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Introduction

The IPv6 Forum http://www.ipv6forum.com is a world-wide consortium of leading Internet vendors, Industry, and Research & Education Networks, with a clear mission to promote IPv6 by dramatically improving market and user awareness of IPv6, creating a quality and secure new Generation Internet, and allowing world-wide equitable access to knowledge and technology, embracing a moral responsibility to the world.

The IPv6 Forum was created by the members of the Internet Engineering Task Force (IETF http://www.ietf.org/) IPv6 Working Group and the Deployment WG, led then by Jim Bound who supported Latif Ladid's proposal at the IETF IPv6 WG interim meeting on Feb 5th, 1999 in Grenoble, France, and then at the IETF meeting in Minneapolis in April 1999 which was adopted and launched in May 1999. The IPv6 Forum is the only body which has an endorsement from the IAB (Internet Architecture Board), the IETF IPv6 WG, and the Internet Society (ISOC) to promote IPv6 worldwide. Dr. Vint Cerf has joined this initiative as its Honorary Chairman to strengthen its mission.

The IPv6 FORUM has:

- Established an open, international FORUM of IPv6 expertise on a voluntary basis
- Shared IPv6 knowledge and experience among members and non-members
- Promoted new Internet models and global solutions based on IPv6
- Promoted interoperable testing thru the IPv6 Ready Logo program: http://www.ipv6ready.org
- Created IPv6 Forum Chapters (10) and IPv6 Task Forces (25) around the world
- Addressed worldwide issues that create barriers to IPv6 deployment
- Organized over 50 highly successful IPv6 Summits educating over 25,000 engineers per year

The IETF has sole authority for IPv6 protocol standards development. The IPv6 Forum reserves the right to develop IPv6 Deployment Guides to foster the operational use of IPv6. The IPv6 Forum has among its ranks the original designers of IPv6 from the IETF, the best IPv6 technologists from industry, and the best researchers on planet. The IPv6 Forum is a worldwide recognized authority consulting with leaders in government and industry to support their new Internet promotion and adoption plans.

The IPv6 Forum worldwide leadership recommends this document as a base of a brief strategic roadmap for each organization to understand the impact of the new Internet Protocol version 6 from a business perspective, supported by a simplified technical outline distilling the benefits and way forward on how and where to use IPv6. The IPv6 Forum publishes this document for information purposes, and is in no way binding for any business or other purposes.

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1. BUSINESS DRIVERS

1.1 Building the Business Case for IPv6 Adoption

Defining the business case for IPv6 has been a challenging task. IPv6 stands ready to revitalize the growth and use of networking and the Internet as a platform for commerce, education, entertainment, and general information sharing. However, at the end of the day, it is still just communications "plumbing". The market has long looked to IPv6 to deliver the next dominant Internet application, when in reality IPv6 is just a tool, albeit a critical one, in the development of new applications and network-based services. This reality, combined with the short-term perspective on return-on-investment (ROI) and quarterly earning reports most businesses have had from the post-Dot.Com bubble, and has created an environment hostile to investment in new technologies, most notably in North America and Europe.

Another impediment to IPv6 adoption has been one of the IPv6 community's own making: extolling the virtues of IPv6 primarily from a technical perspective. While IPv6 offers a number of technological advancements, such as a larger address space, auto configuration, a more robust security model for the peer-to-peer environment, and better mobility support, these features offered in a technology vacuum have not resonated with big business. Both business and government leaders are concerned about how problems are resolved, how revenue is generated, or how to build efficiencies and cost savings into their organization. IPv6 certainly has the ability to help deliver these scenarios, but the focus of the story needs to be the solution – not the technology that helped deliver that solution.

As a global advocate for the advancement and adoption of IPv6, the IPv6 Forum must motivate industry by developing appealing and compelling business-case justifications that center on solutions built upon IPv6. To that end, the IPv6 Forum has identified three major approaches to developing a business case for IPv6 adoption. It should be noted that none of these are mutually exclusive – quite the contrary. All three should be taken into consideration. Collectively they are far less about IPv6 adoption than they are about securing the future success of a business or organization.

1.1.1 Global Mandates and Policy for IPv6 Adoption

Over the past six years, IPv6 has enjoyed remarkable success for integration via support from government or industry standards bodies. The reasons for these mandates vary widely from technical to political, but regardless, they have helped cement the concept that IPv6 is simply not a passing technology, but truly the foundation for the next generation Internet. To provide some specific cases, the list below identifies a number of governments or industry bodies that have called for IPv6 usage:

- 3GPP http://www.3gpp.org/ has mandated exclusive use of IPv6 for IMS (IP Multimedia Subsystems) back in May 10, 2000.
- 3G Internet Multimedia System (IMS) has been selected by the Telecommunications Industry Association (TIA) as the Next Generation Networks (NGN) platform.

- In September 2000, the Japanese Prime Minister identified IPv6 as a critical part of the eJapan 2005 initiative. http://www.kantei.go.jp/foreign/it/network/0122full_e.html. The Japanese government provided tax incentives to companies which integrated IPv6 support. The South Korean Government announced its support for IPv6 in Feb 2001.
- The United States Department of Defense mandated the integration of IPv6 in June 2003 http://www.defenselink.mil/transcripts/2003/tr20030613-0274.html to be ready by 2008. In June 2005 the White House Office of Management (OMB) has set the milestones that federal agencies must use IPv6 by June 2008 http://www.whitehouse.gov/omb/memoranda/fy2005/m05-22.pdf
- The European Space Agency declared its support to IPv6.
- The Japanese Intelligent Transport System (ITS) project and the European Car2Car http://www.car-to-car.org consortium recommended exclusively use of IPv6 for its future Car2car applications.
- The Digital Video Broadcasting (DVB-S) consortium decided to move to IPv6.
- The Chinese government created and financially supports CNGI, an IPv6 backbone network designed to be the core of China's Internet infrastructure. http://www.chinaipv6council.com/upload/Development.doc
- CENELEC has opted for IPv6 for the Smart home concept http://www.cenelec.org/Cenelec/CENELEC+in+action/News+Centre/Press+releases/Smart+House+IPv6+PR.htm
- GRID http://www.gridtoday.com/05/0117/104472.html has adopted IPv6 in its Globus Toolkit 4

These represent just a few of the numerous examples where IPv6 has major support from a government body or an industry consortium. In the case of government bodies, aggressive IPv6 adoption curves have pushed industry, particularly those vendors supporting or interacting with the government, to work toward IPv6 adoption themselves.

1.1.2 IPv6 as a solution tool

Organizations utilize information technology every day to solve business problems (Note: We will use the term "business" in the general sense – applicable to any organization, whether it be government, non-profit, or corporation). With the adoption of networking technologies to facilitate communications, conduct financial transactions, or exchange information, IPv4 has been quite successful, but it has been today pushed to its limit. Ignoring for a moment the issue of potential IPv4 address exhaustion, the limited volume of addresses has short changed technology advancements in areas like anycasting, multicasting, or peer-to-peer exchanges. Most advanced network support features like security and quality of service were afterthoughts – not part of the original design of IP. As a consequence, the standards bodies and industry have provided solutions that extended the capabilities of the network, but also drastically increased the complexity of the network and created additional problems.

Today, organizations are finding it increasingly more difficult to deploy new IT solutions that are cost effective and relatively simple to support. A heavy reliance on Network Address Translation (NAT) hinders network simplicity and becomes prohibitive to the creation and support of additional services. As a simple example, let's examine a Business to Business (B2B) relationship between an organization and its partners.

Company Biz.com has an extranet with 22 different vendors/partners for the purpose of supply chain management. Each company, including Biz.com, must use private addresses to number their internal network (i.e. 10.0.0.0/8). As it turns out, it is quite common for there to be network numbering overlap – e.g. Company Biz.com and 6 of the 22 partners all have nodes using the address 10.1.1.17. This creates a problem that can be remedied by using static NAT mapping to create unique addresses for each device that is accessible to the extranet partners. So 10.1.1.17 becomes 192.168.0.7 externally for Biz.com and an entry is made in the outward facing NAT device. Each partner that also has that address in use creates a similar entry, but with a "unique" address.

Each organization must participate in the process. It requires great coordination, extra equipment, and constant management. Clearly in this case, use of IPv6, with the ability to uniquely identify each node, alleviates the need for this complicated and expensive NAT mapping scheme. And this represents just one of hundreds of ways IPv6 can be used to solve "real world" problems that add value to the organization, and have Return On Investment (ROI) models attractive to management.

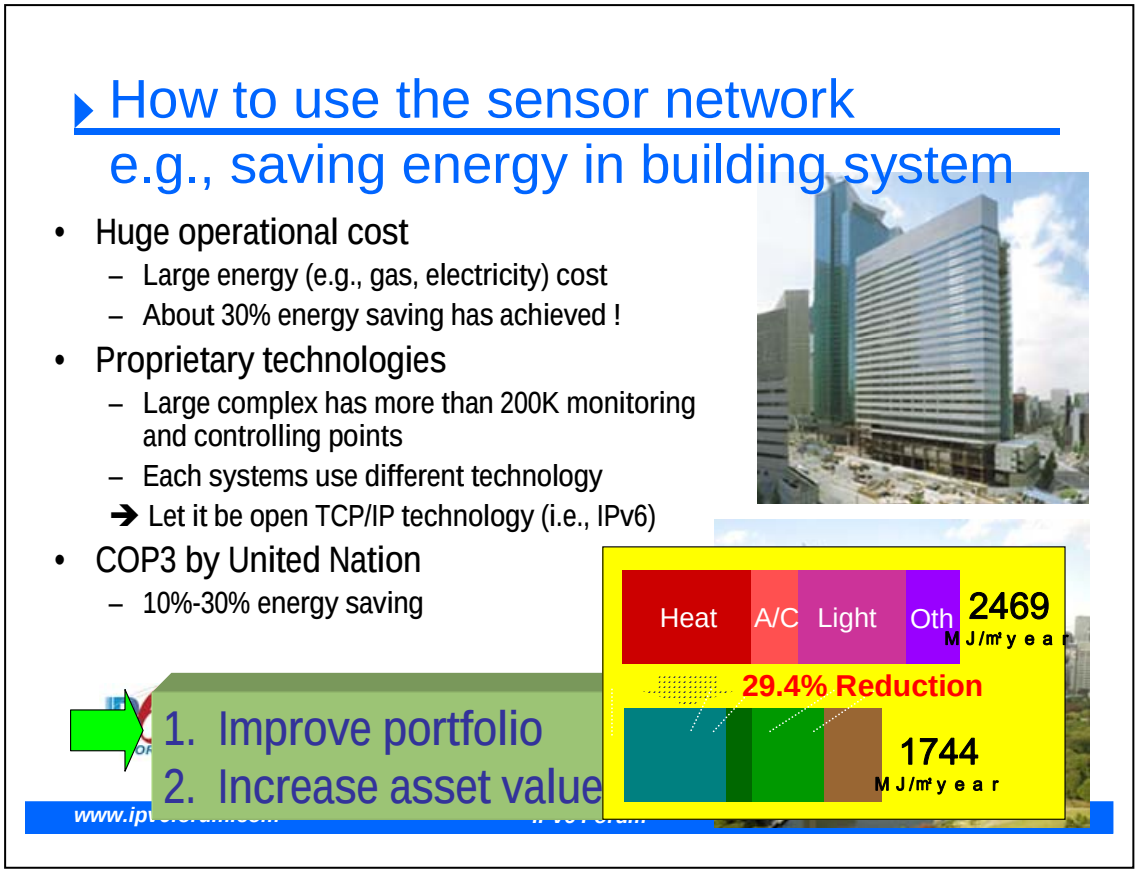
1.1.3 IPv6 as a foundation for innovation

IPv6 has several advantages over its predecessor, including a larger and more diverse address space, built in extensibility, and the power to support a more robust security paradigm. As such, it serves as a powerful foundation for the creation of new and improved net-centric set of products and services. Although the last few years will not go down in the annals of history as revolutionary for the Information Age, innovative thought didn't cease – it just moved into simmer mode. The IPv6 Forum, as pundits for the adoption of IPv6, has actively pursued and identified possible ways to leverage IPv6. This list is by no means exhaustive, but it does highlight a number of very promising technologies where IPv6 will be a critical building block:

- Ubiquitous Communications – With increases in the number of mobile phone users, the expansion of Internet-related services through the cellular networks, and an increasing number of connection mediums (UMTS, WiFi, Wimax, UWB, etc), there is a need for a uniform communications protocol that supports mobility and can handle a large number of devices.
- VoIP/Multimedia Services – VoIP has been making excellent progress from a technology adoption perspective. A move from H.323 to SIP has enabled more robust VoIP implementations with a greater level of simplicity and expandability. Additionally, the type of traffic occurring over the network is far more diverse, including data, voice, and video (currently known as *triple play, now quad-play with wireless*). The ability to access content, be it data, voice, or video on any platform is very attractive to end users, particularly those who are highly mobile. IPv6, with increased address space, a large multicast space capacity, and an affinity for SIP, serves as a logical platform for the expansion of these services.
- Social Networks – People interact. The form by which they do this has changed drastically over the years – from written letters, to phone calls, to e-mails, to SMS and IM messages. That evolution continues today. The ability to transfer photos, conduct conversations in private Peer to Peer (P2P), display personal information on the Internet, find like-minded communities, or play interactive games requires an Internet that is flexible, supports ad-hoc connections, and can be secured. IPv6, with its auto configuration capabilities and support for IPSec at the IP stack layer will be a critical tool to enable this environment.

- Sensor Networks – Sensor networks are a new concept. They can be found in manufacturing equipment, heavy machinery, security systems, and HVAC (heating, ventilation, and air conditioning) systems. What is new is the concept of integrating all those proprietary systems onto one communications systems. In a post 9/11 world, the use of monitoring systems to detect toxins and radioactivity in water systems, air filtration system, or at airport or shipping terminals around the world has substantially increased.

Yet the need for increased security and monitoring has to be offset against the cost of deploying and managing those systems. IPv6 offers a very stable and flexible platform that supports mobility, ad-hoc networking, and a large number of simple devices. See the example below of how IPv6-based sensors in a "smart" building can help lower building energy costs.



- Product Tethering/Communities of Interest – Manufactures would love to have relationships with their product once it leaves the factory. The reality is that most consumer electronic and white goods producers have little, if any, interaction with the end users of their product. In a world where all things can be connected, the opportunity to create new services, be it remote troubleshooting and device management, or providing value-added services – such as automated grocery shopping, are almost endless. Not only could the end users experience be enhanced, but the manufacturers, or their ISP partners can create new services not feasible in an IPv4 world.

