IPv6 – A new definition of network

Jatinder Kumar

Assistant Prof.,

A .S. College, Khanna

Abstract: While designing a network there are number of factors which are required to be taken into consideration with respect to its infrastructure, opera ability, customization and usage in various environments. IPV6 is the new generation protocol, which is dynamic in nature and provides expected mobility, changes incurred by renumbering networks and higher focus on security built into the protocols. The paper provides an insight into the features of IPV6 protocol.

Keywords: *Communication links,* Interoperability, Internet Control Message Protocol.

Since ancient times people have had a need to communicate. This has led to spoken and written languages. We often find a common means to communicate, for instance in one of the prevalent languages like Spanish, English, and French.

Since the first telegraph by Thomas von Soemmerrings 1890 electric signals has been used to convey information. In Germany C.F. Gauss and w. Weber, in 1833, used an electromagnetic telegraph between the astronomical o and the Institute of Physics in Gottingen. By 1834 Samuel Morse had devised a usable telegraph system and alphabet which in 1843 was used to transmit real- time signal across long distance (from Baltimore to Washington, D.C.)

Today we can talk on the telephone with friends, relatives, business partners and others regardless of where they are currently located using long distance cable, satellite links, mobile phones or even portable satellite phones, which work form almost any place on earth.

The Modern computers are based on millions and millions of transistors in integrated circuits, which are often based on the semiconductor Silicon.

The speed of computers have also changed tremendously from executing a few instructions per sec-ond (Hz) to running with clocks in the Gigahertz range and at the same time executing more than one instruction in parallel each clock-cycle.

The advent of powerful computers and higher bandwidth networks has made it possible to store and process data in new ways, and has also radically changed the way people communicate essentially creating what is called the information Age. Imagine a day where:

The bank couldn't transfer money and all ATM's (Automatic Teller Machine) were disabled.

There was no electricity, because the power grid control systems were out of order.

Airport traffic control systems didn't work.

These are just a few examples of dependency we all share. Another example is the telephone system which we all take for granted. It is based on electronic switching systems, and problems in the controlling software or another malfunction could potentially cascade through the telephone system and disable it- perhaps with fatal results [Cohen, 1995].

COMPUTER NETWORKS

Networks can in general be defined as an interconnected system consisting of nodes and the edges that connect them. Using this definition the power grid, water supply and the telephone system can be thought of as networks. A computer network is a system of nodes, hosts and routers, connected by communications links.

COMMUNICATION LINKS

In computer network there are different types of communication links As is seen from the previous section the specific hardware used for sending the bits of information should not influence the higher level abstraction of communication.

The common communication links used for data transmission today include telephone lines, leased lines, DSL circuits to a telephone exchange, or higher capacity dedicated links as ATM. The capacity of a line is measured in latency, and bandwidth.

Point- to- point network

The smallest usable network possible is made of two nodes connected through a single link.

Using a single cable between two computers it is possible to make a connection from one point to another- appoint-to-point connection. Examples of point-to-point links are serial and parallel cables between personal computers, or modem connections if the distance is greater.

Broadcast network

The opposite of point-to-point links are broadcast links where all nodes see the same traffic. The defining property of broadcast links is that all nodes on the same link can listen in on the data when transmitted from the sending node.

NETWORK HARDARE

Network hardware is all the physical components needed to build networks and I will introduce only the common Ethernet technology as an example where cabling, physical topology, and logical architecture influence the network.

Links as described above are often implemented in the real world with cables. Cables can be either thick or thin, long or short placed nicely on the bottom of an ocean, dug into the ground or lying in a pile behind a computer like spaghetti, Inside the cables it can be any of copper leads, fiber optics or some new technology. A single cable can be used as one link, but more often several pairs can be combined and manufactured as one cable, making it easier to lay out and perhaps at a lower cost than laying out several cables.

NETWORKING SOFTWARE

Hardware and software go together, and while low level functions can be implemented directly in hard- ware it would seem unrealistic to implement all high level applications in hardware. Most advanced networking hardware today have a way to upgrade the built in software, making software upgrade easier and faster than physically upgrading the hardware.

