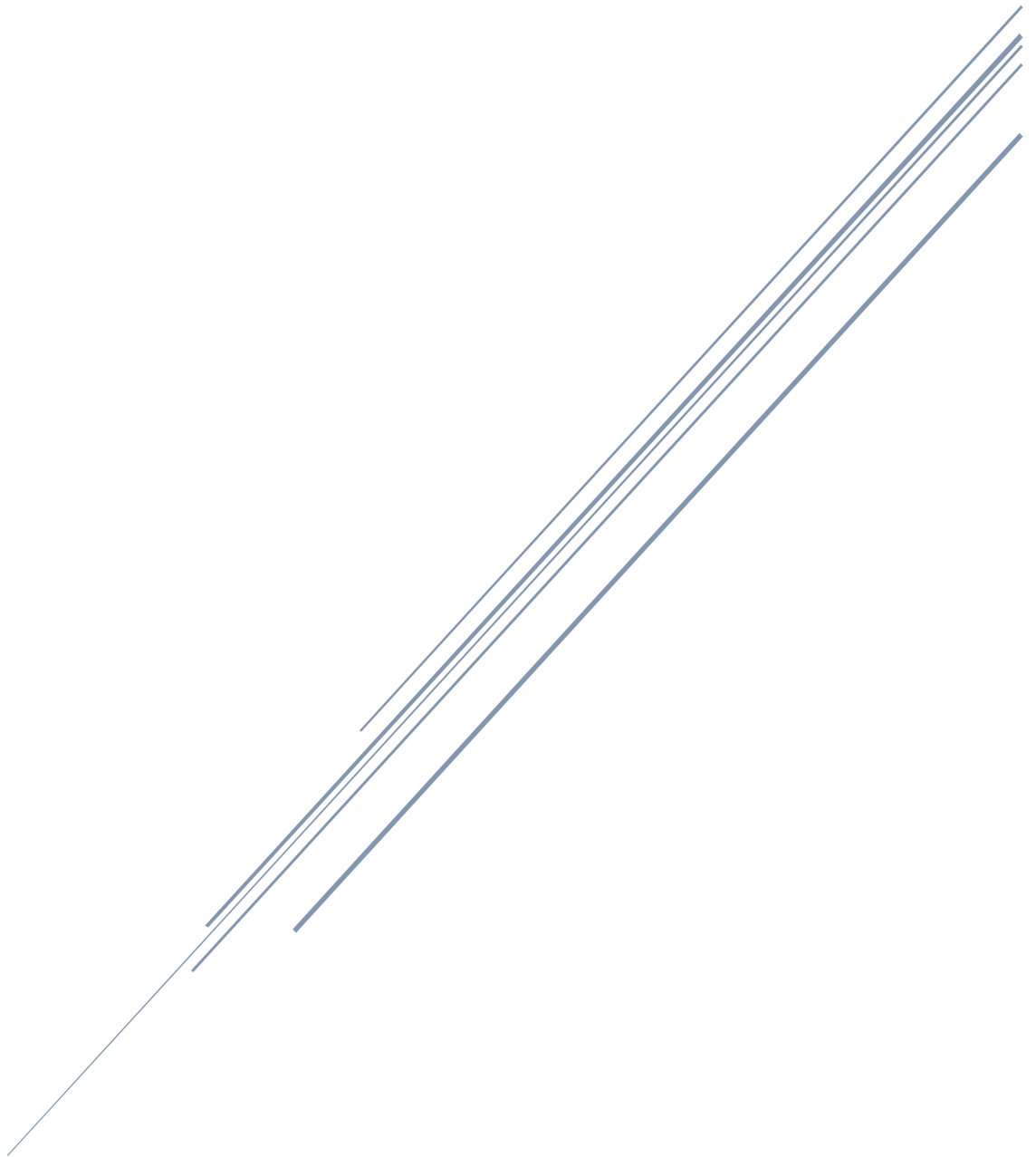


INTERNET PROTOCOLS

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Introduction

IPv4 addresses will be depleted quickly and organizations will need to begin the transition to using IPv6-type addresses. Migration to this type of addressing includes upgrades to all applications, hosts, routers and DNS infrastructure. At the same time, in the transition to IPv6 backward compatibility (with the older version) must be maintained in order to be able to connect to different networks. All these circumstances impose start planning the transition to IPv6, which should start as soon as possible. Transition planning needs to address many technical and business issues. The system administrators of the organizations will soon be facing the need to migrate to IPv6, which must be performed smoothly and seamlessly without disturbing the functioning of business. The following are specific actions that the organization must make the transition to IPv6. These actions are considered it in two aspects - business and technical.