As stated, this is by no means all the opportunities possible in an IPv6 world. Companies in Asia, Europe, and North American have already begun to look at IPv6 as a platform for creating a competitive advantage. Those companies that take the time and effort to understand IPv6 stand a good chance of leapfrogging their competition and vaulting into the next generation Internet with a substantial lead.

1.2 Building a Plan for IPv6

So the opportunity exists with IPv6 for those willing to consider the protocol as a tool for defining solutions to existing business problems, and a platform for innovation for next generation Internet products and services. How does the IPv6 Forum and industry continue the groundswell for IPv6 integration?

First, the need to understand IPv6, its features, and most importantly, how those map to potential networking problems are still needed. Although the IPv6 Forum and the regional task forces have provided all manners of educational opportunities for industry, there remains a need for a coordinated effort to increase IPv6 awareness at three levels:

- Strategic planning at the corporate level
- Return on Investment
- Technical knowledge at a tactical level.

To achieve a measure of success, the IPv6 Community needs to follow this basic strategy:

- Generate an interest in technical solutions at the CEO/CTO level. Stories of the virtues of auto configuration and the power of IPSec EH should be left at the door to the boardroom. Solutions that fix problems or build competitive advantages are compelling. The fact that IPv6 is the glue that makes the solution work should be last. Once these solutions are “sold”, IPv6 will become part of the long term strategies of these organizations.
- Create a framework for return on investment to justify sound decision-making. The IPv6 Forum is not in the business of defining a specific number, percentage, or time frame for ROI – organizations need to do these themselves. But providing them with the framework for an ROI model will expedite this process.
- Solutions sold at the Cxx level will need competent engineering and architecture to deliver. This requires formalized education and knowledge transfer... The Cxx level needs to understand and support this process.

This approach has achieved great success in the following three cases to name just a few:

- US DOD as a long term strategic planning large-scale organization
- The Chinese government that has a 20-year plan to connect its entire Industry, institutions and nations favored by its central planning system.
- 3GPP as a Greenfield standard for next generation wireless with strategic thinking in terms of scale and dimension of the project.

There are great many industries that the IPv6 Forum could approach – transportation, manufacturing, retail, security, health care – each has great potential and merit. The purpose of the Forum is to act as a catalyst for change that is grounded in IPv6.

Success will not be achieved by disorganized grass roots movements, or by repeatedly hammering away at n IPv6-based technology concept. As a body, the Forum should be focused on areas with the most promise, the greatest adoption to change, and where success may have been achieved already.

We have already seen some compelling usages of IPv6 come from Asia. However, these IPv6 wins are not always well publicized or well documented. Only through a coordinated effort will the Forum be able to continue as the leading advocate of IPv6 adoption.

1.3 The Business Initiative: Strategic Planning

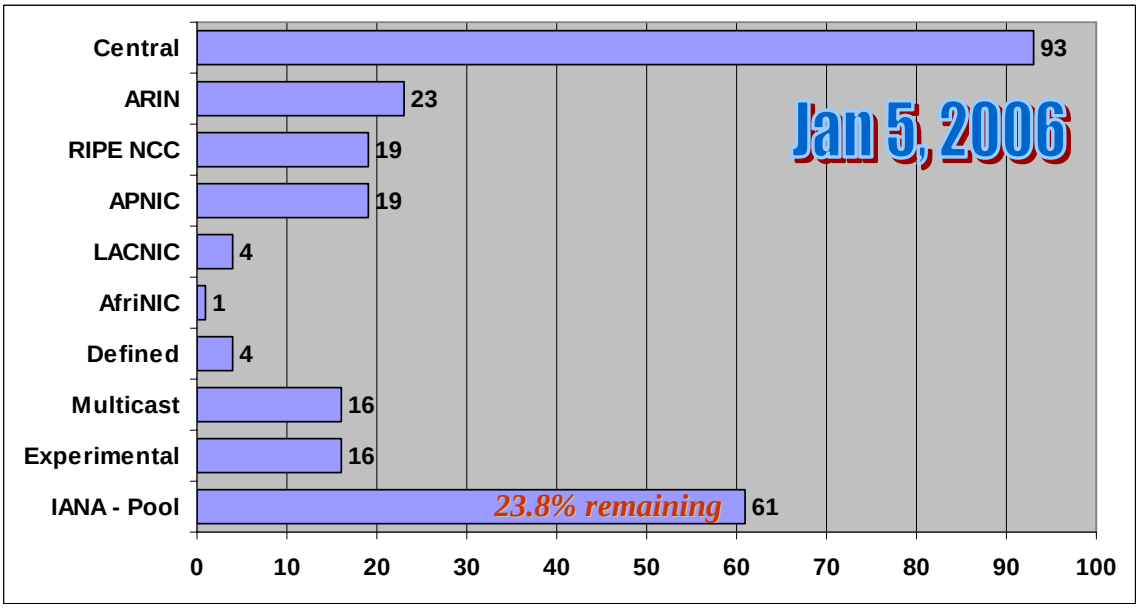
The quest for the ultimate business case has been the Achilles heel of IPv6. The business climate has been hostile to investments in new technologies since the Internet bubble and the 3G spectrum bubble and the successive terrorism attacks and war disruptions. The focus was and is squared on squeezing maximum revenues out of the current infrastructure.

Since IPv6 is viewed primarily as a long-term plumbing exercise, it's quite obvious that even if it offers the best of breed features it does not suffice to justify the investment in the plumbing. Unlike Y2K, there is no 'big bang' date at which IPv4 address space will run out; thus there is no perceived urgency in IPv6 deployment while ISPs can take revenue from IPv4 deployment. The choice between an immediate deployment and a gradual technology refresh is fairly obvious depending on the size of the address space allocated to the region in question.

1.3.1 Address Space

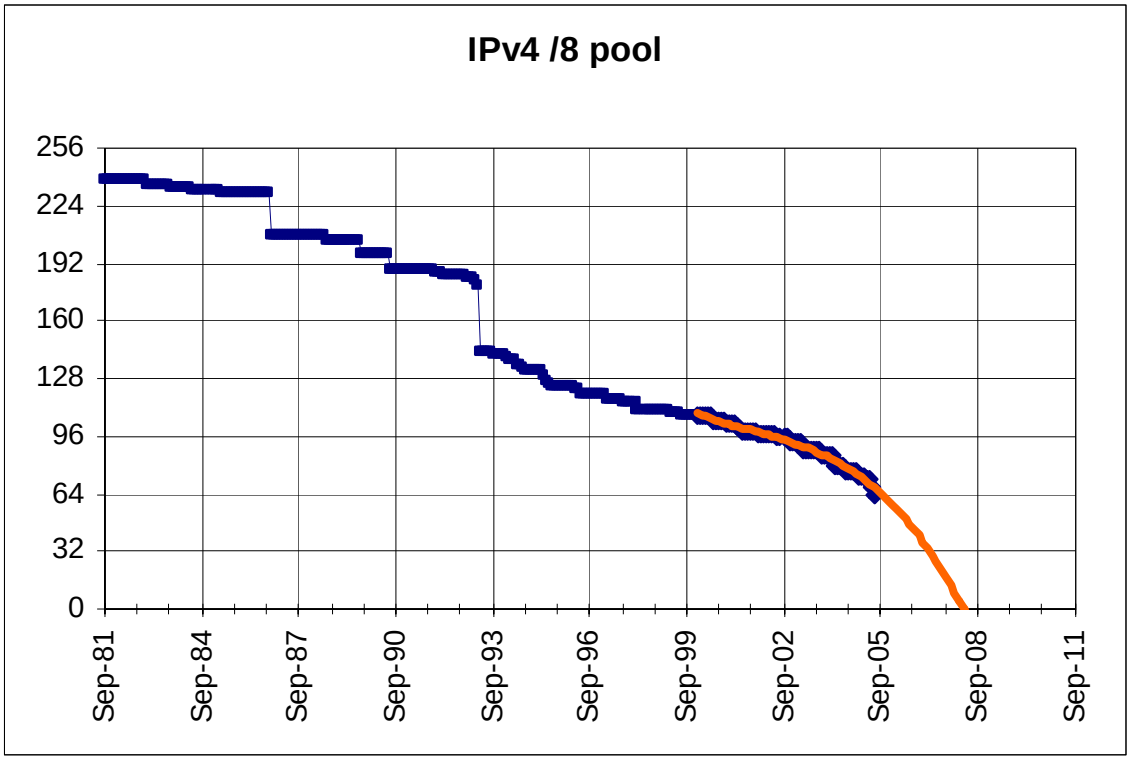
The new study published in Sep 2005 by Tony Hain @ Cisco demonstrates an alarming trend of the IPv4 address depletion rate.
http://www.cisco.com/web/about/ac123/ac147/archived_issues/ipj_8-3/ipv4.html

The following chart shows the distribution of all 256 IANA /8 allocation units in IPv4 as of July 1, 2005. The Central registry represents the allocations made prior to the formation of the *Regional Internet Registries* (RIRs). ARIN (North America) [2], RIPE NCC (Europe) [3], APNIC (Asia/Pacific) [4], LACNIC (Latin America) [5], and AfriNIC (Africa) [6] are the organizations managing registrations for each of their respective regions. RFC 3330 [7] discusses the state of the Defined and Multicast address blocks. The Experimental block (also known as *Class E*—RFC 1700 [8]) was reserved, and many widely deployed IPv4 stacks considered its use to be a configuration error. The bottom bar shows the remaining useful global IPv4 pool. To be clear, when the IANA pool is exhausted there will still be space in each of the RIR pools, but by current policy [9] that space is expected to be only enough to last each RIR between 12 and 18 months.



IANA allocated 25 /8's between Jan. 1, 2004 and Jan. 5, 2006
Typical RIR re-allocation period 9-12 months

The following graph provides the exhaustion perspective, showing the entire address pool from the publication of IP Version 4 (note that data prior to 1995 is accurate as to where it was allocated, but with very coarse granularity as to exactly when). The projection curve is based on the IANA allocations from January 2000 onward.



This study will be reviewed and updated by Tony Hain on a quarterly basis: http://www.tndh.net/~tony/ietf/ipv4-pool-combined-view.pdf

1.3.2 Recent study of Lumeta

The recent study of Lumeta (http://www.lumeta.com) its conclusions as follow:

- The IPv4 growth will slow/stop/reverse in 2-5 yrs while IPv6 growth will accelerate.

- The IPv6 adoption will reach 95% coverage with following growth assumption:
  - Too Slow: At 76% average per year: 24-25 years
  - Too Fast: At 668% average per year: 6-7 years
  - Just Right: At 334% average per year: 9-10 years

- The U.S. will be reach 95% coverage by 2015.

Lumeta concluded that *Network Address Translation* (NAT) and CIDR did their jobs and bought the 10 years needed to get IPv6 standards and products developed. Now is the time to recognize the end to sustainable growth of the IPv4-based Internet has arrived and that it is time to move on. IPv6 is ready as the successor, so the gating issue is attitude. When CIOs make firm decisions to deploy IPv6, the process is fairly straightforward. Staff will need to be trained, management tools will need to be enhanced, routers and operating systems will need to be updated, and IPv6-enabled versions of applications will need to be deployed. All these steps will take time—in many cases multiple years. The point of this article has been to show that the recent consumption rates of IPv4 will not be sustainable from the central pool beyond this decade, so organizations would be wise to start the process of planning for an IPv6 deployment now. Those who delay may find that the IANA pool for IPv4 has run dry before they have completed their move to IPv6. Although that may not be a problem for most, organizations that need to acquire additional IPv4 space to continue growing during the transition could be out of luck.

1.3.3 Independent study on IPv6 RTI for US DoC

The US Department of Commerce released in February 2006 the first independent study of the fast forming IPv6 marketplace, as well as a cost benefit assessment of the transition to IPv6. http://www.ntia.doc.gov/ntiahome/ntiageneral/ipv6

Some of the highlights of these reports, which were supported by economic impact analysis from RTI International in the later half of 2005, should make businesses and Government organizations stand up and take notice.

This report presents estimates of the costs and benefits associated with transitioning from Internet Protocol Version 4 (IPv4) to Internet Protocol Version 6 (IPv6). Cost estimates are based on likely development and deployment scenarios provided by stakeholders during interviews conducted by RTI International (RTI). Based on interviews, RTI estimates the present value of incremental costs associated with IPv6 deployment over a 25-year period to be approximately $25 billion ($2003), primarily reflecting the increased labor costs associated with the transition. Although these cost estimates seem large, they are actually small relative to the overall expected expenditures on IT hardware and software and even smaller relative to the expected value of potential market applications.

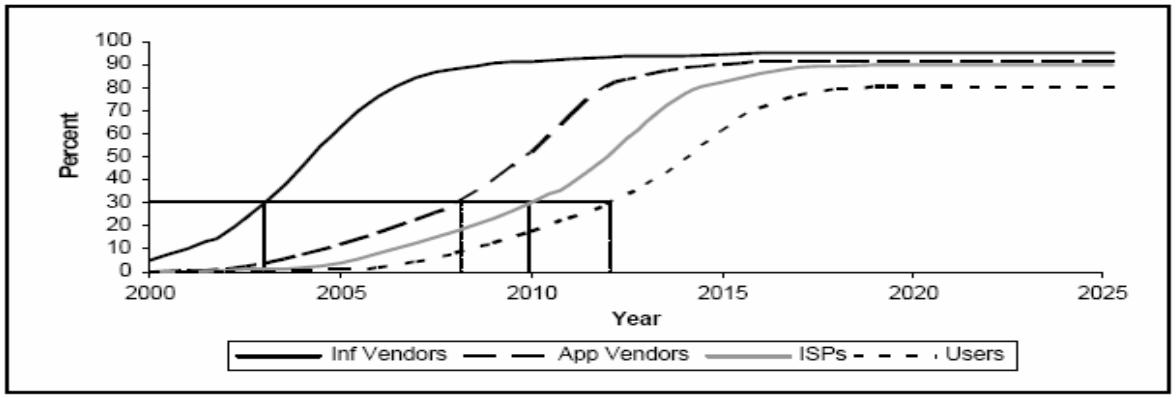
Because major applications for IPv6 have yet to emerge, it is more difficult to quantify their potential benefits. Stakeholders participating in this study identified several major categories of IPv6 applications that, in total, are estimated to have potential annual benefits in excess of $10 billion. These categories include Voice over IP (VoIP), remote access products and services, and improved network operating efficiencies.

However, benefits estimates included in this report are more subjective than cost estimates because they are based on Internet applications that are yet to be well defined. In addition, benefit estimates are potentially conservative because they do not reflect future, next generation applications that may be enabled by IPv6.