Introduction of IPV6

Basically IPv6 is the internet protocol well suited for large- scale implementation, but IPv6 is also a whole new way of thinking and some features are completely new.

Today there are systems being deployed which has built- in IPv6 capabilities, and most vendors have published plans for inclusion in future products.

TCP/IP version 6 is a suite of network protocols based on best- efforts delivery of data packets across heterogeneous networks. The protocol suite is intended for use in the smallest as well as the largest networks- the current worldwide internet.

The new features in IPv6 are many but for the most part default values and auto configuration can help networks getting installed quickly and managed easily. It should be noted that large networks, such as the Internet, still need configuration and care!

Core IPv6 PROTOCOLS

The current protocol are the result of process started in the early nineties. Today the core set of IPv6 protocol that were made an IETF Proposed Standard has been updated by the following IPv6 core documents which are currently Draft Standard.

Internet Protocol, version 6 (Ipv6) Specification, RFC -2460 (IPv6)

Neighbor Discovery for IP version 6 (IPv6) [RFC-2461]

IPv6 stateless Address Auto configuration [RFC-2462]

Internet Control Message Protocol (ICMPv6) for the Internet Protocol version 6 (IPv6) [RFC-2463]

Path MTU Discovery for IP version 6 [RFC-1981]

Some other very important documents are:

IP Version 6 Addressing Architecture [RFC-2373)

DNS Extensions to Support IP version 6 [DNSv6]

These documents describe what I would call the second wave of IPv6. As prescribed in the IETF process of standardization a new standard has to pass from proposed standard over draft standard before they finally (perhaps) can receive the notion of being an IETF standard.

IPV6 VENDOR AVAILABILTY

During the years several group have implemented and tested the IPv6 protocols, while they were being specified. Since then the protocols have matured a lot, and today multiple vendors include IPv6 support in their bas products. This all leads up to a list of some products that ship IPv6 implementations with a varying degree of functionality.

IBM AIX has had some IPv6 support since version 4.3. Sun Solaris has had an IPv6 prototype since 1995, and with Solaris 8 Sun delivers IPv6 integrated and the support for IPv6 is very transparent and complete.

Cisco IOS has worked with the Internet community and has stated that official support for IPv6 will being with IOS 12.2 (I) T.

Juniper Network which also makes routers even have hardware support for IPv6 in some of their systems.

The KAME project has provided a complete IPv6 stack for BSD derived operating systems for server years. The KAME IPv6 stack and tools for IPv6 has been well- integrated in the many operating systems.

Microsoft Windows XP is the first software package in the Microsoft Windows family to have IPv6 support built in capabilities.

Operating systems based on the Linux kernel has had some support for IPv6 in several years.

NEW FEATURES IN IPv6

Those that know IPv4 already will soon feel at home with basic IPv6 features. The proposal that was selected as the basis of IPv6 can in many cases be viewed as enhancing and re-implementing IPv4, rather than redesigning it. The reason for enhancing is to solve identified problems with IPv4, and optimize TCP/IP for the future- allowing the internet to grow even bigger. Further the architects behind IPv6 has learnt from the evolution on the Internet that new functionality will be needed in unexpected areas, so they have built a high degree of flexibility into the protocol suite.

The features described are part of the basis IPv6 protocol. Since the protocol header is one very visible change from IPv4, and also a defining feature of a network protocol I will start describing the basic IPv6 header which is included with every packet.

a) The IPv6 headers compared to IPv4

The IPv6 header is new, and is designed to be both flexible and well suited for implementing in routers that need to route as many packets as possible in a very short time.

The basic header used on all IPv6 packets is shown in figure 5.1 The characteristics worth nothing are compared to IPv4

Fixed header size 40 bytes- whereas the IPv4 header length is variable but at least 20 bytes without extra option.

Source and destination addresses are 128 bit compared to 32 bit addresses in version 4.

