NEXT GENERATION INTERNET

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ABSTRACT

In today's connected age, almost everyone knows what the Internet is. However, very few people have an idea about the workings of this worldwide network. The Internet, as we know it today, has had a long history of evolution and like any other interesting and useful invention, is governed by a set of rules and protocols. This blog introduces the reader to the basics of the fundamental protocol behind the workings of the Internet – the Internet Protocol, and the current and upcoming versions of this protocol.

The current Internet Protocol, IPv4, is the original standard Internet Protocol set up for handling IP addresses when the Internet was initial developed by DARPA (Defense Advanced Research Projects Agency) in the early 1970s. The IPv4 uses a 32 bit address field which provides for 4,294,967,296 unique Internet addresses. This number was deemed to be more than enough to last beyond any foreseeable requirements because in the early 1970's the population of the earth was less than 4 billion people and personal computers did not exist. Now, the rapid explosion of the Internet fueled by the vast number of personal computers attaching to it, made it clear that the IPv4 address space was already consumed to the point that a replacement had to be found. The next generation IP, IPv6, was developed in response to this situation. In this paper, I will try to give a complete overview of this new protocol. I start by giving a history of the internet and its current protocol. Then I will describe the main features of the new protocol, IPv6, and how they have solved the current limitation of the current protocol.

Keywords: Internet Protocol, Networks, IPv4, IPv6, IP address, worldwide network

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INTRODUCTION

Next generation Internet Initiatives are the research activities going on around the world towards developing the current Internet in terms of service and speed and launching a entirely new range of applications which will make use of these new opportunities, bringing wealth and knowledge to the entire world.

Internet Protocol, IP, is the network-layer protocol and one of the pillars which supports the Internet. A protocol is a set of rules which specifies how a packet of bits will be interpreted and how a node should react to the datagrams it receives. It defines the semantics of a packet, how the bits should be interpreted, but also what the node should do if something goes wrong. In general, the IP has the following main services:

Addressing: This is the field of the destination of a packet in the packet header. While packet travel from root to root intermediate roots decide according to this address to which root to send the packet next.

Fragmentation: Larger packets are divided into smaller ones and at the target the packets are recombined.

Packet timeouts: In each IP packet there is a Time to live field. Each time when a packet travel through a router, that router decrements the Time to Live number and forward the packet to the next router. When the number gets to zero the packet will be discarded.

Type of Service: Each IP packet is labeled whit an abstract type of services and according to this label the prioritization of packet is defined.

The number of the Internet users is increasing more and more day after day, and it is realized that the lifetime of the IPv4 address space is limited. IPv4 uses 32-bit addresses, and with the growth of the Internet, these have become a scarce and valuable commodity. Organizations have gone to great lengths to deal with the shortage and high cost of IPv4 addresses. In 1991, the IETF decided that the IPv4 had outlived its design.

The new version of IP, called either IPng (Next Generation) or IPv6 (version 6), was the result of a long and tumultuous process which came to a head in 1994, when the Internet Engineering Task Force, IETF gave a clear direction for IPv6. Since the new IPv6/IPng architecture solves the address space problem in an effective way, the need for the new version is increasing day after day.

BACKGROUND

As evidence of the strategic importance of the development of the Internet, in year 2002 the European Union released a statement recommending a European plan of action to accelerate the implementation of IPv6, a key technology for the Next Generation Internet.

In response to the technology changes the European Union has also introduced a new regulatory framework that is intended to provide a coherent, reliable and exible approach to the legal regulation of electronic communication networks and services in fast moving markets.

INTRODUCTION TO IPV6

The Internet Protocol Version 6 (IPv6), also known as IPng (IP Next Generation), is the latest version of the Internet Protocol (IP). Formally, IPv6 is a set of speci_cations from the Internet Engineering Task Force (IETF). IPv6 is being designed as an evolutionary set of improvements to the current IP Version 4. The most obvious improvement in IPv6 over the IPv4 are that IP addresses are lengthened from 32 bits to 128 bits which anticipates the future growth of the Internet and provides relief for what was perceived as an impending shortage of network addresses. Besides, IPv6 o_ers technical advantages over IPv4, including self-con_guration mechanisms, enhanced security, quality of service features and native mobility support. IPv6 aims to be the protocol capable of bringing together access and core networks, the 'glue' for the deployment of the future 'all-IP' telecommunication network.

