Ipv6: A Real Time Vibrant Internet Protocol

Iroegbu Chibuisi, Ihekwuaba Chigoziem, Nweke Chisom B

***Abstract*— This paper presents the significant of Internet Protocol Version Six (IPv6). To capture the place of Internet Protocol Version Four (IPv4), a new edition of the protocol called Internet Protocol Version Six (IPv6) has been introduced. IPv6 is the next generation design that supports unlimited addresses, flexibility, robustness, enhanced security, better support for quality of service, higher performance, built-in multicasting, enhanced mobility, unlimited addresses etc. The research has shown that, moving from IPv4 to IPv6 present an opportunity to rethink on how technology can spark business innovation.**

***Index Terms*— IPv6, IPv4, Performance, Security, Robustness**

I. INTRODUCTION

Internet Protocol is a set of technical rules that defines how computers communicate over a network. It is a network-layer protocol that contains addressing information and some control information to enable packet routing through a network. Along with the Transmission Control Protocol (TCP), IP is the primary network-layer protocol in the TCP/IP Protocol Suite [I].

IP provides connectivity, interoperability, security, and discovery, end-to-end across an Internet network. The IP addressing scheme is key to the process of routing IP datagram through an internetwork. Each IP address has specific components and follows a basic format. These IP addresses can be subdivided and used to create addresses for sub-networks. There are two standards for IP addresses: IP Version 4 (IPv4) and IP Version 6 (IPv6) [II][III]. All computers with IP addresses have an IPv4 address, and many are starting to use the new IPv6 address system as well. IPv4 uses 32 binary bits to create a single unique address on the network. An IPv4 address is expressed by four numbers separated by dots. Each number is the decimal (base-10) representation for an eight-digit binary (base-2) number, also called an octet. For example: 216.27.61.137. IPv6 uses 128 binary bits to create a single unique address on the network. An IPv6 address is expressed by eight groups of hexadecimal (base-16) numbers separated by colons. Groups of numbers that contain all zeros are often omitted to save space, leaving a colon separator to mark the gap. At the dawn of IPv4 addressing, the Internet was not the large commercial sensation it is today, and most networks were private and closed off from other networks around the world. Under IPv4, there are 232 possible combinations, which offer just 4.3 billion unique addresses; thus, IPv6 raised that to a panic-relieving 2128 possible addresses.

II. INTERNET PROTOCOL VERSION 4 (IPV4)

Internet Protocol version 4 (IPv4) is the fourth version of the Internet Protocol (IP) and it is the first version of the protocol to be widely deployed. IPv4 is still by far the most widely deployed Internet Layer protocol. It uses a 32 bit addressing and allows for 4,294,967,296 unique addresses [IV]. It was the first that was widely used in modern TCP/IP. It provides the basic datagram delivery capabilities upon which all of TCP/IP functions and has proven its quality in use over a period of more than two decades. Figure1 shows a typical IPv4 Internet Edge Network

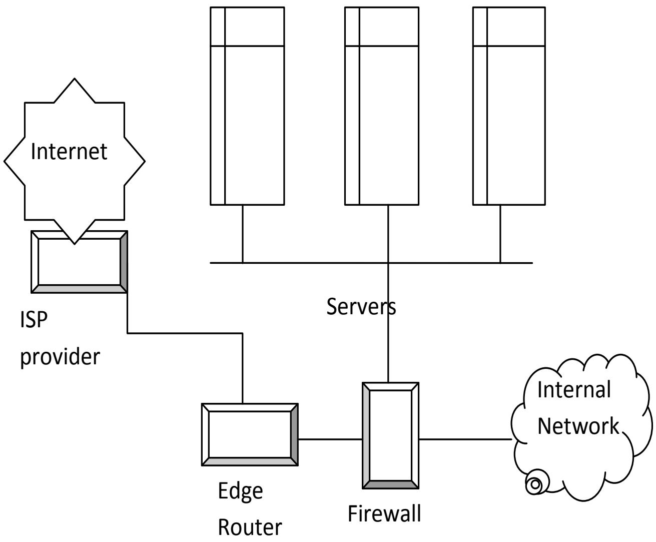

Figure1: IPv4 Internet Edge Network

III. INTERNET PROTOCOL VERSION 6 (IPV6)

Internet Protocol version 6 (IPv6) stands for Internet Protocol version 6 and also known as Ipng (IP next generation). It is the second version of the Internet Protocol to be used generally across the virtual world, and intended to succeed IPv4. IPv6 uses 128-bit addresses, for an address space of 2128 (approximately 3.4×1038) addresses [V]. This expansion allows for many more devices and users on the internet as well as extra flexibility in allocating addresses and efficiency for routing traffic. It also eliminates the primary need for network address translation (NAT), which gained widespread