Based on interviews with stakeholders, the penetration curves in Figure ES-1 were constructed to represent likely deployment/adoption rates for the four major stakeholder groups. The infrastructure and applications vendors' curves represent the path over which vendor groups will offer IPv6-capable products to customers. For example, based on information provided in interviews, RTI estimates that 30 percent of infrastructure products offered by vendors were IPv6-capable by 2003, and 30 percent of Internet applications offered by vendors are projected to IPv6-capable by 2008.

As shown in Figure ES-1 below, the ISP curve represents the share of ISPs' networks that are expected to be IPv6-enabled. On average, RTI estimates that 30 percent of ISPs' networks will be IPv6-enabled by 2010. Similarly, the users curve represents the share of users' networks (including infrastructure vendors, application vendors, and ISPs' internal network users) that are projected to be IPv6-enabled. For example, on average, 30 percent of users' networks are projected to be IPv6-enable by 2012.

Figure ES-1. Penetration Estimates of IPv6 in the United States



The analysis of the report for the US market includes:

- A services market that is approximately 25 Billion dollars over the next quarter century.
- A market that generates 10 Billion dollars of cost savings EVERY YEAR.
- A market that for every dollar invested returns 10 dollars in cost savings.
- A market that has 8 cents of every dollar going toward the actual infrastructure update, with the other 92 cents being invested in taking advantage of it.

A market that has important cost savings in 4 key areas:

- Improved Security
- Increased Efficiency
- Enhancement of Existing Applications
- Created of net-new Applications

We see a market that is enabled by creative thinking, solid training, and enlightened delivery mechanisms. This report should act as a sign post to prosperity. Too early to be a road map, but a powerful indicator for forward thinking organizations around the globe.

No longer is IPv6 an 'unfunded mandate' waiting for a multi-billion dollar appropriation from the US Congress or any other government. Now we have the first independent assessment of this new marketplace as a large market, with a ten to one return on investment, which unlocks hidden value within organizations while saving them real dollars in operations.

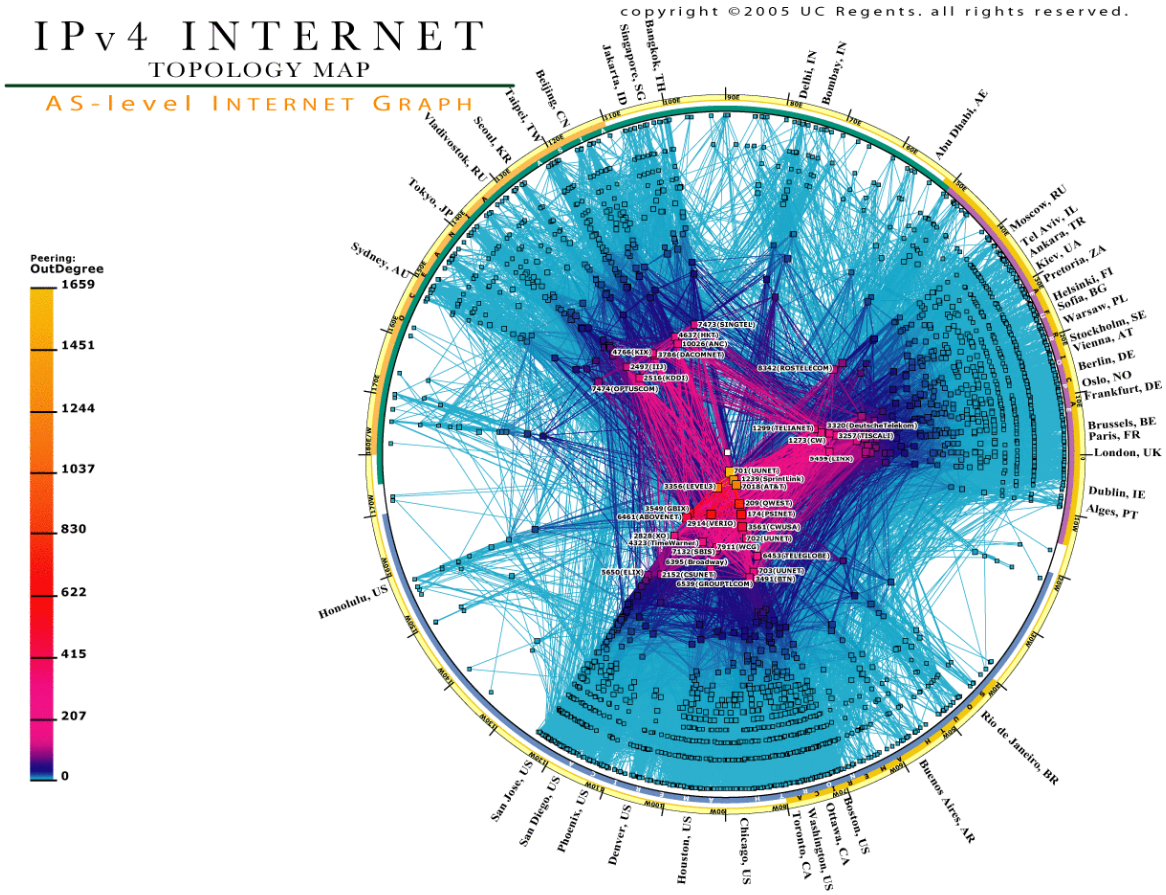
The RTI report has prompted the very senior Washington DC business executive, Jim Garrettson, to organize an IPv6 briefing conference in DC as part of his ExecutiveBiz briefings to Corporate CEOs and Congressmen. Congressman Tom Davis, an advocate of IPv6 has accepted to join. The president of the IPv6 Forum was invited to deliver a keynote on **The New, New Internet** IPv6: Technology's Next Big Step: **https://www.execbizevents.com/ExecutiveBiz/events/event.php?event_id=17**

Conclusion and recommendation:

IPv6 is the place to be. IPv6 is already available to forward-thinking countries and corporations wanting to sustain an advantage over their competitors. Only now have European organizations begun taking steps towards a transition to IPv6. This document describes the features and functions that will keep them competitive globally.

1.3.4 Deployment of IPv6 worldwide

The following chart shows that the IPv4 connections are highly meshed around a very dense core with MCI/UUNET (now Verizon) at its centre. The US has by far the highest density of networks.



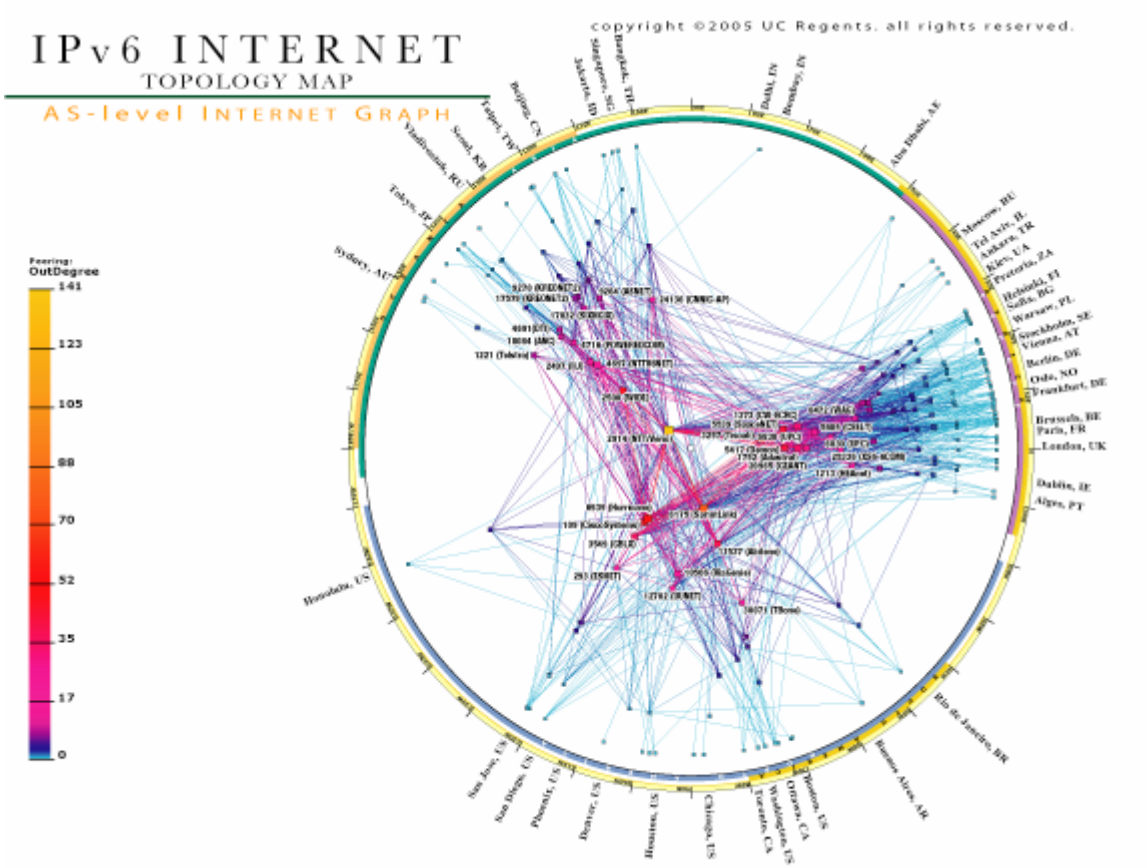
Source: Page URL: http://www.caida.org/analysis/topology/as_core_network/AS_Network.xml

Last updated: Tue Jul 19 14:34:10 PDT 2005 Maintained by: Bradley Huffaker

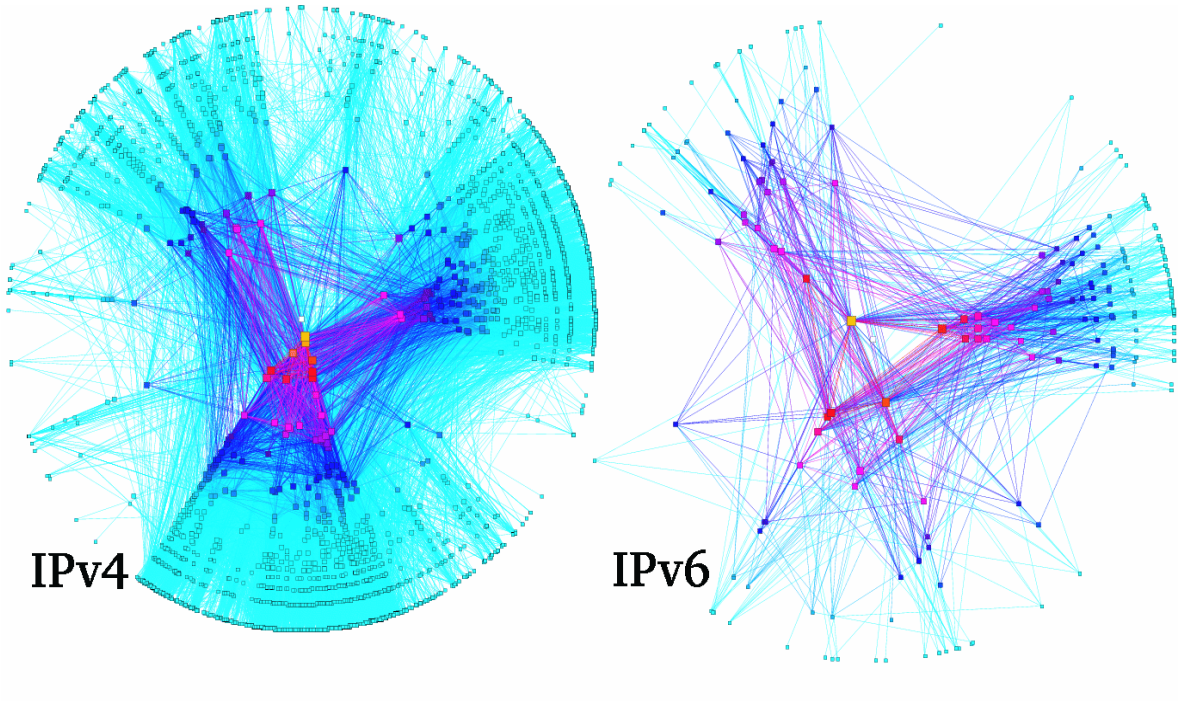
The following chart shows that the number of IPv6 connections is increasing constantly reaching a respectable size. Europe leads with over 50% of the connections. A comparison to the densely connected IPv4 to the IPv6 world demonstrates the readiness of the non-US based networks and the possible domination of their IPv6 services in the future

This visualization represents a macroscopic snapshot of the IPv6 Internet topology collected around March 4th, 2005. Topology data gathered from 17 monitors probing approximately 860 globally routable IPv6 network prefixes include 2,913 IPv6 addresses and 7,905 IPv6 links.

This view aggregates the network into a topology of Autonomous Systems (ASes). Each AS approximately corresponds to an Internet Service Provider (ISP). Each IPv6 address is mapped to the AS responsible for routing it, i.e., to the origin (end-of-path) AS for the IPv6 prefix representing the best match of this address in Border Gateway Protocol (BGP) routing tables.



In comparison with the IPv4 AS graph, the IPv6 AS graph is much sparser with drastically fewer nodes and less richness of peering observed. The geographical patterns of the graphs also differ. While the majority of ISPs with the highest outdegrees in IPv4 space are all located in the U.S., the company with the richest observed IPv6 peering is NTT/Verio headquartered in Japan, with 141 peers. The largest cluster of high degree IPv6 AS nodes is in Europe (clustered around Tiscali which is headquartered in Germany) in the graph.



The purchase of Teleglobe by India-based VSNL places India as one of the largest international production IPv6 ISPs. In Europe, so far only Telesonera has announced its IPv6 service to end-users while France Telecom is readying its network for international and large-scale service after acquisition of its /19 IPv6 address space. Of the dominant ASes in the IPv4 AS graph, only SprintLink and UUNET are near the core in the IPv6 graph, and only SprintLink shows rich IPv6 connectivity. This disparity is consistent with the U.S. industrial attitude toward IPv6 as still more experimental rather than operational reality. However, we must note that these IPv6 peering relationships are not exclusively native (i.e. some are built on IPv6 over IPv4 tunnels). Understanding which are native will give us a better perception about IPv6 evolution, because in some cases non-native IPv6 peering might prove to be negative (when heavily distorting geographic topology).

1.3.5 Vendor Readiness

Under the initiative of the IPv6 Forum, the IPv6 Ready logo program was introduced in 2004 to create a worldwide interoperability scheme to get vendors to accelerate adoption of IPv6 based on real interoperable compliance testing and validation.