Six fields in the new header compared to 10 fields in IPv4 header. No checksum- not needed!

64 – bit aligned fields, if header is aligned in memory then field in the header will also be aligned. First 64 bit includes all six fields.

b) No checksum in IPv6 header!

The specification prescribes that the checksum known from the IPv4 packet header has been removed in IPv6. It might at first seem a bit risky to remove some form of error correction, but in fact it was a qualified decision based on the experience from IPv4.

c) Understanding IPv6 address

IPv6 addresses are 128 bit entities. Since this is much longer than their IPv4 counterpart. The addresses allocated to networks are also expected to change from time to time, due to renumbering. It is advisable to use DNS for translation from names to addresses and vice versa.

Networking administrators are the only ones that in general have to be confronted with the actual ad- dresses when they configure equipment and document the network. The agreed upon textual representation for IPv6 addresses are described fully in [RFC-2373] from which the information in this section is adapted.

In short the preferred way of writing IPv6 addresses X:X:X:X:X:X:X:X: - where the 'x's are the hexadecimal values of the eight 16- bit pieces of address. Since the addresses are likely to have strings of zero bits a short hand for this is defined as "::" – which can only appear once in a written address.

Since the usual way of writing Uniform Resource Locators (URL) include the port number with a colon, it can be a bit confusing how one should write an URL including an IPv6 address and a port- number- which usually is written after the address with a colon.

The path chosen is to put the textual IPv6 address in brackets ([]), and then put the port number after this. This is consistent with the use of brackets when writing absolute IPv4 addresses, and removes nay ambiguity.

REASONS FOR IMPLEMENTING IPV6

In this section I will list the main reasons for implementing IPv6, by listing the features and the value they add in today internetworks.

The section will cover these parts:

Robustness and performance improvements

Security is a great reason to use IPv6, since IPsec is mandatory

Auto configuration and less management

New features- future proof

Flexibility

New features and flexibility combined with a secure, robust and transparent Internet is the reason sees for promoting IPv6.

a) Addressing

The initial driver for a new version was the shortage of address which forced the formation of the IETF Next Generation (IPng) Area in late 1993. Addressing is the very visible parts of IPv6 and has drawn a lot of attention from the other features!

IPv6 nodes are also much easier to configure if auto configuration is used, and manual configuration of client and servers are no less complicated than configuring the same with IPv4.

IPv6 also has the promise of easier configuration of mobile clients , I will not go into the Mobile IP area, as it is still in a flux and being revised for IPv6

b) Robustness and performance improvements

When building network and IT solutions for production use it is expected that these are running with predefined service level agreements and can withstand some errors and unusual incidents. These means of having a robust and well performing network should be built- in when designing the components and the overall structure. Luckily the nee protocol suite includes features for improving the robustness and performance of networks. Performance might not mean faster than IPv4 but perhaps equal to IPv4 when the network grow as expected – or even faster!

Robustness and performance improvements

IPv6has incorporated the valuable features from IPv4, and complemented with new. This should in no circumstances be viewed as a complete list, but I see the very important features which enhance the usefulness of IPv6 as:

Congestion control has improved

Path MTU discovery- recommended, efficient use of the network as the MTU for a network path is discovered and used

Fragmentation only in end- nodes, either a host sends packets of size 1280 octets, or use path MTU

IPv6 has the notion and support for deprecated addresses, in which a host can begin using new addresses for opening connections, while keeping old deprecated addresses only for existing connections.

However IPv6 is more dynamic and since the addresses are not fixed this creates focus on and exacerbates an existing problem from IPv4, which is the trust we have in the Domain Name System. IPv6

The IPv6 header format in much simpler, yet new features can be added easily. The fixed size basic header without a checksum should improve the handling of packets by routers, by eliminating steps that need to be carried out for each packet.

