPv6 is also known as IPng (Internet protocol next-generation).
Some of the advanced features of IPv6, which make this possible, are:

- **QoS (quality of service).** IPV6 brings quality of service that is required for several new applications such as IP telephony, audio/video applications, interactive games, and e-commerce. While IPv4 is a best effort service, IPv6 ensures QoS, a set of service requirements to ensure that network performance is guaranteed while transporting traffic over the network. For example, in case of networking traffic, the quality can refer to data loss, latency (jitter), or bandwidth. In order to implement QOS, IPv6 packet structure provides a traffic-class field (8 bits) in the IPv6 header and a separate 20-bit flow label field.

- **Mobile IPv6.** This feature ensures that a transport layer connection does not break regardless of the movement of a device in an IPv6 network, which allows a computer or a host to remain always reachable. With the help of mobile IPv6, even though the mobile node changes locations and addresses, the existing connections, through which the mobile node is communicating, are maintained. This feature makes seamless communication possible in an IP world as in mobile networks. This feature is well documented in RFC 3775 and is very useful for designing of intelligent transport systems for improving public transportation.
- **Stateless auto configuration.** This feature allows any IPv6 host to configure automatically when connected to an IPv6 network. The biggest advantage of this feature is in the operation of sensor networks. Sensor networks with IPv6 make it possible to have applications like smart buildings and smart grids, which have tremendous scope in India in the areas of energy management and electricity distribution.

The Government of India has been putting lot of efforts to ensure that all service providers and government departments do a timely transition to IPv6 and start offering IPv6 services by December, 2011 and March, 2012, respectively. As a result of these initiatives, the country will see the benefits of IPv6 flow to different sectors of the economy in the next couple of years.

This article has been submitted by Mr. M. R. RAMESH, Scientific Assistant,
Indira Gandhi Centre for Atomic Research,Kalpakkam-603102

QUOTES / MESSAGES

ICANN is pleased to be among the many organizations who support World IPv6 Day. We encourage website providers to join in deploying IPv6 in production. Deployment of IPv6 enables the Internet's future growth, which is good for users in India and around the globe.

Rod Beckstrom, President and Chief Executive Officer, ICANN

IPV6 protocol is a technological upgradation of IPV4 and is designed to addresses the requirements of Portability of IP addresses and security.

Gulshan Rai - Director, CERT - India

IPv6 will play a vital role for internet's continuous growth impacting economic development through inclusion of the people living at the bottom of the pyramid.

Kali Krishna Mahapatra, Senior General Manager Anand Bazar Patrika

I would like to convey in the context of the IPv6 launch day. It is one of support because a lot of action is needed for IPv6 and you efforts are invaluable.

But it is also one of concern, because there is still a dangerous lack of concerted action on the international level - 10 years after the alarm bells started to ring. Symbolic action like World IPv6 Launch are valuable to raise awareness, yet awareness alone does not move us close to transition.

The specter of a speculative bubble in IPv4 "real estate" looms. It can lead to prices in the hundreds of dollars per IPv4 number on secondary markets, companies borrowing money using IPv4 addresses as collateral, companies being valued on stock markets for their IPv4 holding, and ISPs failing because they are hypnotized by market prices. And even after the burst of such as bubble, the result could simply be the proliferation of NATs and no transition to IPv6.

It is enough to look at GSM roaming to see that a vast benefits in the long term are no match against paltry illegitimate short-term profits, so long as the former require international concerted action whereas the latter require no more than blind opportunism by individual actors.

In other words, the benefits of IPv6 will never become a reality unless strong incentives are introduced. The minimum is an V4 Fee: each single-stack IPv4 address should be charge for at a rate of USD 10 cents per year by the respective RIR, going up to USD 1 dollar within 5 years. The revenue would go towards efforts for transition and Internet development in less favoured geographical areas.

Werner Staub,
Coordinator of the Permanent Secretariat &
Vice Chair of the Executive Committee, CORE, Geneva

IPv6 will play a vital role for internet's continuous growth impacting economic development through inclusion of the people living at the bottom of the pyramid. With the world wide exhaustion of IPv4 addresses, IPv6 is the only way to meet the global requirement of addressing internet nodes. With 128 bits, IPv6 provides a large address space that can address 2128 i.e., approximately 3.4×1038 unique nodes. IPv6, that supports the present Internet architecture as well as capable of supporting the next generation evaluations, promises to meet the requirements of Network addressing efficiently, at least for the next 30 years. With the global increase in Internet users, it is now mandatory to deploy this Technology to run current Internet Technology smoothly. Governments & semi-Government Organizations are thereby required to take up the initiation to implement IPv6 in their country right now, as it would be too late if it's now. Thus on this IPv6 day, let us be aware of IPv6 and its technical aspects and implementation, and we are Thankful to INTERNET SOCIETY to take the initiative.