Due to the complexity and worldwide scope of this task, an executive committee was formed from the leaders of this work winning the Japanese TAHI team, the US-based UNH-IOL and the European-based IRISA to collectively design the interoperability specifications for worldwide execution. http://www.ipv6ready.org

A two-phased program was launched sanctioned by two levels of logos. The IPv6 Ready Silver Logo program a minimum set of RFC compliance to be obtained, while the Golden Logo requires mobility support, Multicast and IPsec support. It is envisioned to introduce a third phase in 2007 to mandate IPsec in all implementation, a task that needs careful market assessment and vendor acceptance since it put a very high pain level of investment on the design and deployment of these products.

Status April 2006:

	Europe	USA	ASIA						
			Total	Japan	Korea	Taiwan	China	NZ	India	PH
Silver Logo	8	30	191	107	27	32	12	8	4	1
Golden Logo	1	8	28	18	4	2			3	
Total	9	38	219	125	31	34	12	8	7	1
%	4%	14%	82%	48%	12%	13%	5%	3%	3%	

An important recent development for broadband and IPv6 is the development of the DOCSIS 3.0 standard for cable modem deployment. The DOCSIS 2.5 standard cannot wait for the whole features set but need to have immediate features like IPv6. DOCSIS 3.0 includes IPv4 and IPv6 support as standard, such that providers can deploy and use IPv4 and/or IPv6. Also, in scenarios where the provider has millions of customers, private IPv4 addressing is not sufficient to manage the volume of infrastructure devices, so DOCSIS 3.0 also facilitates use of IPv6 for infrastructure management, whether or not the provider's end-users are offered IPv4 or IPv6. The ITU has supported previous DOCSIS versions so are expected to also support DOCSIS 3.0.

Most of the P2P applications are driven out of the US and therefore the IPv6 awareness among the applications designers is not under their radar.

The issue of raising awareness in above sectors resides in two levels:

- Strategic planning at corporate level and
- Lack of knowledge at tactical level.

To win these two levels, we need to address:

- The strategic awareness issue at CEO/CTO level, so that IPv6 is built-in in the long term corporate strategic business planning
- The corporate planning to prepare skills and knowledge of its engineering work force ahead of the deployment. Grassroots efforts have no chance in these rough times.

This Forum should not use the fire hose approach and try to convince any CEO/CTO into this exercise. The approach should be focused on a first come first served innovation opportunity to achieve fast track take-up. Industry sectors with high potential of immediate adoption of IPv6 should be specifically targeted with a convincing technical and business case.

This approach has achieved great success in following three cases to name just a few:

- US DOD has a long term strategic planning large-scale organization
- The Chinese government that has a 20-year plan to connect its entire Industry, institutions and nation, favored by its central planning system.
- 3GPP as a Greenfield standard for next generation wireless with strategic thinking in terms of scale and dimension of the project.

The targeted industries by this Forum hold some promise but are not a guarantee of success as an application that needs IPv6 is not always developed by the vendor that has the vision and the skills to deploy IPv6. So, the surprise effect will always play a major role in this undertaking. IPv6 should also not create a planned economy but should be a catalyst for unpredictable innovations.

However, every effort should be made to win 10 new large-scale applications that will rival the web browsing and email access as everyday key applications adding value to business and social users. These applications could directly be access infrastructure-oriented like broadband and Home networks or end-user applications like VoIP, 3G IMS, Peer-2-Peer gaming, etc, see the TA for the targeted industries.

1.4 Recommendations: The Way Forward

Above discussed sectors will deliver in the long run IPv6 services. Now, we need to achieve short-term successes to ramp up deployment of IPv6 in immediate infrastructure and applications over the course of 2005 and 2006.

Industry worldwide is called upon to:

- Promote IPv6 over Broadband: as a benchmark, the Taiwanese and Japanese success story with broadband access using IPv6 is the first visible service where IPv6 can be deployed immediately and in larger scale. Taiwan will deploy IPv6 broadband access for 6 Mio users by 2008 and Japan's Softbank will deliver IPv6 by end of 2006 to its 5 Mio users. The Korean strategy is to drive WiBro with IPv6. These are examples for ISPs to look into and win experience from. The EU IPv6 Task Force has published a Communication for this potential deployment: http://www.european-ipv6-tf.org/Whitepapers/Forms/AllItems.aspx
- Promote VoIP over IPv6: The other immediate and strategic area where IPv6 could be introduced immediately is in VoIP. An effort in convincing the Telecom industry and operators is critical since in the US corporate operators are deploying VoIP to eat their own lunch. Operators need to be convinced to have a new approach to VoIP using IPv6.
- Promote IPv6 ready technologies and the companies working in the ICT domains, facilitating the development and growth of SMEs working in new innovative ICT fields and promote the use of SMEs products by the large groups. One domain we should focus is Software. Innovation comes mainly from software. Off-the-shelf networking software reduces drastically the Time to Market and Costs.
- Promote open source Linux and BSD implementation of IPv6
- Promote IPv6 for home networking. The IPv6 Forum partnership with CENELEC outlining the technical guidelines and practices to achieve successful use of IPv6 in the home connectivity market
- Fully participate in the R&D activities with a view to put in place an integrated and structured set of IPv6 activities, covering the full range of IPv6 aspects, from basic research through the development of service enablers and associated software suites, to the large scale trailing and testing of IPv6 features, for a diversity of applications.
- Actively contribute towards the acceleration and alignment of on-going IPv6 work within standards and specifications bodies and urgently develop key guidelines permitting the rapid integration of IPv6 infrastructures and interoperability of IPv6 services and applications, especially in The IPv6 Forum Ready Logo Program: http://www.ipv6ready.org
- Where appropriate, develop roadmaps for the design, development and deployment of IPv6 services, equipment and networks, to include technologies such as AAA, DNS, xDSL, etc.

- Contribute actively to the work of the National IPv6 Forum /Task Forces, ensure the collectively increase of IPv6 awareness and permit its members to individually derive their own perspective of the IPv6 business case and their own IPv6 integration strategy.
- Devote efforts towards the establishment of a world-wide, vendor independent, training and education program on IPv6.
- Consider in their manufacturing plans that the majority of mobile devices, and a growing number of household and consumer-electronic devices will require some form of IP connectivity and that the simplest way to offer these devices the fullest range of services is to have a unique globally routable IPv6 address available for all network-enabled components.
- Seek to develop innovative IPv6-enabled devices, e.g. biometric security devices, "IP in a chip" embedded systems components, in-car sensor devices. Seek to design and implement innovative peer-to-peer applications where appropriate, e.g. peer-to-peer gaming in the entertainment industry.
- Take early steps to obtain adequate IPv6 address allocations and where appropriate, and to either accelerate the offer of IPv6 capable services or consider on a priority basis how best to rapidly evolve towards IPv6.
- Address the multi-vendor interoperability issues impeding the wide-scale deployment of PKI and to conduct extensive trials with IP security in IPv6 and the parallel implementation of a PKI.
- Promote IPv6 over Satellite and HDTV over IPv6: With the advent of the all-digital TV by 2010, there is a clear potential in this strategic market. It would be highly recommended to promote High Definition Video Delivery Service over IPv6 Internet by:
    - Establishing operation and extension of IPv6 network infra for HDV contents delivery service.
    - Applying network-monitoring tools for analyzing the number of users and IPv6 traffics with VoD service.
    - Developing HDV contents service techniques based on VoD and its management schemes.
    - Building VoD server & its web site for HDV contents (e.g., cultural, medical, educational multimedia contents) service and testing operation and by developing multi-user remote videoconference system based on HD video delivery service and encouraging it.

2. TECHNOLOGY DRIVERS

2.1 Introduction to IPv6

Internet Protocol version 6 (IPv6) is the next generation protocol for the Internet, designed to support continued Internet growth in number of users and functionality. The current Internet protocol version, IPv4, was developed in the 1970's and provides the basis for today's Internet interoperability. IPv4 suffers some limitations that inhibit the growth of the Internet and its use as a ubiquitous global communication medium.

IPv4 allows for as many as 2^{32} addresses, which is 4,394,967,296. While this seems like a large number, inefficiency in the assignment and use of addresses limits the practical scaling to a few hundred million active public addresses[1], severely limiting Internet growth. Considering that the population of the Earth is approximately 6.6 billion people, we can not even afford to give a single IPv4 address to every person on the Earth. Since many people in developed countries already have several IP capable devices per person, the limitation of the Internet to a few hundred million active devices is severely limiting the ability to converge global communication infrastructure on the Internet.

IPv6 has been under development by the Internet community for over ten years and is designed to overcome IPv4 limitations by greatly expanding available IP address space (every entity on the network needs an address), and by building in features such as end-to-end security, mobile communications, quality of service, and easing system management burdens.

The emergence of the Internet as a fundamental technology for commercial and social activity has been most apparent since the creation of the World Wide Web in the mid 90's. The Internet has grown rapidly in the past five years, to a scale well beyond that which the original Internet designers envisaged over twenty years ago.

Today worldwide Internet economy is a reality. Growing adoption of the Internet by consumers drives several markets such as home devices, mobile wireless equipment, transportation, media and others to introduce a new generation of products that embed the IP protocol. It is anticipated that with global connectivity, which is different from global access to the network, a network may want to keep some privacy. This is a foundation for Business to Business (B-to-B), Business to Consumer (B-to-C) and Consumer to Consumer (C-to- C) services and its inherent evolution to push the services towards the edge of the network, where a particular device needs to be reached, served or monitored. It must be also noticed that recent deployment of new broadband access technologies such as Ethernet-to-The-Home, WiFi, and SDSL, enable symmetric communications from end user sites.

Future network growth requires that Internet-enabled devices can be assigned and use a globally unique IP address. Without sufficient global IP address space, applications are forced to work with mechanisms that provide local addressing for local internal communications and workaround "fixes" to communicate externally across the Internet.

[1] *Practical address space utilization is measured according to the "HD-Ratio" [RFC 3194], which is calculated as follows:*

$$\text{HD Ratio} = \frac{\log(\text{number of assigned objects})}{\log(\text{maximum number of assignable objects})}$$

While waiting for a permanent address space solution, there have been numerous optional "fixes" (such as Network Address Translation – aka "NAT") and extensions to IPv4 to try to overcome the address space limitations.

Network Address Translation (NAT) allows multiple devices to be "hidden" behind one or more real IPv4 addresses. Such mechanisms restrict the end-to-end transparency of the Internet. While NAT has to some extent delayed the pressure on IPv4 address space for the short term, it places severe restrictions on application bi-directional communication.

While a client behind a NAT device can communicate out to servers on the Internet (the "client-server" communication model), that same client cannot be guaranteed to be accessible when external devices wish to establish a connection to the client (as typified by the "peer-to-peer" communication model). NAT breaks the end-to-end principle of the Internet, restricting many applications that could be deployed as peer-to-peer to be deployed with a more complicated and expensive modified client-server model that relies on communications gateways and "middlebox" servers to connect hosts. NAT is inhibiting the evolution of next generation applications that demand IP address space and direct remote connectivity into business premises and home networks (e.g. from IP-enabled mobile handsets).

IPv6 reintroduces the ability to provide true end-to-end security that is not always readily available through a NAT-based network.

IPv4 fixes like NAT have generally been applied at the cost of greatly increased network complexity and slower network performance. Introduction of IPv6 will reduce the complexity and solve many of these problems.IPv6 is the only solution that provides the vastly increased IP address space and new features that will allow the Internet to grow and to scale into the next decade and beyond.

The ongoing transition of the global Internet from IPv4 to IPv6 will span many years, and is projected by many to last longer than a decade. Many organizations introducing IPv6 into their infrastructure will operate in a dual-stack environment, supporting IPv4 and IPv6 concurrently for the foreseeable future. For organizations that are beginning a transition to IPv6, it is very hard to recommend any one IPv6 transition strategy. Though deploying dual stacks to support native IPv6 capability is the preferred solution, one size doesn't fit all. Transition strategy depends on individual business case and whether new infrastructure is being installed and can be "born IPv6" or IPv6 is going to be integrated into an existing IPv4 infrastructure.

The three main transition strategies are:

1. **Dual Stack Everywhere** – hosts (workstations, PCs, and servers) and routers all running IPv4 and IPv6 stacks on the same network interfaces. Network applications, services, management, and security infrastructure are upgraded to operate on both IPv4 and IPv6. Application level gateways or proxy servers built on dual stack servers can also be used to transition legacy IPv4 based client-server applications to IPv6.

2. **Tunneling** – encapsulating IPv6 packets within IPv4 packets for transmission over IPv4-only network infrastructure. A network infrastructure may also be born "IPv6-only" and tunnel IPv4. Tunneling may be through manually set up tunnels, brokered tunnels[2], or numerous automated host-to-router tunneling solutions. If tunneling is used, an enterprise's security and network management infrastructure still needs to be upgraded for IPv6.

3. **Protocol Translation** – last resort. Translation of IPv4 packets to IPv6 and vice versa, but only as a last resort this is because translation interferes with end-to-end network communications and security. Since most new IPv6 equipment is deployed with a dual stack, the IPv4 side is compatible with legacy IPv4 devices without translation.

Organizations utilizing these transition methods must make careful consideration of issues related to security, interoperability, performance, and cost when developing detailed plans.

An incremental phase-in transition approach allows for a significant period where IPv4 and IPv6 will co-exist using some or all existing transition mechanisms. Depending on an organization's policy, transition to IPv6 could occur during a regular "technology refresh" programs where IPv6 capable products are introduced during regular network upgrades, or may be "mandated" to occur out of cycle.

It is critical that planning is done prior to introducing IPv6 into a network. Successful IPv6 transition should be designed to have almost no impact existing IPv4 infrastructure and allow co-existence of IPv4 and IPv6 networks.

2.2 IPv6 Technical Advantages

IPv6 has numerous technical features which, when compared to IPv4, making it a more powerful and flexible framework to deploy next-generation network applications and services. These numerous advantages combined make IPv6 a "more powerful toolkit" for building new network services and applications, while extension headers make it easy to integrate future features and services without rewriting the protocol.