Historically, the main reason for the transition to IPv6 is the depletion of IPv4 addresses that has occurred due to the rapid increase in internet-connected devices. Others the drivers of this transition are: the development and adoption of broadband access for home users; spread of intelligent devices connected to a cable or wireless and connecting to a network ordinary devices. Despite the emerging need to transition to IPv6 enterprises are not yet ready for this.

For the first time, Internet Protocol (IP) or IPv4 is used on the network ARPANET and later IP protocols became the basis of communication in Internet. The new protocol to replace IPv4 is Internet Protocol version 6 (IPv6). It was designed in the mid-1990s, when it was determined that IPv4 addresses will be a serious barrier to the inevitable expansion of the Internet. While IPv4 uses 32-bit addressing, which provides 4.3 billion unique addresses for use, IPv6 uses 128-bit addresses that provide practically infinite number of usable addresses. The total number of usable addresses within an internet protocol is determined by raising 2 to the power of bits that the protocol uses and 2^{128} looks like this: 340,282,366,920,938,463,463,374,607,431,768,211,456. IANA (Internet Assigned Numbers Authority) has restricted the available IPv6 addresses to 1/8 of the total capacity which is only 42,535,295,865,117,307,932,921,825,928,971,026,432 in comparison Earth's age in seconds is this number - 143,300,000,000,000,000 (Space.com, 2019)

The IPv6 address is made out of 128 bits or in other words 8 groups of 4 hexadecimal digits. The hexadecimal system uses sixteen digits: the digits 0 through 9 and the letters from 'a' to 'f'. IPv6 address looks like this 2001:0eb8:86a3:0000:0000:8a2e:0370:7335. It's not sensible to write down the whole address the subsequent optimizations are often made when writing these addresses:

The leading one or more zeroes in each group can be removed –2001:eb8:86a3:**0:0**:8a3e:371:7335
Several consecutive fully zero groups can be replaced by "::" – 2001:eb8:86a3::**8a3e:371:7335**.

As with IPv4, the size of blocks of IPv6 addresses is decided with the aid of the tiers of the pair. Lead groups are the same for all addresses in a block and are called a network address or network prefix. For example, the 2001:0db8:0000:0000:25fd network will include all addresses from 2001:0eb8:0000:0000:26fd:0000:0000:0000 to 2001:0eb8:0000:0000:26fd:ffff:ffff:ffff.

The size of the network blocks is decided by a decimal range that indicates the length of the prefix in bits preceded by a slash. Recall that every cluster of four positional notation numbers within the address is sixteen bits long. Thus, the preceding network block are often in brief represented as: 2001:eb8:0000:0000:26fd:: / 80

Types of IPv6 Addresses

Unicast

One-to-one communication, the only source that transmits data to a single destination. “The most significant types are global unicast addresses, which are equivalent to IPv4 public addresses, and link-local addresses.” (Ciscopress.com, Unicast Addresses, 2019)

Global unicast addresses (GUAs) – globally routable and reachable on the IPv6 Internet. Equivalent to public IPv4 addresses. Begins with the prefix 2000::/3. (IANA, 2019)

Link-local addresses – unicast address that belongs to a single subnet. Not globally reachable. Automatically or manually assigned to any IPv6 device. Begins with the prefix fe80::/10

Loopback addresses – all 0s address except for the last bit, which is 1. Equivalent to 127.0.0.1 in IPv4.

Unspecified addresses – all 0s address. Cannot be assigned to an interface. Used to indicate the absence of an address.

Unique local addresses – private address space. Not globally reachable. Begins with the prefix fc00::/7

IPv4 embedded addresses – IPv4-mapped addresses used to represent an IPv4 address inside an IPv6 address.

Multicast

One-to-many communication, transmission received from a group of devices as a destination. Multicast is used instead of broadcast, because there is no broadcast like in IPv4. (Tenouk.com, 2019)

Well-known multicast addresses – reserved for predefined groups of devices, such as IPv6 nodes and IPv6 routers multicast groups. (Ciscopress.com, Summary, 2019)

Solicited-node addresses – special multicast address assigned to an interface. Automatically created.