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deployment as an effort to alleviate IPv4 address exhaustion. It support is available operating systems such as Unix, Mac OS and Windows etc. Figure 2 shows a typical IPv6 Header Format

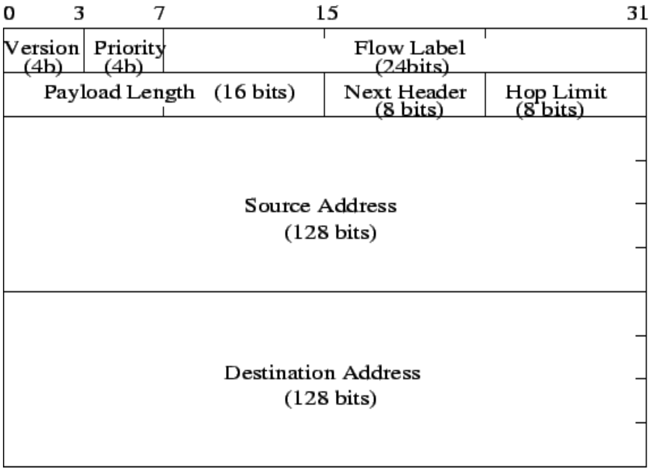

Figure2: The IPv6 Header Format

IV. LIMITATIONS OF IPV4

The limitations of IPv4 include:

A. Insufficient IP address space

With only 32-bit capacity, IPv4 addresses have become relatively scarce, forcing some organizations to use Network Address Translation (NAT) to map multiple private addresses to a single public IP address. While NAT promotes conservation of the public address space, it does not support standards-based network layer security or the correct mapping of all higher layer protocols and can create problems when connecting two organizations that use the same private address space. The continued expansion of Internet-connected devices and appliances continues to put greater and greater stress on the public IPv4 address space [VI].

B. Address prefix allocation

Because of the way that IPv4 address prefixes have been and are currently allocated, Internet backbone routers are routinely required to maintain unreasonably large routing tables of over 85,000 specified routes. The current IPv4 Internet routing infrastructure is a combination of both flat and hierarchical routing.

C. Complexity of configuration

Most current IPv4 implementations must be either manually configured or use a stateful address configuration protocol such as Dynamic Host Configuration Protocol (DHCP). With more computers and devices using IP, there is a need for a Simpler and more automatic configuration of addresses and other configuration settings that do not rely on the administration of a DHCP infrastructure.

D. Data security

Private communication over a public medium like the Internet requires encryption services that protect the data being sent from being viewed or modified in transit. Although an add-on standard now exists for providing security for IPv4 packets (known as Internet Protocol Security or IPsec), this standard is optional and proprietary alternatives are commonly used.

E. Quality of Service (QoS)

While standards for QoS exist for IPv4, no identification of packet flow for QoS handling by routers is present within the IPv4 header [VII]. Instead, real-time traffic support relies on the IPv4 Type of Service (ToS) field and the identification of the payload, typically using a UDP or TCP port. However, the IPv4 ToS field has limited functionality and payload identification using a TCP and UDP port is not possible when the IPv4 packet payload is encrypted.

A new suite of protocols and standards known as IP version 6 (IPv6) has been developed to address these limitations. Previously called IP-The Next Generation (IPng), IPv6 was intentionally designed to minimize impact on upper and lower layer protocols by standardizing packet header formation and making it easy to handle new data types without causing a negative impact on network performance[VIII].

V. BENEFITS OF IPv6

The introduction of IPv6, alongside unrestricted access to broadband, is of great importance, offering citizens wider access to an advanced Information Society. IPv6 and broadband deliver improvements in economic growth, competitiveness, and productivity through the provision of a whole new generation of services and applications, including 3G. As 3G mandates the use of IPv6, requiring the restoration of end-to-end connectivity, with the phenomenal uptake of mobile communications, particularly in the developing world, the introduction of IPv6 offers the possibility for greater digital inclusion. From a technical perspective, the ITU, in an article titled “Internet for everyone: IPv6 2005 Roadmap Recommendations,” highlights the following benefits of IPv6:

a. Unlimited addresses

IPv6 allows for more than 340 undecillion (340 followed by 36 zeros) addresses. Because of the vast number of IPv6 addresses available, virtually everything can be Internet enabled. Devices can be easily networked for inventory tracking, performance-based maintenance scheduling, and instrument monitoring over an IP rather than proprietary control system network.