Some key features are:

IPv6 Feature	Advantage (Compared to IPv4)
128-bit Addressing [RFC 2460]	Scalability from 2^{32} potential addresses to 2^{128} addresses, vastly expanding usable unicast and multicast address space
End-to-End Addressing [RFC 2460]	Reintroduces the end-to-end model to greatly lower the cost and complexity of peer-to-peer communications by eliminating the need for Network Address Translation (NAT)
Network Layer IPsec	Improved security support via IP layer security (IPsec) making it cheaper to deploy VPN-like security for all

[2] *Ref: RFC 3053 "IPv6 Tunnel Broker"*

[RFC 2460, 4301, others]	applications
Improved QOS Support [RFC 2460]	More QOS options with flow labels and extension headers
Autoconfiguration [RFC 2461, 2462, others]	Improved "plug and play" support using IPv6 link-local addressing, scoped multicasting & anycast support to automatically self-configure and discover neighbor nodes, routers, and servers
New Address Types [RFC 4291, 4193]	New addressing options for link local, anycast, intra-domain[3], and globally unique Internet communications.
Security Addressing [RFC 3041, 3972]	New security addressing options for randomly generated addresses to protect privacy and cryptographically generated addresses used to sign and authenticate messages
Enhanced Multicast Features [RFC 2460, 3306, 4291]	Enhanced local and global multicasting support scoped multicasting, and tremendous expansion of usable multicast address space. Each site receiving an IPv6 prefix can generate 2^{32} globally routable multicast groups[4]. IPv6 multicasting can support creation of new geo-spatial and community of interest information distribution paradigms. Multicasting is a key feature used extensively for IPv6 autoconfiguration features
Multihoming Features [RFC 4291]	Multiple addresses can be assigned to IPv6 network interfaces. Use of different addresses can be used to differentiate link-local, intra-domain, and global messages. Addresses can be assigned and utilized for specific security, reliability, load-balancing, and QOS policies.
Simplified Header [RFC 2460]	Improved header structure that retains only the absolutely necessary header fields and eliminates IPv4's unnecessary CRC checksum fields. Speeds up packet processing in routers and makes basic IPv6 header more compressible (than IPv4) for low data rate wireless and dial-up connections.
Extensible Headers [RFC 2460]	Extension headers are an extremely powerful feature that allows additional protocol-level information to be added to the basic IPv6 header. This is the way additional protocols and services such as IPsec and mobile IPv6 are easily integrated on top of the basic IPv6 protocol
Advanced Network Services [RFC 2460]	Basic Ipv6 features and extension headers can be leveraged to build more powerful network services for mobility, security, QOS, peer-to-peer applications, etc.

[3] *Ref: RFC 4193 - Unique Local IPv6 Unicast Addresses*
[4] *Ref: RFC 3306 - Unicast-Prefix-based IPv6 Multicast Addresses*

2.3 New IPv6 Network Services

New network services have already been written to take advantage of the powerful IPv6 protocol framework. Two emerging network service protocols, Mobile IPv6 (MIPv6) [5] and Network Mobility (NEMO) [6] already provide powerful and scalable network services that enhance connectivity and reachability.

Mobile IPv6 provides an efficient, scalable mechanism for reaching nodes while they move to different points in the Internet. Using Mobile IP, nodes may change their point-of-attachment to the Internet without changing the IP address where they can be reached. This allows them to maintain transport, higher-layer connections, and stationary DNS entries while moving. Node mobility is realized without the need to propagate host-specific routes or active DNS updates throughout the Internet. MIPv6 is designed to support movement across wide area networks where users need to carry their mobile devices across multiple LANs with different IP addresses.

Some good operational examples of MIPv6 deployment environments are laptop users migrating to various WIFI hotspots and 3G PCS networks where MIPv6 provides a transparent movement service that keeps applications working when users migrate to different carrier networks.

Network mobility provides a low-cost and scalable common convergence mechanism to provide mobility service to support VPNs, SIP and VOIP telephony, streaming media, and many peer-to-peer messaging and collaboration applications. Though limited mobility support can be provided in an IPv4 network, IPv6 multihoming, security, and extension header features make it more efficient, scalable, and secure.

NEtwork MObility (NEMO) enables entire networks to move to new attachment points in the Internet without reconfiguration of every node. The protocol is an extension of Mobile IPv6 and allows session continuity for every node in the Mobile Network as the network moves. It also allows every node in the Mobile Network to be reachable while the network is moving around to new attachment points. A NEMO enhanced mobile router, which connects the network to the Internet, runs the NEMO Basic Support protocol which sets up a bi-directional tunnel to a Home Agent router residing at the network's home connection point. Messages arriving at the home network for mobile network's nodes get forwarded from the home network to the NEMO router at the new location. This type of mobility allows entire network to be rapidly moved to new areas and attached to the Internet without renumbering the nodes inside the network or changing DNS entries. The protocol is designed so that network mobility is transparent to the nodes inside the Mobile Network. NEMO is currently an IPv6-only service built leveraging IPv6 multihoming, security, and extension header features.

2.4 IPv6 Standardization and Deployment Today

IPv6 adoption is rapidly accelerating as IPv6 infrastructure is deployed throughout the Internet backbone and major wide-area networks. IPv6 has been extensively tested and deployed in tier-1 Internet backbone networks run by AOL Transit Data Network, AT&T, Global Crossing, Level 3, MCI, NTT (Verio), Sprint Nextel, Qwest, SAVVIS, VSNL-Teleglobe, Telesonera, France Telecom, Telefonica and others.

[5] *Ref: RFC 3775 - Mobility support in IPv6 (MIPv6)*
[6] *Ref: RFC 3963 - Network Mobility (NEMO) Basic Support Protocol*

Many major wide-area research and development networks have been running IPv6 infrastructure, services, and applications over the last few years. Some example networks that are now running native IPv6 backbones are:

- AARNET in Australia
- Abilene (Internet2) in US
- ERNET in India
- CSTNet2, CERNET2 in China
- Gigabit European Academic Network (GEANT) and All European NRNs
- JGN2 and WIDE in Japan
- KREONET2 in Korea
- RedCLARA in Latin America
- RUNet and FREEnet in Russia
- TANET2 and TWAREN in Taiwan

The IETF now considers IPv6 to be mature enough to begin shutting down the IPv6 working group and concentrate on deployment issues with the IPv6 Operations (V6ops) working group. At the 64th IETF, the IPv6 WG chairs Brian Haberman and Bob Hinden made a presentation on "Advancing IPv6 Core Specification to Full Internet Standards" which further highlighted the standard's maturity. See: http://www3.ietf.org/proceedings/05nov/slides/ipv6-5.pdf

The IPv6 core specifications are generally defined as consisting of:

- [RFC 1981] Path MTU Discovery
- [RFC 2460] IPv6 Protocol
- [RFC 2461] IPv6 Neighbor Discovery
- [RFC 2462] IPv6 Stateless Auto-Configuration
- [RFC 2463] Internet Control Message Protocol for IPv6 (ICMPv6)
- [RFC 4291] IPv6 Address Architecture
- [RFC 4301] Security Architecture for IP (IPsec)
- IPv6 over "XYZ" Link Layer (Ethernet, ATM, PPP, etc)

These core protocols form the framework for the deployment of other IPv6 protocols and services. Following a deployment report from the IPv6 working group, these IPv6 standards will be advanced to the highest level of IETF standardization "Internet Standard" and be added to the 66 RFCs that currently sit at that level of full standardization.

In order to track IPv6 deployment on a global scale, the IPv6 adoption rate was tracked during 2005 by a joint project between Lumeta Inc. (http://www.lumeta.com) and the IPv6 Forum.

As we have seen in the Lumeta report, the IPv6 core is well supported, proven interoperable, is deployed in the latest generation of routers and operating systems, and is being extended to the last-mile infrastructure necessary to support complete enterprise transitions. Additional standards for stateful autoconfiguration (DHCPv6), IPsec key exchange (IKEv2), SEcure Neighbor Discovery (SEND), and IPv6 over emerging link layers (802.15, WiMAX, etc) are being tested and deployed in new IT infrastructure. The final transition steps to integrate IPv6 into enterprise applications, network management, and security infrastructure are already taking place to support major government enterprise transitions initiatives in Asia and the United States. This final transition to IPv6 capable enterprise networks is a major technology transformation requiring a concentrated effort to upgrade networks to meet growth and technology deployment challenges of the 21st century.

2.5 Recommendations

- Software developers should begin taking advantage of IPv6 as a common convergence layer by making their applications IPv6-capable today. This will enrich the applications with global reachability over IPv6, utilize IPv6 network address translator (NAT) traversal and mobility support (MIPv6 and NEMO) methods and make use of capabilities offered by new APIs. Developers must consider their product strategy 2-3 years in advance, and IPv6 will have a much wider reach in that time frame. Developers need to start transitioning their applications now.

- Service providers should deploy 6to4 (reference as above) relays and Teredo servers and relays to further enhance IPv6 transition technologies for their customers. Operators also need to conduct native IPv6 pilots and gain experience with new services and support issues. All new product purchases need to require IPv6 in order to future-proof the new investments and minimize the overall cost of future network upgrades.

- Network administrators interested in learning IPv6 should deploy IPv6 minimally on their IPv4 networks as a first step. Learning how to manage a new network will take time, so starting out early, conservatively, and transparently to users is the most logical approach. Organizations should also future-proof their investments now by requesting IPv6 capabilities in new product purchases and services. These capabilities might remain dormant in a network in the beginning, but this policy ensures a cost-effective way to acquire IPv6 capability while minimizing expenses. Gradually, as the network traffic sent over native IPv6 increases either internally or externally, you can move your network to support native rather than IPv4-encapsulated IPv6 traffic. Let your network traffic and application benefits drive your network upgrade schedule toward IPv6.

3. IPV6 FORUM & WORLDWIDE CHAPTERS PROFILE & SUCCESS STORY

3.1 Japan IPv6 Promotion Council

The Japanese IPv6 Council has demonstrated strong leadership in aggressively promoting IPv6 as national infrastructure mission. http://www.v6pc.jp/en/index.phtml

The Japanese Government has designed its latest program around the concept of ubiquity called "u-Japan" (Ubiquitous Japan) as the 2010 ICT Society platform. It is centered on empowering the Japanese end-user:

- Ubiquitous access, connecting everyone and everything
- Universal and user-friendly
- User-Oriented
- Unique, be something special

The technologies designed by the Japanese government were focused on making that ubiquity happen from home networks, over 4G networks (skipping 3G) to space communications and from sensor networks to RFID, clearly separating networking from edge devices that will be connected to networks rather than being network devices itself. This chart is from the Japanese MIC and demonstrates the depth and insight government officials have in the technology:

The e-Government Creation Plan was designed to encourage the procurement of IPv6-enabled devices in the government agencies. This action item is still under discussion in the European Commission and even an interesting attempt by the International Chambers of Commerce to block such a recommendation had to be rebutted forcing ICC to retreat from interfering in this process.

The Japanese government created a concerted forceful effort by combining global initiatives to work for their vision to become the Most Advanced IT Nation in the world.

Their strategy was that Japan should not promote IPv6 in Japan only but promote it around the world and become the leader of the IPv6 deployment showing to its own industry how global the opportunities are and how to position themselves in a globally networked world. It supported the creation of the IPv6 promotion council and created a public-private partnership. It placed its own IPv6 advocates anywhere they could like in the ICANN GAC to promote IPv6 to ICANN for faster uptake. Speakers at IPv6 conferences from the Japanese government are the most knowledgeable and the best prepared in their mission. Japan adopted the IPv6 Forum Ready Logo Program and funded it to enhance the image of its global mission. The net result is that over 30% of the products that obtained the IPv6 Logo are from Japanese vendors of the phase I Logo and 50% of the phase II Logo, giving the Japanese a leapfrog effect in terms of time-to-market.

For further information, see the following web sites:

- IPv6 Promotion Council http://www.v6pc.jp/en/index.phtml
- BSD KAME http://www.kame.net/ code base and Linux USAGI http://www.linux-ipv6.org/ code base
- IPv6-based phone service FreeBit http://www.freebit.com/english/index.html

- Live E! project http://www.live-e.org
- InternetCAR Project http://www.sfc.wide.ad.jp/InternetCAR/
- IPv6-FIX http://v6fix.net/

3.2 South Korean IPv6 Forum

South Korea followed suit in Feb 2001 with similar measures. The former Minister of Information and Communications, the past Samsung CEO that converted Samsung from an entertainment company to a computer company, is rallying the same strategy with strong focus on industry promotion by devising a new platform called IT839 selecting 8 new services, 3 infrastructures and 9 growth engines. IPv6 is his main personal focus and holds 3-monthly meetings called IPv6 promotion committee with 30 industry CEOs to follow up on progress. He is the main keynote speaker in every Korean IPv6 summit for the past 3 years. The South Korean model is an interesting benchmarking case for Europe as it shows a syndrome of a leader and follower at the same time. Understanding what's happening in this country reveals a model that Europe can learn from. Boosted by government support and early adoption by communication carriers, domestic equipment makers, large and small, and research organizations are accelerating development of equipment needed for deployment of the next-generation Internet address system.

As part of their IT839 strategy, the Ministry of Information and Communication implemented first phase pilot project of KOREAv6 last year, and it plans to conduct second phase pilot service this year to foster adoption of IPv6 technologies and energize the new communication service.

The South Korean public sector has already been engaged in deploying IPv6 on national level by building a nation-wide IPv6 MPLS backbone. IPv6 is has been deployed in 2004 in the e-Government networks, the postal office, universities, schools, ministry of defense, local governments, etc.

According to industry sources, communication equipment makers, including Samsung Electronics, LG Electronics, Locus, iBIT, Mercury and AddPac Technology, and research organization such as the Electronics and Telecommunication Research Institute (ETRI) are developing small and medium-sized routers, home routers, trunk gateways, access gateways, VoIP, and wireless access points. These firms are expected to begin rolling out products mid 2005.

Communication carriers such as KT, Dacom, Hanaro Telecom, SK Telecom, KTF and LG Telecom are beginning to install gears for IPv6 service. With a goal to commercialize it in this year, ETRI is now finalizing the development of medium-sized routers. The institute has been also developed a variety of IPv6-related gears such as home gateway, home server, next-generation Internet server, gear linking VPN with IPv4, NMS, AAAv6 certification server, and WiBro equipment.

Comtec Systems and LG Electronics plan to roll out medium-sized routers in July and December this year, respectively. AddPac Technology, iBIT, Mercury, Dasan Networks and LAN Bird plan to launch small routers in June, and will participate in interoperability tests to be carried out in July jointly by the National Computerization Agency and the Telecommunication Technology Agency.

Snet Systems, Mercury, Locus and the ETRI are expected to develop home routers by June, Moimstone, Samsung Electronics and AddPac Technology will commercialize by the end of this year VoIP gears such as IP phones, IPBX and IMS. In addition, Fumate, iBIT, WIZnet, Modacom, Snet and Future System intend to develop wireless access points and VPNv6 by September.

Telecommunication service providers intend to accommodate IPv6 equipment in their premium networks this year.
KT already installed 2 units of large dual stack routers to accommodate IPv6 functions and began upgrading platform of routers. Dacom is mulling over installing 12 units of large dual stack routers in the first half. Hanaro Telecom also began upgrading equipment to adopt dual stack.