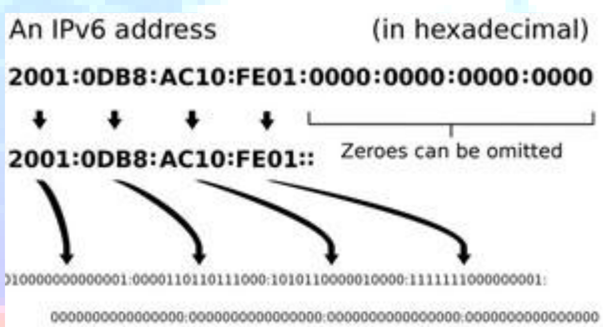
In summary, IPv6 provides new security opportunities which include message integrity, authentication, and confidentiality (IPSEC) and the possibility for a mobile node to be always addressable by its home address (MobileIP).

KEY FEATURES AND ADVANTAGES OF IPv6 AND DIFFERENCES FROM IPv4

IPv6 uses a new header format which is significantly different from that of IPv4, making the two protocols not interoperable. IPv6 also specifies a new packet format, designed to minimize the computing overhead in processing the packet headers. Some of the key features of IPv6 are listed below.

- Larger address space

The most important feature of IPv6 over IPv4 is that it provides a 128 bit address compared to a 32 bit one for IPv4, increasing the addressing capability by several trillions. An example of the addressing provided by IPv6 is shown below.



IPv6 (Internet Protocol Version 6) is the name given to the next generation of the Internet Protocol. IPv6 will eventually replace IPv4 (Internet Protocol Version 4), the workhorse of todays Internet. The Internet Protocol provides the envelope within which information is packaged and transported across the world-wide Internet. For example, when you connect to Lokvani.com from your computer, the content from Lokvani.coms web server is sent to your PC packaged in IPv4 information packets. The Internet Protocol suite also provides the set of rules and procedures using which Internet-connected devices address each other and communicate with each other over the Internet.

Even though IPv4 is an established and entrenched technology today, it is over a quarter of a century old. The exponential growth in the number of devices connecting to the Internet, and the daily blooming of new applications for the Internet is pushing IPv4 to bulge at its seams, and it is anticipated that it will not be too long before the fabric bursts at its seams. IPv6 is the Internet Engineering communitys answer to IPv4s problems. IPv6 addresses a number of issues with IPv4, while its design incorporates the lessons learned from the IPv4 experience.

IPv6/IPng is a new version of IP which is designed to be an evolutionary step from IPv4. It is designed to solve the problems of IPv4 and to be a natural increment of it. It does so by creating a new version of the protocol which serves the function of IPv4, but without the same limitations of IPv4. The differences between IPv6 and IPv4 are in five major areas: addressing and routing, security, network address translation, administrative workload, and support for mobile devices.
In this paper we are going to represent IPv6.IPv6 is the short for "Internet Protocol Version 6". IPv6 is the "next generation" protocol designed by the IETF to replace the current version Internet Protocol, IP Version 4 ("IPv4").

Most of today's internet uses IPv4, which is now nearly twenty years old. IPv4 has been remarkably resilient in spite of its age, but it is beginning to have problems. Most importantly, there is a growing shortage of IPv4 addresses, which are needed by all new machines added to the Internet.

IPv6 fixes a number of problems in IPv4, such as the limited number of available IPv4 addresses. It also adds many improvements to IPv4 in areas such as routing and network auto configuration. IPv6 is expected to gradually replace IPv4, with the two coexisting for a number of years during a transition period. We have included addressing, routing, security issue, headers and advantages of IPv6 over IPv4.

The functionalities of the next generation Internet protocol, IPv6, have become increasingly interesting due to the current merging of the traditional cellular mobile communications and the traditional data-communications into the future wireless systems, as e.g., UMTS. IPv6 provides several enhanced functionalities requested for the future mobile systems. The Internet is rapidly evolving into a commercial infrastructure, resulting in an increased demand for Quality of Service (QoS) guarantees from the network. To meet the service requirements of the next generation.

Internet (NGI) applications, new mechanisms for ensuring QoS need to be developed, requiring fundamental changes to the Internet's existing connectionless best-effort architecture. It is envisioned that in NGI, users will enjoy different levels of service for their traffic by executing contracts with their service providers. An important characteristic of NGI is to allow the users to dynamically adjust their desired service levels along with acceptable prices for the service.

This feature is necessitated not only by the requirement to provide flexibility for the users, but also by the heterogeneity in the wireless sub-systems and end device capabilities. A mobile user with ubiquitous connectivity is expected to have multiple radio interfaces, so that the user can choose the interface that provides the best instantaneous connectivity. While this will ensure ubiquitous connectivity, the mobile user will experience varied levels of service depending on the capacity of the wireless connectivity. It is also expected that a user will maintain connectivity through devices with diverse abilities.