Nilotpal Chakraborty, Member, Internet Society-India Kolkata Chapter,

IPv6 will play a vital role for internet's continuous growth impacting economic development through inclusion of the people living at the bottom of the pyramid. India being a geographically vast country with people continuously in search of mediums to keep themselves connected & updated with the rest of the world, the dependency of Internet is on its bloom. For better service and proper channelization of network the need of better mobility support has turned out to be a primary point of concern for all the service providers. To address all this issues, a dependable, scalable network protocol is mandatory. Though IPv4 addresses suffice most of the requirement, IPv6 is better up gradation alternative suited for commercial use and also to make the best Potential use of Internet.

The government of India has been putting a lot of effort to ensure that all the Service Providers and Government departments do a timely transition to IPv6. As a result of these initiatives, we can expect the country will see the benefits of IPv6 flow to different sectors of economy in upcoming years.

Santanoo Bhattacharjee Member-ISOC Kolkata Chapter

IPv6 also implements additional features not present in IPv4. It simplifies aspects of address assignment network renumbering and router announcements when changing network connectivity providers. The IPv6 subnet size has been standardized by fixing the size of the host identifier portion of an address to 64 bits to facilitate an automatic mechanism for forming the host identifier from link layer media addressing information (MAC address).

Finally, the conclusion IPv6 offers larger address space for internet users in comparison with IPv4 and added some extra tremendous features which facilitate users in an better manner.

Anurag Srivastav, Member – Internet Society Kolkata Chapter

In few years we have seen that number of servers on Internet has grew exponentially as everybody want to be exclusively on internet for increasing the business opportunity. Also addresses of IPv4 is nearly exhausted and its time for some new technology to take place of it. Here comes IPv6 which has large addresses, capable of auto configuration, Secure, Backward Compatible and is very fast and flexible. If we want to see the internet industry growing in India, then we will have to make a move towards IPv6. Howsoever it is a matter of fact that implementing IPv6 is a very challenging task and we must take it as an opportunity which will bring many technically sound technocrats into the picture.

Rajan Sharma
Member Internet Society Kolkata Chapter

Strengthen people to people contact with neighboring countries in the East, Nepal, Bhutan, Bangladesh, Burma, China by tracking use of internet & its up-gradation to IPv6, discussing the enhanced functioning with security, with low monetary value trade as trial.There is HAM Radio license holders updating itself to www.sdrradio.org with internet radio as a backbone. They are renowned for disaster information co-ordination around the world.

Praddyot Kumar Sikdar
Member – Internet Society Kolkata Chapter

IPv6 will be an important component of the future internet and of the Galactic network. Communication will break existing bounds and establish new horizons for mankind and the reach of technology and IPv6 will be an important stepping stone towards that direction.

Sanghamitra De, Assistant Professor
Future Institute of Engineering & Management, WBUT, Kolkata

The other protocols served the growth of the internet in the west whilst ipv6 is all about the next phase of growth - asia, brazil and other rising powers.

Sachin Malhan
Chief Volunteer & Co Founder – Inclusive Planet

IPv6 brings new possibilities of change and growth for the Internet. Its new technologies and protocols like this that can further enhance and support the growth of developing nations throughout the world. India is one country that will definitely benefite from the IPv6 Deployment worldwide. Its fast expanding Internet businesses will definitely benefite from the new and affordable addresses.

Prof Dr.Sureswaran Ramadass
National Advanced IPv6 Centre (NAV6), Malaysia

IPv6 will play a vital role for internet's continuous growth impacting economic development through inclusion of the people living at the bottom of the pyramid. IPV6 is definitely a great milestone with a a lot of future benefits.However this also comes with certain security risks which we need to handle proactively. There are potential flaws which can cause DOS, Trespassing, Filtering device bypass etc if not handled properly. Also most of the current security tools are not geared up to secure IPV6 networks and hence this would need added attention and investments. So careful transitioning keeping security in mind is going to be critical.