Wireless communication carriers, SK Telecom, KTF and LG Telecom, also plan to adopt dual stacks in their WiBro networks to accommodate IPv6 functions, and begin to invest in IPv6 equipment next year.

The development of most IPv6 gear is anticipated to be completed by the end of this year. The size of the market will be decided by support of the government and communication operators. http://www.ipv6.or.kr/english/index.new.htm

3.3 Taiwan IPv6 Forum

Taiwan has implemented the most aggressive policy after coming late in the game by announcing a 1B US$ budget for their e-Taiwan program, designed by the National Information and Communication Initiative Committee reporting directly to the Minister Dr. Lin. The program calls for a complete package to contain e-Society, e-Commerce, e-Government and e-Transportation with the announcement to make Taiwan the most advanced nation in Internet technologies. The Taiwan National IPv6 Program addresses all aspects and can be regarded as the most complete and concerted effort between industry and Government. The IPv6 program office sits at the heart of the equation and gets full authority to define policies and promotion plans with a five years program given 10M US$ as a seed money. The total budget that will be allocated on this purpose will be tens or hundreds than that. The most formidable announcement of the e-Taiwan initiative is the plan to have 6 million Broadband end-users by 2008 using IPv6. The government networks will be made to be IPv6 ready by the end 2007. This is the most concrete and credible agenda formulated so far by any government. http://www.ipv6.org.tw

3.4 China IPv6 Council

China has instituted a full adoption policy of IPv6 by creating the China Next Generation Internet budgeted with over 170 M$ for completion by 2006. The group that started the first IPv6 initiative called 6TNET was formed by Liu Dong at BII, Patrick Coquet, Tayeb Ben Meriem and Latif Ladid and Japanese and Chinese government and industry members. This group recommended the adoption of IPv6 in the CNGI project to the Chinese government that will be by far the largest commercial backbone ever-built from scratch for a single technology to become the glue for all services in China for fixed, mobile, GRID and research. This proves again the case that a latecomer can become a leader and leapfrog other nations by policy.

Dr. Wu Hequan, Vice President of Chinese Academy of Engineering, initiator and chair of the CNGI project recently declared in the recent Beijing IPv6 Summit that: "China has shortened its gap with developed foreign countries by developing the Next Generation Internet while at the same time challenges are rising up, which require our continuous exploration and innovation. In recent years, IPv6, CNGI, NGN and 3G are quite hot topics in China's IT industry.

When the Internet first appeared in the world, no Chinese devoted itself to the study. Until ten years ago, that was September 20, 1987, Professor Qian Tianbai was the first Chinese to send out an email titled "Span the Great Wall, Walk to the World" by the Internet.
After that, some institutes and colleges began to study the Internet. We are ten to twenty years later than the foreign countries when we started to study the first generation Internet. These years Internet is developing very fast in China.

Now China is the second largest country in aspect of the quantity of Internet users. At present, during the global transition to NGI and IPv6, China also starts up the development of IPv6 and experiment of Next Generation Internet. International organizations and foreign test beds have already studied IPv6 for several years. In that sense, we are once again several years left behind. But the gap is not that big contrast to last generation Internet. It indicates that China has shortened the gap with developed countries in the Internet development while from another aspect it also brings some challenges for our next step development.

The Internet industry in our country is very healthy in the past. We achieved the success that took the foreign countries several decades of years in very short time. It is not only because we have carried out correct policy to Internet, but also that we were a follower. The pioneers, especially the foreign countries', have many successful experiences. We can walk along the right road they have walked and do not have many risks. But now, when we are studying the Next Generation Internet, the foreign countries do not have mature experiences for us to share. Up to now, the Internet function is not merely limited to sending e-mails but can now handle many more applications. These applications are all bound to its social system and culture background.

Although there are some successful practices in the foreign countries, it does not mean that we can just copy the foreign successful application to China. So now, if we can enter into the study of Next Generation Internet, it means we will shorten the gap. But under this base, we cannot expect to solve problems we may meet during the study by simply following the foreign countries. We need to explore. I think the future need us to create. Many things need us to develop from a creative aspect and at the same time to cooperate with the persons within this industry and to communicate with foreign countries. Internet is an open environment. On a developing view, the scale of the Next Generation Internet will be larger than the first generation, which is good for us to participate. Internet will play a more important role in our well-to-do society".

"Birth, Position, Goal and Feature of CNGI"

CNGI can be traced back to the end of 2001. At that time, approximately 57 academics wrote a letter to the leaders of State Council stating that they hoped to construct an academic network of second generation Internet and the position at that time was only an academic network. Later National Development and Reform Commission (NDRC) felt that studying NGI was also mentioned in some other domestic projects, so NDRC organized a strategic experts committee about the Internet development in August 2002.

After half-year's study, they called the project CNGI. Actually, they positioned the project as the Demonstration Project of Next Generation Internet. During the discussion, there are some disputes about this project: It should be NGI or NGN? Its position is academic or demonstration network? Whether or not it is going to be running application or commercialized in the future? Whether it is just a platform or expected to bring along some R&D?

In March 2003, the group finished the strategic research paper and implementation plan about the CNGI project and reported to relevant supervising department.

After the authorization of major leaders of State Council, this project was then initiated. NDRC is the leading ministry and Ministry of Science and Technology (MST), Ministry of Education (ME), Ministry of Information Industry (MII), the State Council Information Office (SCIO), Chinese Academy of Science (CAS), Chinese Academy of Engineering (CAE) and National Natural Science Foundation of China (NSFC) organize it. Some major government departments will be responsible for investing on this project. It involves the science and technology project and the application, development and experiment. At the same time, some applications will be tested on it and some business experiment. Except this, in this project, there will be some development on hardware, software and middleware and it will also include the research on application and standardization. In general, CNGI includes following six features:

First, 8 ministries unite to organize this project, which receives extensive support and participation. In this state-class network project of science and research, you nearly can see a project jointly organized by 8 ministries. At least, there is no such situation in network research and experiment projects. The national ministries provide great support to this project. It has becomes a feature of it. Of course, it is not all invested by the government. A large part of it is from the participating units. So, fully monitoring the enthusiasm of all parts is also one of the features of this project.

Second, carriers are leading actors. In the foreign NGI and IPv6 projects, carriers mostly provide some resources as supporter and the leading actors are mainly research institutes and universities. In the CNGI project, research institutes and universities are an important part but CNGI also attracts 5 of the 6-telecom carriers in China. Except that China Satcom is not invited to participate, the 5-telecom carriers are all expected to be the leading actors in this project. But they request that they will provide their own transfer resources and contribute part of presenting network resources into the project. According to the plan, 30 GigaPOPs will be built and now the number will exceed 40. The 10 G or 2.5G-fiber cable between the GigaPoPs is both provided by the contractors for the experiment out of their own willingness.

Third, including mobile IPv6 into the project at the first beginning. NGI in foreign countries always begin from fixed access. But at the beginning in China, we include the mobile IPv6 into our project. For the mobile Internet will firstly need the application of IPv6 and the real IPv6 application is the important driving force of IPv6 development.

Forth, it is not excluded to discuss the goal and technology NGN will achieve. Although we call the project CNGI, it is not excluded that we discuss the goal and technology NGN will achieve. Maybe, using IPv6 technology can satisfy the needs of NGI, but from the aspect of NGN, we still need to think about the problem of QoS, which includes introducing some characters facing connection. We hope to make some exploration from this.

Fifth, encourage different network to adopt different characters. CNGI designs to set up 6 backbone networks that support all IPv6 products. We encourage different network to adopt different characters only if their public interface is the same. Some may support only IPv6 based products and some may support IPv4 and IPv6 dual stacks at the same time. For there are different participants, there will appear different backbone networks. We are glad to see one business's QoS difference when passing different technology supported network routes.

Sixth, emphasizing on characteristic application. China should make contribution to the global IPv6. The reason why I emphasize more on application here is that we can develop many businesses through it. Different backbone network has had its own focused target. For example, CERNET in the CNGI has aimed at education. During the 10th "5 years plan", the network cannot reach that scale and even cannot cover preliminary and middle school at the beginning, which mainly connects the colleges. But, the goal to cover all the schools in China can be realized. In the future, it will not be merely limited to distance education and it will also include digital library and other applications. The network designed by CAS and China Netcom will make some sensors access to the Internet and include the gridding business into the major scope of application; China Unicom is very concerned about stream media technology; China Telecom also have such application like "Hu-lian-xing-kong"; China Mobile and Unicom hope that they can combine this experiment together with 3G experiment; China Railcom hopes to apply it in the rail system and commonality. This may be the largest IPv6 trial bed. Although we cannot tell exactly it is the largest after completed, it is not important for China is very easy to become the biggest one in the world such as so many people, steel production, concrete production. The key point is that it should not only be the biggest but also the strongest. The key to CNGI is whether we can make some special application. We should make some contribution to the global IPv6. I think China is IPv6's hope and meanwhile we shall also let IPv6 bring hopes to China.

In CNGI, IPv6 is a key technology. Now we can see that NGI will surely use IPv6 but IPv6 is absolutely not equal to NGI. In CNGI, IPv6 is a very important protocol, but at the same time, we shall also discuss IPv4, IPv4 and IPv6 interoperability. It is like: whether complete IPv6 based network also can support all the applications? Whether IPv4 can support the later application we imagine, too? In addition, whether or not we need to explore some friendly protocols to IP including some new protocols. I think it is one of the things CNGI needs to do. It is really a big project, which at least will connect 100 universities, 100 institutes and 100 research centers of enterprises. Carriers' participation is not simply for an experiment. They hope that they can explore technologies, cultivate personnel, innovate some applications with commercial value, change the non-profitable situation of Internet, do research on charge, which is not aroused high attention in foreign NGI, fee and some other difficult problems in management and bring the fruits of CNGI to future commercial use. http://www.ipv6.net.cn/

3.5 North American IPv6 Task Force NAv6TF

NAv6TF mission includes promotion, consultation, a center of technical expertise, white papers, business and marketing support, educational support, and guidance on for the adoption and deployment for IPv6 throughout North America. http://www.NAv6TF.org

The NAv6TF is committed to working with other IPv6 Forum Task Forces around the world to support the adoption and deployment of IPv6, and develops Memorandums of Understanding (MOU) agreements with other geographies and industry forums when it will foster the advancement and deployment of IPv6.

NAv6TF was created in 2001 following the July 2001 U.S. Navy SPAWAR IPv6 Seminar in Charleston, SC, and the December 2001, at a U.S. Army IPv6 Seminar at FT. Monmouth, NJ.

Regional interactions (Industry, Governments and Consortia)

Working with the North American IPv6 Task Force, the US DOD demonstrated leadership by announcing support for IPv6 back in June 2003 after lengthy discussions and recommendations of the IPv6 Forum and the North American IPv6 Task Force. A core team led by Jim Bound and Latif Ladid had started this work back in October 2002 in the very first private meeting with Richard Clarke, then as the security top advisor to the White House.

This triggered a chain of events and created a resounding impact on the major industry players to rush to add IPv6 to their strategies. The military sector responded immediately with support from the German and French Ministries of Defense who did their homework independently and are now cooperating together.

The US Department of Commerce convened a hearing in July 28th, 2004 at the premises Department of Commerce in Washington to which the IPv6 Forum was invited. DOC has announced its support in January 2005 in this document:
http://www.osec.doc.gov/cio/oipr/SITP_IPv6_addendum.htm
http://www.ntia.doc.gov/ntiahome/ntiageneral/ipv6/draft/draftchap4.htm

Dr. Linton Wells II, Assistant Secretary of Defense, Networks and Information Integration/DoD Chief Information Officer-Acting, in his keynote speech positions IPv6 as a Key to Net-Centric Combat Operations with a clear call to industry to support the DOD vision to empower the edge, i.e. the soldier.

In August 2005, the Executive Office of the President of the United States of America, Office of Management and Budget (OMB) issued a memo stating it set June 2008 as the date by which all agencies' infrastructure (network backbones) must be using IPv6 and agency networks must interface with IPv6 infrastructure. It also stated that since the Internet Protocol is core to an agency's IT infrastructure, beginning in February 2006 OMB will use the Enterprise Architecture Assessment Framework to evaluate agency IPv6 transition planning and progress, IP device inventory completeness, and impact analysis thoroughness. This paper can be located at this address: http://www.cav6tf.org/html/related-articles.html

In January 2006 the United States Department of Commerce delivered its current IPv6 assessment titled Technical and Economic Assessment of Internet Protocol Version6 - IPv6 U.S. Dept of Commerce NIST NTIA. Its contents can be found here: http://www.cav6tf.org/articles/IPv6-final.pdf

NAv6TF worked with Lumeta to establish a MOU that will provide resources for having a dynamic composite map of the transition between IPv4 and IPv6.

A working relationship between NAv6TF and the World Wide Consortium for the Grid (W2COG) has been formed. W2COG, is an international, collaborative association of networking technology and operational experts focused exclusively on accelerating the development and availability of tools to support secure, net-centric operations for global security and peaceful commerce, delivering tangible NCO solutions quickly and cost effectively.

NAv6TF works to support various activities and projects like the IPv6 Business Council. This business council is not directly under the auspices of NAv6TF, but it is recognized by the task force to be a good conduit of information between the task force and industry.

Moonv6

The idea of Moonv6 and definition was developed during the course of the work between NAv6TF and the U.S. Government Cyber Security Office and the Department of Defense. http://www.moonv6.org. In March 2003 at a meeting at the University of New Hampshire, when it was decided to investigate the deployment of a U.S. wide IPv6 Network Pilot the term Moonv6 was selected to name this Network Pilot. The Moonv6 test bed made reference to its importance and that the US should treat IPv6 as the US did for going to the Moon in 1969.

Today Moonv6 is an all inclusive project with many participants in the US and around the world. The Moonv6 Project continues to be ongoing. Moonv6 is an international project led by NAv6TF to execute deployment testing of IPv6 technology.

Moonv6 is jointly implemented by commercial service providers, UNH-IOL, Government organizations, academic entities and network equipment vendors. Test items are determined by network operation requirements of the US Government Agencies and commercial service providers. Erica Williamsen, Tim Winters and Ben Schultz spearhead this project.

North America IPv6 task force regional sub-chapters

At the US state-wide and local levels the NAv6TF has worked diligently to establish regional sub-chapters to further assist with IPv6 transition and awareness at the state and city government levels.

The first two sub-chapters formed are the California http://www.cav6tf.org and MidAtlantic http://www.mav6tf.stealth.net IPv6 Task Forces.