The maximum payload size with IPv6 is basically 65,535 octets comparable to IPv4 packets length which includes the header length in the length. Since some networks might surpass this barrier, IPv6 includes the possibility of jumbogram packets with very large payloads. Using jumbograms it is possible to send packets with a payload between 65,536 and 4,294,967,295 octets in length!- should a specific link have this property.

c) Security

When the Internet was young there was not the same hostile environment as there is today, with businesses and people whose lives depend on the ability to communicate. The architects behind IPv6 decided to make security mandatory, by making IPsec mandatory to counter some threats in the global Internet today.

There might also be grounds to believe that the IPv6 implementations are programmed in a more secure way, as more people focus on security today. As an example the KAME implementation has gone a long way to ensure that some bogus packets are discarded along the way in the IP stack.

d) Auto configuration, less administration

IPv6 is different from its predecessor with regards to configuration. The Internet started out with a few links that were definitely configured manually. As the network software matured and the technology was being implemented in large local area networks it was enhanced with protocols allowing for hosts to discover their own addresses or being allocated addressed on request. Protocols that fall in this category ate reverse Address Resolution Protocol (RARP), Bootstrap Protocol (BOOTP) and the most advanced is the Dynamic Host Configuration Protocol (DHCP) which allow for the configuration of many advanced parameters related to network administrator configures a server to answer the requests from the clients.

Since ease of use was envisioned for the new internet protocol, and it was to be automatic it was named auto configuration. The goal of auto configuration is that anyone should be able to install and use an IPv6 network in the office without having to worry about allocating addresses by hand, or install a DHCP server.

First we will take a look at the devices that need addresses, and some kind of configuration before being able to function on an internetwork. These components that need configuration can be classified in these categories (non disjunct categories) according to their primary characteristics:

Clients, individual machines of the user community, there are likely many of these clients- perhaps even thousands. Manual configure and reconfiguration is best avoided as it is very time consuming. Servers, relative few in number maybe few hundreds. These need to be installed before use and also need both monitoring and manual configuration for the most part.

e) New features

The architects behind IPv4 did not anticipate the growth, but the community around TCP/IP has extended and evolved IP for 25 years.

The original protocol has been augmented with new features that have extended the functionality to cover a wide range of uses.

Flows and resource reservation are one area where IPv6 is trying to distinguish itself from IPv4. Flows are a term used to describe packets that need special handling from the network and they are identified by 24- bit quantities in the IPv6 header. It is expected that flows can give extra functionality compared to the Traffic class field but needs some form of flow- setup. Flows in IPv6 are also expected to perform better than their existing IPv4 counterpart which uses more field to implement the same functionality.

Another area where IPv6 is gaining market acceptance is Mobile IP where at least the 3rd Generation Partnership Project (3GPP) forum has used IPv6 as component n the architecture.

f) Flexibility:

IPv6 is more flexible than IPv4. Just about anything that is retrofitted will, in my opinion, fit less elegantly with IPv4 than the IPv6 which have more ways to integrate new functionality- through extension headers, flow label, large address space, multicast, anycast etc.

IPv6 provides auto configuration and promises mobile IP. Furthermore the big address space makes it feasible to give any computer a globally unique address- removing the kludge called network address translation (NAT) and again making the Internet end-to-end transparent for the user community.

References:

1. S. Deering, R. Hinden, Internet Protocol Version 6 (RFC2460), 1998

2. IPV4/IPV6 Translation Technology, Masaki Nakajima, Nobumasu Kobayashi,2004

3. Amer N.AbuAli, Ismail Ghazi Shayeb, Khaldoun Batiha, Haifa Yabu Aliudos ,The Benefits of Using Internet Protocol Version 6 (IPV6)by , Vol. 5. n. 6, pp. 583-587.

4. Charles M. Kozierok, "TCP/IP Guid A COMPREHENSIVE , ILLUSTRATED INTERNET NTERNET PROTOCOLS

5. Hitesh Ballani, Paul Francis, Cornell University, Ithaca, NY, Understanding IP Anycast".

6. Amer Nizar Abu Ali, Comparison study between IPV4 & IPV6, IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 3, No 1, May 2012.