For example, a Personal Computer (PC) may be used at home or inside an office. While driving, a small handset will be more suitable and a Personal Digital Assistant (PDA) or laptop can be used when traveling. These devices differ not only in their processing and communication capabilities, but also in the applications they can run.

Today's Internet is an outgrowth of decades of Federal investment in research networks, such as the Defense Department's ARPANET, the National Science Foundation's NSFNET, the Department of Energy's (DOE) ESnet, the National Aeronautics and Space Administration's (NASA) Science Internet, and National Science Foundation (NSF)-initiated regional networks, which have been applied in successive evolutionary multiagency programs that build on the successes of the previous programs.

The NGI is the next, but perhaps not the last, logical step in the cycle of evolving networking technologies and infrastructure necessary to support U.S. research and industry.

Today's Internet suffers from its own success. Technology designed for a network of thousands is laboring to serve millions. Fortunately, scientists and engineers believe that new technologies, protocols, and standards can be developed to meet tomorrow's demands.

These advances will start to put us on track to a next generation Internet offering reliable, affordable, secure information delivery at rates thousands of times faster than today. Achieving this goal will require several years of generic, pre-competitive research and testing. It is appropriate that the Federal government promote and participate in this research because critical Federal missions require a next generation Internet for their success and because much of the needed research is too long-term or high-risk for the private sector to fund. As with Internet development to date, success will depend on effective partnerships among universities, the private sector, and the Federal research community.

THE NGI VISION

In the 21st Century, the Internet will provide a powerful and versatile environment for business, education, culture, and entertainment. Sight, sound, and even touch will be integrated through powerful computers, displays, and networks.

People will use this environment to work, bank, study, shop, entertain, and visit with each other. Whether at the office, at home, or on travel, the environment will be the same. Security, reliability, and privacy, will be built in. The customer will be able to choose among different levels of service with varying prices. Benefits of this environment will include a more agile economy, a greater choice of places to live or work, easy access to life-long learning, and better opportunity to participate in the community, the Nation, and the world.

The most important part of a network is what people do with it -- their applications. But applications require adequate network services and infrastructure. The NGI initiative will conduct research to advance all three areas together: applications, services, and infrastructure.

In order for the applications and new technologies to be developed, the initiative will also have a goal to develop a prototype high-performance network infrastructure, or testbed, to provide system-scale testing of advanced services and technologies and to support testing of advanced applications that enable new paradigms of use.

Through the development of the Internet, the U.S. Government has led the world into a new way of communicating and stimulated industry which has provided numerous jobs. Now we are on the threshold of a next generation Internet (NGI), one that has the potential again to create a new type of interconnected community. This NGI community will be able to exchange information in far richer ways and with far less delay and risk than using today's Internet.

The NGI initiative will develop and demonstrate the advanced network service technologies needed to support next generation applications. For NGI to be successful, it is not sufficient merely to deploy a testbed that can move bits at 100 million bits per second (Mbps) to 1 billion bits per second (Gbps) because an Internet is not merely the movement of bits, and a next generation Internet is not merely faster movement of bits. The NGI applications will require a rich collection of advanced network services.

For example, high-quality team collaboration and videoconferencing support requires several types of network services not available on the Internet today. These services must be richer in features, higher in performance, and deliverable at reasonable cost. Achieving all three of these apparently conflicting subgoals simultaneously will drive NGI technology. The NGI initiative will succeed only if it deploys faster networks without also developing and demonstrating the richer, more flexible, and affordable network service technologies needed by next generation applications.

The main areas of network services and corresponding protocols that need to be developed and demonstrated are the following:

· Quality of service (QoS)
· Security and robustness
· Network management, including the allocation and sharing of bandwidth

· Systems engineering and operations, including definitions and tools for service architectures, metrics, measurement, statistics, and analysis

· New or modified protocols for routing, switching, multicast, reliable transport, security, and mobility

· Computer operating systems, including new requirements generated by advanced computer architectures

· Collaborative and distributed application environments.

EXPECTED DELIVERABLES

The NGI initiative will deliver new networking technologies that have the potential to advance human communications, access to information, and productivity as greatly as did the current Internet. These technologies will make the future Internet as different from today's Internet as from today's telephone. The resulting new capabilities will dramatically improve the way in which new Federal applications will be developed and used in the future, allowing us, for example, to break the remaining barriers to activity-at-a-distance.

The NGI initiative will develop and demonstrate new technologies within the next three years. Underlying partnerships will be crafted and managed to promote the rapid transfer of these technologies into applications, both public and private. The new capabilities will attract Federal and Federally-supported research networks to NGI technologies. Widespread adoption will elevate the technological foundation on which to build qualitatively improved Federal applications and government information service delivery.