Bikash Barai
CEO, iViZ - Cloud Based Application Penetration Testing

The move to IPV6 will have all the benefits and challenges of migration to a new platform. While IPV6 provides "built-in" security features for communications that can be leveraged by application and network component developers providing more managed security environment to work. The the move to IPV6 would mean fresh investment in new equipment and network elements to support the new platform. In the interim there would a migration cost with the spiraling cost to a hybrid ipv4/ipv6 stack where few components remain on ipv4 and few supporting ipv6. The benefits from the enhanced security against the cost of migration would may not provide an ROI. The huge drain on resources and increase cost might not justify the security investment from a ROI standpoint. In the long run when the older IPV4 gear is replaced with IPV6 and it becomes the the default standard the benefits will clearly show. in short while the long term benefits are clearly there in the short term there maybe investments in resource allocation, new equipment and migration expenses with low ROI.

Kartik Shahani, Country Manager, RSA

IPv4 or the current internet, was an outcome of the technology designed in defense labs – DARPA for connecting computers, the internet has progressed and evolved since then, wherein our economies and lives are internet based. Though IPv4 address exhaustion was the driver for the birth of IPv6, but the creators of IPv6 kept a visionary perspective and designed a new protocol for the future internet requirements and needs. Organizations should make use of the various new features in IPv6 to a build an innovative and better connected computing environment for the future.

It is really nice to see, that the World IPv6 day, on June 6th, 2012 heralds the launch of IPv6, wherein organizations would enable IPv6 on their web sites and stay on in the IPv6 world, providing various services therein. I would like to wish the various organizations participating in this event the best and look forward to them ushering a new innovative internet using the various new features and capabilities of IPv6.

Srinivas Gudipudi
Chief Technology Officer, Neosixth Technologies Pvt Ltd

The Internet has been a transformative force in the last two decades of its public presence, and its growth and penetration during this period has been nothing staggering. Not only are all continents on earth connected to the Internet, but different models of delay-tolerant, store-and-forward interplanetary Internet are also being developed at this time. The future of humanity is inextricably linked with this network-of-networks of computers.

One of the aspects of this unprecedented growth has been the explosive increase in the demand for IP addresses, which are an essential pre-requisite for the current models of Internet connectivity. The older IP version 4, which served us well for over 25 years, has no more further room for growth, and it is time to shift to the next generation of IP, IP Version 6.

The Internet Society, under whose stewardship the adoption of IPv6 is being initiated, is celebrating 6th June 2012 as the World IPv6 Launch Day.

It is heartening to note that Internet Society Kolkata Chapter is releasing a compendium titled "IPv6 - The way forward for India", which will have different perspectives on the transition to the new standard. I congratulate the volunteers at the ISOC Kolkata Chapter who are behind this initiative.

I wish the World IPv6 Launch Day 2012 all success, and hope that this important milestone will persuade the rest of our country to move to IPv6 and so that we can utilize it as an essential infrastructure of tomorrow.

Satish Babu, President Computer Society of India

Sensitization of Version 6 is an utmost priority for India aiming at conversion of 900 million mobile Users into internet users and thankfully in this journey govt. by setting directions is becoming an example for rest of the world. Further investment in internet exchanges by the Government would expedite the adoption of IPv6 by all important stakeholders"

Naresh Ajwani, ADDRESS COUNCIL, ICANN

IPv6 isn't the future but is the present. IPv6 is critical to the Internet's continued growth as a platform for innovation and economic development. With growth comes change and change is inevitable. The Internet has created a virtual world that transcends physical and political boundaries making a global network of communities. With plethora of devices creating a greater need for addressibility it was only a matter of time that we ran out of IPv4 space. With the phenomenal growth that Internet has experienced comes the need to rebuild and reinforce the foundation which is IP. With IPv6 we have many opportunities and fresh challenges to overcome and as it stands is the ideal building block for the Internet for years to come.

Suchit Nanda
Advisor to Chairman & Managing Director Reliance Industries Ltd.

The current IPv4 addressing scheme will be a major constraint for the emerging trend of the Internet of Things as we are already running out of Internet addresses. IPv6 offers us the potential to build a much more powerful Internet on a scale that is vastly larger than today. The 128-bit IPv6 addressing scheme will allow some 340 trillion, trillion, trillion addresses which I understand will guarantee an IP address for every person and device on earth for years to come. This will drive introduction of new innovative services since Internet of Things and Everything on Internet will become a reality.