b. Plug and play for ease of management

IPv6’s stateless auto-configuration enables new devices to be added to the network without any further action on the part of IT staff. Just being physically connected to the network will enable a machine to configure itself automatically and communicate with other machines.

c. Enhanced mobility

Because IPv6 facilitates the deployment of online mobile communications by supporting seamless and continuous Internet connectivity, a device can have an IP address that is reachable no matter where the user may be [IX].

d. Built-in multicasting

IPv6 advances the art of multicasting to meet the growing demand for high-bandwidth multimedia applications. Multicasting also makes it easier to set up automatic IP failover for replication servers, helping to ensure high availability in fault-tolerant environments.

e. End-to-end services and applications

IPv6 will ultimately eliminate the need to deploy and support network address translation (NAT) devices to conserve public Internet address space, saving money and simplifying network administration.

f. Higher performance

Simplified header processing in IPv6 allows for more efficient packet handling.

g.Better support for QoS

Inclusion of levels of assured service enables enhanced quality of service support for time-sensitive applications such as VOIP with IPv6, eliminating the latency, jitter, echo, and other quality issues experienced on IPv4 networks [X].

h. Enhanced security

IPv6's built-in IPsec support allows devices to securely authenticate remote nodes and encrypt communications with them for true end-to-end security.

i. Robustness

Application-level routing techniques can exploit the redundancy in underlying connectivity to improve robustness.

j. Flexibility

Active Networking-like technology allows the network to be upgraded or extended with new protocols, and is thus able to evolve quickly as new peer-to-peer routing technology emerges.

k. Serverless ("stateless")

It supports IP auto-configuration, easier network renumbering, and much improved plug and play support.

VI. RESULTS ANALYSIS

Stated in table 1 below are the summarized key results arising from the comparative evaluation between IPv4 and IPv6.

Services	**IPv4**		**IPv6**	
	Solution	**Limits**	**Solution**	**Limits**
Security	IPSec	In the form of additional layer; -Cannot support peer-to-peer security; - Cannot be used adequately through NAT today; - The relatively small size of the IPv4 network offers the possibility to look for, at lower cost, the stations by scanning the four billion addresses available.	Native IPSec	- End-to-end security can be deployed. - Because of the large number of IPv6 addresses, the network is very difficult to scan in order to attack it. One IPv6 subnet is longer to explore than the sum of the IPv4 network in its entirety. - IPv6 protocol may result in security problems in the future. With IPv6 connectivity an attacker can reach all internal IPv6 enabled nodes even if they reside in a private IPv4 address space.
Mobility	IPv4 NAT-Transversal Protocol	- Mobility must be added as a new feature.	MIPv6	-Mobility is built into the IPv6 node, thus one can use mobility as needed. - Supports a new paradigm for node discovery through neighbor discovery.
Wireless Network	MIPv4		MIPv6	- Designed to handle the forecast computer population security issue.
Quality of Service (QoS)		Impossible to distinguish packets in a flow.	- QoS supports IPv6 with the addition of two header fields (traffic class and low label). - IPv6 enables broadband power lines.	- VoIP with minimum delay. - High-quality video distribution. - QoS in IPv6 allows ISPs to better route traffic by avoiding the points of congestion in networks, thereby making more efficient use of the available bandwidth.
Auto-configu ration	DHCP4	-Required to configure a server. - Enormous consumption of CPU resources.	DHCP6	- Supports stateless node discovery (RFC2462). - Supports prefix delegation to customers and provider networks. - It is used with stateless DHCPv6, so there are no addresses or other entities with lifetimes.
IP addresses number	NAT & CIDR	- Shortage of address space. - NAT threat to end-to- end.	- 128-bit address space.	- Solves the IP address exhaustion problem.

				- IPv6 enables home networks.
End-to-end	IPv4	- Inadequacy of IP addresses to allocate actual and future hosts and devices which need pee- to-peer connectivity. - NAT, which solves the IP address shortage problem, on the other hand breaks the end-to-end principle.	IPv6	- Easily allows secure peer-to-peer connectivity to all Internet hosts and devices that need it.

VII. SUMMARY AND CONCLUSION

From the result in Table 1, it is evident that there are many reasons why IPv6 tends to be a better choice for the next IP generation. It supports unlimited addresses, flexibility, robustness, enhanced security, better support for QoS, higher performance, built-in multicasting, enhanced mobility, unlimited addresses etc. Therefore, technology that enables the real-time dynamic flow of information is critical for top- and bottom-line growth.

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