For example, improvements will be implemented in new services dealing with civil and natural emergencies. These services may require five-minute response from initial data collection through analysis, event identification, local authority identification, and notification. Such capabilities would dramatically reduce losses.

Expected Benefits

The NGI initiative will benefit society at large by providing technology that enables widely available and rapid access to information and services in many locations and forms.

As an example, consider the area of crisis management. When a crisis occurs, it will no longer be necessary to spend weeks or months assessing damage and initiating federal aid. With advanced networking, government information services will provide key decisionmakers with immediate information on the scope and severity of an emergency whether it be a hurricane, tornado, earthquake, oil spill, or airliner crash. Instead of spending hours or days traveling to the scene and assembling a team, the crisis manager will have the needed information available instantly with required security. Instead of searching local records and negotiating with local officials for access to data as was required after hurricane Andrew, advanced networking services will allow the local networks to be quickly reestablished, and provide the emergency manager with secure access to information as needed. National security systems will use these same technologies to respond to domestic and international security emergencies.

Telemedicine is a second critical area that will benefit society while also driving the development of advanced networking technologies. Advanced telemedicine will improve the quality of life in all regions, not just those remote from current medical services.

Another benefit of this program will be an improvement in knowledge discovery and dissemination. More effective and efficient knowledge discovery and information dissemination will benefit research areas as diverse as energy, the environment, and biomedicine. Education, including distance learning, will benefit from advancing the NGI suite of technologies. Together, these advances will drive corresponding improvements in the practice and services of all sectors.

The resulting high-performance network infrastructure will also function as a distributed laboratory and help improve the U.S. R&D effort. The NGI ultra-high-performance network infrastructure will enable leading-edge data communications research into the properties of very-high-speed networks themselves. It will also lead to a better understanding of future high-quality multimedia and real-time networks.

NGI will have important benefits for both the public and the private sectors of the economy. All citizens will benefit from improved communications, and better information will permeate our daily lives. Networks will improve the nature of telephonic communication both at work and at home. At work we will receive information more quickly and reliably; at home our Internet experience will be enhanced by faster communications, the ability to guarantee an acceptable line speed, and appropriate security protections. New applications, emerging from the availability of much faster, more reliable network services, will enhance our lives in unimagined ways. By partnering with colleges and universities, the process of developing these technologies will educate a new generation of Americans knowledgeable in the communications technologies required to thrive in the 21st century.

As these students move into industry, our national economic and technological competitiveness will increase. Finally, just as advanced networking provides exciting opportunities to improve the efficiency of government, so too will it make businesses more effective international competitors.

The Internet developments of the last decade have helped to propel the U.S. to a commanding lead in information technologies. The technology developed under this initiative will enable U.S. industry to develop hardware and software required to enhance our worldwide leadership in advanced networking services and applications.

CONCLUSION

IPV6 provides a platform for new internet functionality that will be required in the near future. Enormous improvements have been made in IPv6 over IPv4. The first improvement is the extending of the address length from 32 bits to 128 bits, creating a huge number of available addresses.

The Second major improvement of IPv6 is the simplification of the header. IPv6 contains only 7 fields as compared to 13 fields in IPv4. As a result, router can process packets faster, resulting in the improvement of throughput. The third improvement is the support for multicasting, IPv4 repeatedly routes multiple copies of data to each and every receiver, creating obvious congestion problems.

IPv6 introduces an anycast address to help with this problem. Anycast identifies nodes that can share packets, and routers use that information to send just one set of data to service several nodes. The fourth improvement is the better support for security; IPv4 has trouble supporting security because an application can encode operations at only one length: 40 bytes. IPv6 permits encoding at variable lengths and at lengths greater than 40 bytes. Now applications can support authentication and security encapsulation.

A final improvement is the support for autoconfiguration, this means that IPv6 hosts can plug into the network and start communicating without requiring special configuration, whether the connection is to isolated stand-alone networks or to a large corporate network.

IPV6 may take some time to be fully used and deployed. The factors that support this opinion include the following: IPV6 represents a straightforward evolution of IPv4. It provides huge address space that takes along long time to be exhausted. It is already supported by major Operating Systems. And since, as with an operating system upgrade, users must only learn the new features, relying upon the fact that many of the reasons they chose the operating system in the first place are still present.

IPv6 offers users a number of new, or restored, features that will enhance the Internet for decades to come. This fact will make the migration and replacement phase much less painful, and costly, than if IPv6 were an entirely new and dissimilar protocol.

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