The **California IPv6 Task force** is based in the state capital of Sacramento and is focused on awareness and education pertaining to the IPv6 transition. Founded by NAv6TF Vice Chair, Geof Lambert, it has a working steering committee of twenty-five members.

As a means of fostering development of its objectives it has formed the Sacramento Association of IPv6 Adopters as a sub-chapter. In addition it supports the efforts of the NAv6TF at NAv6TF events throughout North America.

The California task force is working with NAv6TF to demonstrate to various national, state-wide and local governments and agencies the value of an interoperable emergency services communication system based on the IP. The **MetroNet6** project is an offspring of this effort. As a means of communicating this effort to various sectors of the government it is working with representatives from the US House of Representatives, and Senate who are part of the Congressional Committees on Homeland Security.

In November 2005, various members of the task force participated at Information Technology Association of America First Responder Interoperability and Technology Demonstration held in the offices of the US Congress. At that event there was a First Responders Interoperability Issue Briefing featuring speakers from the Association of Public Safety Communication Officials, Congressional Fire Services Institute, FCC, and several Members of Congress.

At the local level, Sacramento, California has been chosen as a site to initiate a working model of MetroNet6 SACRAMENTO (MetroNet6).

Metronet6 http://www.cav6tf.org/html/metronet6.html is an emergency responder network concept built using IPv6. It is a 24x7x365 ad-hoc mobile network that integrates E911, Internet, and voice on a common IPv6 infrastructure. The technology capability should support multiple simultaneous deployments from a central infrastructure. The project is in the process of building a prototype MetroNet6 in the State of California beginning in Sacramento, with communications city-to-city with Palo Alto. In addition, state-to-state MetroNet6 network

communications would be part of the project. For city-to-city and state-to-state communications the current NAv6TF Moonv6 project can provide an IPv6 native backbone peering network to be used. North American IPv6 Task Force steering committee member, George Usi, who is also a member of the CAv6TF steering committee, is the SME acting as the project manager for MetroNet6 SACRAMENTO.

The **MidAtlantic IPv6 Task Force** is the second NAv6TF sub-chapter. John Brzozowski has taken on the responsibility for the formation and development of the MidAtlantic IPv6 Task Force. This task force covers the area of: Pennsylvania, New York, Deleware, Maryland, New Jersey and District of Columbia.

This task force plays and has played an instrumental role in the coordination of various members of the IPv6 Forum, and North American IPv6 Force to have visibility at events in the region.

MAv6TF is working with various members of industry and government to initiate a project similar to the MetroNet6 SACRAMENTO project in the area of New Jersey. In addition various members of the MidAtlantic IPv6 Task Force help facilitate at NAv6TF and CAv6TF events.

3.6 The European IPv6 Task Force

The European Commission demonstrated strong leadership and was exemplary in this respect. The number of excellent projects funded (6INIT, 6WINIT, 6NET, Euro6ix, to name just a few) and awareness efforts deployed exceeded all expectations. The EU funding exceeded over 100 M€ over the past 5 years.

The IPv6 Forum proposed in 2001 to Dr. Joao Da Silva the creation of the European IPv6 Task Force as a voluntary effort in order to engage Europe into awareness work and dissemination efforts. Commissioner Erkki Liikanen endorsed this initiative and the first recommendations were worked out followed by the continuation of the Task Force Steering Committee project for phase II and then Phase III. http://www.eu.ipv6tf.org/in/i-index.php

The following European government and national regulators have expressed interest though extended no funding or whatsoever to promote IPv6:

- The **French Government** has shown the first light in the tunnel through Senator Tregoue and then later on by the Minister of Research Mrs. Haigneraie. This political goodwill has enabled the creation of the French IPv6 Task Force http://www.fr.ipv6tf.org/ which has performed an extraordinary job with no single funding and just voluntary work under the leadership of Patrick Cocquet supported by a very capable group of IPv6 advocates including leaders and founders of the G6 and CN6, forming the largest IPv6 group in Europe, setting milestones after milestones. The recent achievements were the creation of an IPv6 Competence and a regional IPv6 Task Force in Brittany. http://www.point6.net/
- The **Austrian Government** supported the creation of the Austrian IPv6 Task Force. But it's the Regulator RTR, which was the driving force with its highly energetic and competent General Manager. The reason behind his decision was his 2003 promotion of the nation-wide broadband policy. In his inaugural speech at the Austrian IPv6 task Force in March 2004, he declared that IPv6 was the logical missing piece in achieving the objectives set out for broadband. http://www.at.ipv6tf.org/

- The **Finish Government** supports the Finish IPv6 Task Force. The Finish Regulator Ficora is the host and the leader of the Finish IPv6 Task Force. http://www.fi.ipv6tf.org/
- In **Portugal**, a strategic group was formed last November 2004 to prepare a policy document to have it addressed by the Portuguese Government. This was planned to be done during a major public event with invited key-speakers and the press, but the government was changed by he end of 2004. This will be started soon after preliminary talks with the new government now in place. During 2004, together with ANACOM – Portuguese Telecom regulator -, a questionnaire about IPv6 for the operators/ISPs (internet, fixed, mobile & cable) was made to get an insight about their actual status and future plans concerning IPv6 deployment. ANACOM is very supportive of IPv6. This year new contacts with the Portuguese military forces have been initiated. A meeting with the new government has already been requested. A few presentations were done in public events this year. A meeting with the incumbent Portuguese operator (Portugal Telecom) is set to discuss their own IPv6 plans. FCCN is planning a major pilot trial with schools that are being migrated to Internet broadband connection. FCCN already has some of its services available in IPv6, like the web site, and nearly all of them will be migrated until the end of 2005. http://www.pt.ipv6tf.org/
- The **German Defense Ministry** was the motivator behind organizing the German IPv6 Summit in July 2004 in order to rally support around its decision to move to IPv6 especially from vendors and operators. http://www.ipv6tf.de/tiki-index.php
- The **Dutch Ministry of Economic Affairs** has appointed ECP NL to coordinate the Dutch IPv6 Task Force and appointed Dr. Erik Huizer as chair.
- The **Irish Government** has appointed the Wattford Institute of Technology as the centre of Excellence for IPv6 after a call for proposal. http://www.ireland-ipv6.org
- The **Luxembourg Government** is discussing the creation of an IPv6 Competence Centre within the University of Luxembourg under the recommendation of the chair of the EUv6TF.
- It's interesting to note that the **British DTI** that expressed that it needs to be motivated by the private industry to move to support IPv6. Since that call to action did not come from the leading players despite awareness efforts, the UKv6TF http://www.uk.ipv6tf.org/ had no political goodwill to support it.

3.7 India IPv6 Forum

India has 5.0 M IPv4 addresses with a plan to deploy 20 M always-on broadband access. The digital divide is in India. India has recently established it own DNS registry and Internet Exchange point.

The India Telecom Regulatory Authority (TRAI) http://www.trai.gov.in is an active driver in aggregating public policy and opinion on IPv6. TRAI did encourage Ministry of Communications (MCIT) to pursue important IPv6 policy discussions and decisions. They issued a consultation paper on issues relating to transition of IPv4 to IPv6 in India (Aug 2005) and made recommendations on Transition from IPv4 to IPv6 in India (Dec 2005). TRAI also just issued a consultation on issues pertaining to Next Generation Networks (NGN).

IPv6 is part of India's government (MCIT) ten point agenda. A detailed IPv6 Country Roadmap is under preparation under the joint leadership of the IPv6 Forum India and MCIT/TRAI. They are considering strong recommendations of IPv6 in Union & State e-Governance projects and in the Indian Armed Forces (Ministry of Defense). India's government created an Inter-Agency IPv6 Implementation Group (IPIG): Members (DIT/MCIT, IDBRT, MoD/DRDO, National Security Council, ISP Assc of India, Cellular Operators Assc of India, IPv6 Forum India, IIT-Kanpur, BITS-Pilani Industry). The India IPv6 Forum http://www.ipv6forum.in/ is forming an IPv6 Forum India Technology Board chaired by Sai Sree, Technology Head, Wipro Technologies and reporting into the IPv6 Forum India board of director.

The Indian Industry contributes to IPv6 outsourcing. Much of the outsourced IPv6 related work (stack development, writing apps etc) in North America / EU markets happen out of Indian IT locations (Bangalore, Pune, Chennai, Hyderabad, Gurgaon/Noida). These include IT Services companies such as Wipro, Infosys, HCL and offshore centers of MNC vendors such as HP, Cisco, Juniper, Microsoft, Infineon, IBM, Sun Microsystems. Samsung & Huawai have IPv6 R&D center in Bangalore (this is where IPv6 is done). Sify released IPv6 ISP Service nationwide (they do VPN service across the country since they cannot get IPv4). VSNL bought Teleglobe and therefore India has second largest IPv6 International ISP (2 to NTT-Com). Universities are very active the following academias are participating in the activities of IPv6 Forum India: Indian Institute of Technology, Kanpur, BITS, Pilani, Indian Institute of Science, Bangalore, Educational & Research Network (ERNET), Delhi and Many South Indian Engineering Universities (student projects and activities). ERNET has an IPv6 testbed.

3.8 Latin & South American IPv6 Forces

Nowadays, there are no real IPv6 Promotion Councils in Latin American and Caribbean countries. However, the first steps have been taken with the integration of the Latin American and the Caribbean IPv6 Task Force (LACIPv6TF), in 2004, with an active participation from almost the 29 countries and territories.

Only in some countries like Cuba exists a strong IPv6 Promotion Policy. In two of them Brazil and Mexico, the pioneers of IPv6 research in the region, exist an IPv6 Forum Chapter. In others, such as Argentina, Brazil, Colombia, Cuba, Panama and Peru, IPv6 Task Forces operate following the objectives of LACIPv6TF.

Latin American and the Caribbean IPv6 Task Force (LACIPv6TF)

The main objective of the IPv6 Task Force for Latin America and the Caribbean is to promote de adoption of IPv6 within the region. In order to do so, it coordinates the cooperation among the different parties involved in the adoption of IPv6 in Latin America and the Caribbean; it also promotes different activities aimed at informing and educating on IPv6 and related technologies.

This regional Task Force is coordinated by LACNIC providing its services in 29 territories in Latin America and the Caribbean.

Among the activities organized by LACIPv6TF since 2004 are four meetings called "Forums" which have been hold in Montevideo, Uruguay; San Jose, Costa Rica; Lima, Peru; and recently in Guatemala City, Guatemala.

For more information on LACIPv6TF, visit: http://www.lac.ipv6tf.org

Latin American IPv6 Policies in LACNIC

Currently, and until new LACNIC board decision, organizations qualifying to receive IPv6 will have the first two years fees waived. This means, the initial fee and the first annual renewal fee. This regulation is taken up as a way to promote the adoption of IPv6 in LACNIC´s coverage area as well as a response to several organizations that requested so.

Use of IPv6 in Latin American and the Caribbean's

At the end of 2005 was performed a survey for the status of the adoption of IPv6 in the ccTLDs of the Latin-American region. A classification of the different organizations was proposed, where it was uncovered that 17 % of the ccTLDs have already adopted IPv6 and another 17% have a clear plan for implemented IPv6 during 2006.

In the survey were asked the main difficulties, from the ccTLD perspective, in the adoption of IPv6. The most frequent answers were: the lack of interest from the community; the lack of economical or technical resources; and finally, the lack of IPv6 access from local service providers, even if this is not a requirement for the implementation of IPv6 services.

Latin American IPv6 Task Forces and IPv6 Forum Chapters by country

Argentina: http://www.ar.ipv6tf.org

The IPv6 working group of Argentina, known as ARIPv6TF, as others in Brazil, Cuba, Mexico and Peru, has the goal to promote the adoption of IPv6 in the country, and is completely open and with volunteer work.

The "AR IPv6 Task Force" will coordinate the cooperation between different parts related to IPv6 adoption in Argentina, as well as sensitization activities, disclosing and training about IPv6 and related technologies.

Briefly, with all the future members, this chapter will develop a document describing its mission.

Nowadays, the organizations with IPv6 assignments in Argentina are: Cabase, Retina, Fibertel, Impsat, Telecom, Coop Villa Gdor Galvez, Comsat, Iplan

Brazil: http://www.br.ipv6tf.org

The Brazil IPv6 Task Force, called BRv6TF has the goal to interact with the sectors interested in preparing Brazil for the Next Internet Generation, collaborating with the development of services and tools and with the testing of the new protocol of Internet, (IPv6). This goal is being done for the proliferation of technologies like VoIP, Wireless Networks (WiFi), ADSL and many others such as the Digital TV, which is in a development phase.

Recent events organized by BRv6TF include: IPv6 Global Summits in 2005 and 2006, Workshop ICT & OSA-Parlay 2006.

Colombia: http://www.co.ipv6tf.org

The Columbian IPv6 goals are to coordinate efforts of different participants of Colombian Internet (government, academy, public and private telecommunications sector, developers and users) to an efficient and quick adoption of IPv6. The plan is to drive IPv6

awareness and training and to define the best practices for IPv6 adoption by developers, ISP and users; to promote the execution of pilot projects. To recommend an action plan or roadmap for the IPv6 implementation in the country and to establish permanent communication and identify collaboration opportunities with the Task Forces from others countries.

The Colombian IPv6 Working Group does not have a juridical status and it is open to the whole world. However, to guarantee its legitimacy and efficiency, it must be represented by at least the following sectors: Government, Industry (developers, Internet providers), Academy (Universities and other research institutes) and Users

Cuba: http://www.cu.ipv6tf.org

Mexico: http://www.ipv6forum.com.mx

The IPv6 Forum Chapter Mexico is a common effort to promote the knowledge of IPv6, to identify its opportunities of use and its possible deployment scenarios in the country, as well as to create a community of institutions and active people in IPv6.

To achieve its goals, this group works closely with the IPv6 Forum and the IPv6 Task Forces around the world.

Each year since the end of 1999, seminaries, workshops and other activities have been organized in order to give sufficient information and promote the advantages and benefits of using IPv6.

This IPv6 Working Group is supported by: Some vendors (Allied Telesyn, Foundry, etc.), ISOC Chapter Mexico, the National Autonomous University of Mexico (UNAM). Founder and ISPs such as Protel, and others.

The most significant IPv6 achievements in Mexico are the support of native IPv6 traffic in all the Backbone routers of the Mexican Internet2 Network (since December 2001), and the first native IPv6 connection to USA by Internet2 (June 2002) with large scale IPv6 networks like Abilene. Recent projects include working together with other research groups to support and use IPv6 in areas such as: GRID Computing; Remote Control of telescopes, microscopes, microprobes, etc.; Volcanic Monitoring; and Parallel Processing.