V V R Babu, CIO ITC GROUP

With Union Cabinet approving National Telecom Policy 2012, next generation network, including IPV6 will become a REALITY and "digital divide" a HISTORY!

Vakul Sharma, Advocate, Supreme Court of India

EPILOGUE

One important issue of strategic importance which has not been mentioned thus far is the early adopter advantage that corporates and governments can derive from IPv6. The early adopter advantage is an important justification for the immediate roll out of IPv6 in India and is, I feel, as important as any of the other excellent reasons which the pioneers of IPv6 have presented in this compendium - particularly APNIC's section captioned 'Business Values of IPv6 in India' and Rakesh Jha's proposed migration roadmap.

If there is early adoption of IPv6 in India, the government and industry stand to benefit in exactly the same manner that the government and industry of the US, Japan, UK, France and Germany benefited by being early adopters of IPv4 in the '80s. Interestingly, if one studies the distribution of IPv4 blocks from 1995 till their depletion in 2011, it proportionally reflects the growth and development of the economies of that region, accurately over a span of fifteen years. Policy makers in the Indian government should take cognizance of this co-relation and seize the advantage of being early adopters of IPv6.

The early adopter advantage applies to industry as well. As an example of this, I ask you to recall the liquidation of Nortel in 2011 and Microsoft's subsequent purchase of a block of IPv4 addressed from them for 7.5 million dollars. Nortel benefited from being an early adopter because it owned a block of IPv4 addresses unlike other latecomers who had them on lease. It was primarily due to this differentiation that Nortel was able to raise the 7.5 million; latecomers have no hope of repeating this.

Now, I am not suggesting that the Government of India or an Indian IT giant lay claim to a large chunk of IPv6 addresses in the hope of selling them later at a premium - there is unlikely to be a scarcity of IPv6 addresses in the near future, experts feel - but other opportunities for profit will likely present themselves to those who have working knowledge and experience with IPv6 and related hardware and software, especially considering that much of the globe does not have internet access as yet and when they do, they are certainly going to start with an IPv6 infrastructure.

Failing to seize the advantage of being one of the early adopters of IPv6 will result in other countries and regions, which are today considered underdeveloped in terms of internet infrastructure and access, leapfrog ahead of India while we find ourselves saddled with a legacy IPv4 infrastructure working in parallel with partially deployed IPv6 infrastructure and all kinds of troubles with transition.

In summary, there is reward for the early adopter and a corresponding set of barriers and penalties for the late adopter. India should not miss the IPv6 early adopter bus.

Let’s not miss the IPv6 Bus!!

This article has been submitted by Mr. Niel Hirjee , Director of Calport Technologies and Vice Chair Internet Society.

Publication by:

INTERNET SOCIETY - INDIA KOLKATA CHAPTER

About Internet Society

The Internet Society is the trusted independent source for Internet information and thought leadership from around the world. With its principled vision and substantial technological foundation, the Internet Society promotes open dialogue on Internet policy, technology, and future development among users, companies, governments, and other organizations. Working with its members and Chapters around the world, the Internet Society enables the continued evolution and growth of the Internet for everyone. For more information, visit **www.internetsociety.org**.

About Internet Society India Kolkata Chapter

ISOC has more than 80 chapters worldwide and Kolkata Chapter is one of the 4 chapters in India which was chartered in Jan-09 and is currently having a membership base of 1300+ members.

The Kolkata Chapter has been formed with the following objectives:

- To serve the interests of a segment of the global Internet community through a local presence, focus on local issues and developments, and increased use of local languages for Internet.
- To further educate West Bengal's scientific community, local businesses, and the public at large with respect to the technology, use, and applications of the Internet;
- To promote educational applications of Internet technology in State of West Bengal for the benefit of government, schools, colleges, and universities, commerce & industry, and the public at large;
- To provide a forum for local entrepreneurs, professionals, students, and government officials to explore and help develop new Internet application, and to stimulate collaboration among organizations in their operational use of the Internet.

About the Editor

Anupam Agrawal is the chair of Internet Society Kolkata Chapter and works for the biggest IT Company in India, TATA Consultancy Services. He is a member of NASSCOM Internet Working Group and part of Government of India IPv6 Implementation Task Force. He has special interest in Internet Governance and has attended European Summer School on Internet Governance under University of Aarhus, Germany. He also attended Internet Governance Forum and ICANN meetings as ISOC ambassador and fellow respectively.