Finally, the following promotion activities are beginning to take place in the Mexico: IPv6 Government support; Mexico IPv6 Exchange Point; Some trial services; R&D projects; Creation of specific IPv6 working groups; Spanish documentation; and Education programs.

Panama: http://www.pa.ipv6tf.org

Peru: http://www.pe.ipv6tf.org

The Peruan IPv6 Task Force is an open community integrated by Information Technologies professionals, Networking Engineers, Technicals, Operators, Consultants and ISPs, aware of the transition and IPv6 deployment require collective and volunteer actions to promote it, to identify applications, services and potential candidate systems to this deployment, to coordinate actions and share experiences having as basic goal to study the IPv6 perspectives and the actions to take for an adequate transition and the future adoption of IPv6 in the Peruan community.

This Working Group is supported by: Asamblea Nacional de Rectores, COMSAT PERU S.A.C. and INICTEL

CLARA Network

The CLARA organization - Latin American Cooperation of Advanced Networks – is responsible for the implementation and management of the network infrastructure that interconnects the national academic networks (NRENs) of 18 Latin American countries. In August 2005. Native IPv6 implemented in the backbone of RedCLARA and IPv6 peerings were established between two Latin American NRENs already running IPv6, RETINA from Argentina and CUDI from Mexico, and CENIC from California, in the US and GEANT from Europe. In November 2005. Multicast IPv6 implemented in the backbone.

From the 18 NRENs participating in the CLARA network, only 7 are already connected with native IPv6: RETINA (Argentina), RNP (Brazil), REUNA (Chile), CUDI (Mexico), RAU (Uruguay), RENIA (Nicaragua), CEDIA (Ecuador) and REACCIUN (Venezuela).

For further information, see the following web sites: http://lacnic.net/en/ http://www.ipv6.retina.ar http://www.ipv6.cl http://www.ipv6.unam.mx http://www.rnp.br/en/ipv6 http://www.rau.edu.uy/ipv6 http://www.redclara.net/03/06_05.htm

3.9 IPv6 Downunder and ISOC Australia

IPv6 activity in Australia has gone through the typical stages of technology deployment; from initial wild enthusiasm 10 years ago with one of the world's first connections to the 6BONE, through a period of reduced activity and is now entering the phase of more widespread adoption. The largest high speed education network in Australia (the Australian Academic Research Network - AARNet) has implemented native IPv6 transports for some time and provides v4 to v6 transition mechanisms for its member and affiliates. The Australian Department of Defense has announced the adoption of IPv6 in a program that will extend through 2013. The ground is now set for the wider business and user communities to utilize IPv6 and to this end, the Australian Department of Communications, Information Technology and the Arts (DCITA) has approved the funding for new industry stimulation project: **IPv6 for e-Business**.

Lead by consortia of the leading Australian IT trade bodies, (ISOC-AU, auDA, AEEMA), the IPv6 Forum Downunder will help with facilitating project management, Internet technical expertise, IPv6 promotional information resources, development of the appropriate IPv6-enabled DNS Infrastructure and related software applications. The consortia will provide financial oversight, industry linkages and includes ADEISA involvement. The project is endorsed by the National ICT Industry Alliance (NICTIA), a broad coalition of the highest level IT industry bodies in Australia.

The IPv6 for e-Business project will conduct collaborative industry-based activities to accelerate the adoption of IPv6-based business-to-business (B2B) e-commerce solutions across a wide range of industry sectors, especially to build the capacity of SMEs to form clusters and to allow early adopter Australian businesses to participate advantageously in international trade and supply chains.

The project will foster the awareness and strategic take-up of IPv6 based e commerce solutions, within and across industry sectors, to deliver sustainable economy-wide returns and contribute to increased competitiveness. It will build business tools and training for early adopter

businesses, and will assess the opportunity to create test-bed applications to demonstrate the effectiveness of IPv6.

2005 saw the commencement of an annual industry showcase event, the Australian IPv6 Summit. In 2006, a major focus of the year's Summit will be the completion of the IPv6 for e-Business project.

For further information, see the following web sites:

- ADEISA - Australian Defense Information and Electronics Systems Association
- AEEMA - Australian Electrical and Electronic Manufacturers' Association (http://www.aeema.asn.au)
- auDA - Australian Domain Name Authority (http://www.auda.org.au)
- ISOC-AU - Internet Society of Australia (http://www.isoc-au.org.au)
- IPv6 Forum - IPv6 Forum Downunder (http://www.ipv6forum.org.au)
- ICTIA - National ICT Industry Alliance (http://www.nictia.org.au/)

3.10 Middle East and African IPv6 Promotion

Most African Internet infrastructure connects to Europe or USA with little inter-African interconnectivity and little or no local language content. Africa has problems raising capital to develop regional IT infrastructure.

Though Satellite is the fastest way to deploy connectivity, the cost hampers the roll out of IT infrastructure. IP bandwidth in Africa up to 50 times more expensive than in America, though the Internet in Africa is seeing a healthy growth in percentage terms and a fast growth in number of Internet users. Africa is going mobile and started on the path to 3G and WLAN. Wi-fi - Knysna, S.A. is Africa's first Municipal Wi-Fi Broadband Network offers VoIP and Internet Access (allAfrica.com Nov. 7th). Wifinder lists African wifi hotspots for Egypt, Ghana, Morocco, Nigeria, South Africa, Tanzania and Tunisia.

IPv6 factor in Africa: It is the first opportunity for upgrade to a new and improved protocol version and address scheme since 01/1983. It is a prerequisite to make IP Convergence and related service and revenue opportunities a reality. The Internet Governance under the WSIS process was the first opportunity for many African governments to debate in a larger scale the Internet issues and its promotion within the UN Millennium Declaration goals.

The IP convergence will impact many aspects of human activities and practically all industries but periods of rapid change give a chance to leapfrog to new technologies and close development and economic gaps. Transition to IPv6 is one of the essential ingredients to reap the economic benefits of this new converged world.

Some transition has already started. The Research and Education Community and some progressive carriers show the way forward. The Egyptians R&E Community will be ready. MCIT (Egyptian Ministry of Communication and Information Technology) has announced the building of a nationwide IPv6 network for the EUN and National Research Centers.

African R&E Community developed a virtual University Concept which is ideal in very distributed geographies such as Africa or Canada. AFUNET will connect to their IPv4/IPv6 enabled counterparts Géant, Internet2, APAN.

The United Arab Emirates under the leadership of Itidal Hasoon organized the first IPv6 in Dubai in Feb 2001 which was opened by Crown Prince Al Makhtoum, (current Emir). The UAE IPv6 Task Force was created in April 2005 during the Abu Dhabi IPv6 Summit. This Task Force is now running a monthly training program to educate a core team of IPv6 engineers who would be the force to enable the transition to IPv6 in this part of the world. http://www.uaeipv6.ae

The Tunisian Internet Society held the first IPv6 conference in May 2004 and followed up with another joint conference together with the ITU Arab Region office in July 2005. The Tunisian government organized during the WSIS event an IPv6 workshop in November 18, 2005 in Tunis.

The Egyptian government under the leadership of Minister Dr. Tarek Kemal formed the Egyptian IPv6 Task Force in Sep 2004 as a multi-stakeholder organization which organized the first IPv6 Summit in May 2005 and the joint IPv6 Summit with Afrinic in Dec 2005 in Cairo. http://www.ipv6tf.org.eg

The Moroccan Internet Society (MISOC) has organized an IPv6 workshop back in 2004 and is planning to hold an IPv6 workshop during the ICANN meeting in Marrakech June 24, 2006. The Moroccan IPv6 Task Force will be formed during this event to become a working group within MISOC. http://www.misoc.ma

The 6DISS project (http://www.6diss.org) is running IPv6 workshops in Africa and around the world, highly recommendable.

Following countries are planning the creation of an IPv6 Forum or an IPv6 Task Force: Algeria- (started by Tayeb Ben Meriem); Turkey (Started by Bruno Omer); Nigeria (Started by Doo Timbir) and Kenya.

The Khawarizmi concept was first presented at the Egyptian IPv6 Summit in May 2005 and was then to expand to Africa with 6Mandela. The main idea is to negotiate consensus and approval of carriers/ISP's involved (under the auspices of national and regional IPv6 fora, with support of national Ministries of Information Technologies) to enable deployment of IPv6. Start with a core of two, preferably three countries to demonstrate ease of feasibility and trigger a domino effect. The Tunnel broker is the proposed IPv6 connectivity solution in the Arab World as catalyst for Khawarizmi project.

4. SUMMARY

The current Internet based on IPv4 had to wait for 15 years until the introduction of the Worldwide Web (www) in the years of 1992-1995, introducing ease of use of publishing and propelling the Internet to a business, social and entertainment commodity media on a global scale.

When the IPv6 Forum was launched at the IETF meeting in April 1999, the IAB Chair Brian Carpenter endorsed the Forum and pointed that that this project would need at least 15 years to achieve its objectives. Indeed, the IPv6 Forum leadership recognized the scale and the size of this undertaking and designed a long term mission to be based on voluntary work, geographic spread, sound political lobbying though apolitical, industry-orientation, capacity building and dissemination of accurate knowledge worldwide, all cemented with a robust layer of passion and patience.

The IPv6 Forum has indeed just passed one third of the 15 years and achieved way more milestones than IPv4 has reached by then. The new challenges and barriers facing IPv6 are of business nature and political dimension unlike IPv4. This makes the task more critical as the justification has shifted from a simple novelty using IPv4 into a tougher case justifying the ROI and business drivers with clear applications and services excelling the current models. The delaying of IPv6 introduction has aggravated the case since many of the features native in IPv6 have been bolt on IPv4 diluting the perception of the value of IPv6 as a costly transition.

If you missed the internet boom or got in too late, this is your second chance!

The new internet will be a symmetrical and interactive two-way Internet while the current one is just a one- way Internet. IPv6 will be largely driven by technology refresh and technology/business case. The perception that IPv6 will replace IPv4 is incorrect since IPv6 was designed to cater for many deployment scenarios, starting with extension of the packet technology and therefore supporting IPv4 with transition models to keep IPv4 working even for ever and then to cater for new uses and new models that require a combination of features that were not tightly designed or scalable in IPv4 like IP mobility, end to end connectivity, end to end services, ad hoc services; to the extreme scenario where IP becomes a commodity service enabling lowest cost deployment of large scale sensor networks, RFID, IP in the car, to any imaginable scenario where networking adds value to commodity. This is called progress.

IPv6 Readiness:

IPv6 readiness is key and the lowest cost option will be achieved by technology refresh and would make the network future-proof, though a careful review of the firewall security is called for. There's an educational process involved. Again, the scenarios are quite wide and there's no size that fits all. The geopolitical dimension is crucial for any country to remain or become the most advance IT nation in the world. The simplest scenario is that International companies that deal with Asia would be asked to support the new protocol. So, you can deduct the impact of rest of the scenarios from here.

Impact of IPv6 on the end-user:

IPv4 was designed unintentionally to share the complexity with the end-user while IPv6 will try to take away that complexity from the end-user. This is the goal of the design and the

deployment of IPv6 will have to make this vision happen and it will happen. IPv6 should not be even a concern to the end-user as it's part of the plumbing and should be transparent to the end-user and make his new internet experience an easier one.

Leadership:

The US has missed recently a few "deployment" leadership milestones, ironically not listening to its best engineers who have helped the world to move forward: The cell phone leadership went to Europe and broadband went to Asia. IPv6 is the next victim. Thanks to the tireless work of the North American IPv6 task Force led by Jim Bound, CTO IPv6 Forum, the US DOD adoption of IPv6 has restored the leadership of the US as it validated IPv6 deployment to the rest of the world. Again, the message was rather heard by Asia and to a certain extend by Europe and has confirmed the beginning of the race to leadership while the US industry remained deaf to that message, with the exception of international vendors. But we are confident the US industry can pick up the ball fast and recover the lost space if they are well consulted and this is where the IPv6 Forum lends a hand in distilling key messages and multiply awareness at senior level at Corporate and political level. But the task remains a huge undertaking.

Why is Asia first this time?

Without mentioning 9/11, the US was hit by the Internet bubble (Y2K too!) and Europe by the 3G spectrum disaster that depleted industries from investment potential and had to go thru a period of restructuring back to core business which is a repellent process to new innovation. So, the 21st century did not have a good start at all but the worldwide economy survived these massive hacks which is very promising for the future. It would help to have entrepreneurs that built the US economy to come back to leadership as bean counters are running the US industry today and innovation is a very fragile process that can only flourish in the hands of passionate people about new technologies, extending patience and care until the innovation becomes a profit source. Today's gratification in instant money making is anti-progress.

The IPv4 address depletion has been doctored as a global issue, though the reality per country is totally different. The Indian address space of 5 M is far from convincing that the address depletion will happen only by 2015. The Asian countries have clearly understood the impact of address depletion and have taken the lead in investing in IPv6 in terms of knowledge capacity, vendor research and deployment facilitating design of applications and services. So, the perception is that the IPv6 show is in Asia and this is correct.

Impact the IT industry and IT professionals:

The Department of Commerce released the first independent study of the fast emerging IPv6 market space, with focus on the ROI when transitioning to IPv6. The reports concludes that IPv6 will create a services market of 25 Billion dollars over the next quarter century generating 10 Billion dollars of cost savings EVERY YEAR. Every dollar invested returns 10 dollars in cost savings. The press however went ranting with sensational headlines that the move to v6 will cost 25 M$ over the next 25 years. Either people cannot do the math or some people do not want to take strong stances. In both cases, an excellent report got wasted missing a major opportunity to show leadership.

Again, the IT industry is called for action. IT professionals are always seduced in the end by simplicity when they have pushed complexity to its extreme and the last code line won't make it. The return to end to end will blow fresh oxygen into design of new superior networks and end to end applications.

Mission of the IPv6 Forum:

The IPv6 Forum is determined, highly committed and passionately motivated to continue with aggressive plans of deployment, capacity building, new research fields, opening new IPv6 Fora and IPv6 Task Forces until IPv6 becomes the dominant Internet Protocol used on the Internet, shaping slowly but confidently the New Internet to benefit from its many features built in IPv6 to move the Internet from an elitarian space with just 15% penetration worldwide and make the 6 B people potentially use the Internet enabling a digital lift so that every kid on planet will be a resident on the Internet and not just a simple sporadic tourist . As a target the IPv6 Forum projects the worldwide Internet penetration to move from 15% today to 25% by 2010, 35% by 2015 and 50% by 2020.

This mission is called "IPv6 Forum Strategy & Vision 2010", a date by which IPv6 will become a dominant protocol and the New Internet will become commodity for everyone and everything.

On behalf of the IPv6 Forum,
we would like to thank you for your continued support and commitment to this effort.