Anycast

Similar to Multicast, except that the source selects the closest among the many destinations to which to pass the data. “Anycast addresses are special addresses and are used to cover things like nearest DNS server, nearest Dynamic Host Configuration Protocol (DHCP) server, or similar dynamic groups.” (Tenouk.com, 2019)

Improvements in IPv6

Auto-configuration

IPv6 provides the ability to automatically configure the network, which means that any IPv6 device can be connected to the network and it will successfully generate for itself an IPv6 address without having to enter a static DHCP server login. If the device is connected to an IPv6 router, it can generate a local address and a global navigation address, offering instant internet access. (ITWeb, 2019)

Built for security

Another important step forward for IPv6 is the area of security and internal encryption. (ITWeb, 2019). Unlike IPv4, IPv6 packets guarantee end-to-end security because the data contained in them cannot be easily decoded by intermediaries. (RFC 2406, 2019)

Improving the quality of service (QoS)

The adoption of IPv6 also brings significant improvements in terms of QoS. Applications that require low latency, such as VOIP and streaming multimedia, (ITWeb, 2019) will have the appropriate level of priority for transfer over a WAN without delay. (RFC 2460, 2019)

Routing improvements

Internet routing tables have become extremely sophisticated on the internet in its current state. The structured network layout for the allocation of addresses used for IPv6 helps reduce the load on the current wide infrastructure network. (RFC 2460, 2019) IPv6 additionally includes a more sensible scheme to support multicast routing. (ITWeb, 2019)

Simplified title packages

The new simplified and standardized title package used in IPv6 also improves routing. IPv6 uses a fixed title length that includes 40 bytes. This configuration allows information to be routed much faster. IPv6 also eliminates fragmentation of header packets for greater efficiency. Extended titles can still be used, but only when needed. (ITWeb, 2019)

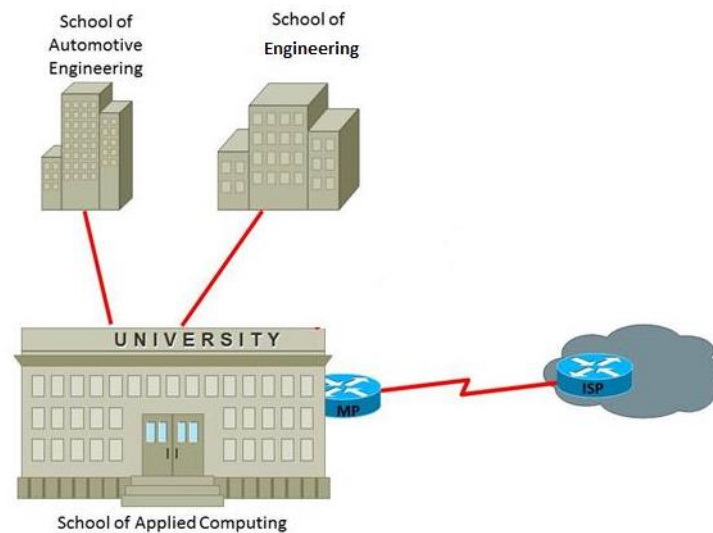
Improved mobility

IPv6 provides better mobility for users moving from one subnet to another. The mobile network connection will be maintained transparently, as any device, such as a smartphone or tablet, will be identified by its home address. If the device connects through a foreign network, its location information will be forwarded to a home agent. The home agent grabs packets destined for the device and then tunnels them to its location. In short, roaming between networks has the potential to be seamless for users running IPv6. (ITWeb, 2019)

References

- Ciscopress.com. (2019). *Summary*. Retrieved from <http://www.ciscopress.com/articles/article.asp?p=2803866&seqNum=7>
- Ciscopress.com. (2019). *Unicast Addresses*. Retrieved from <http://www.ciscopress.com/articles/article.asp?p=2803866&seqNum=4>
- IANA. (2019). *IPv6 Global Unicast Address Assignments*. Retrieved from www.iana.org/assignments/ipv6-unicast-address-assignments/ipv6-unicast-address-assignments.xml
- ITWeb. (2019). *Are you ready for IPv6?* Retrieved from <https://www.itweb.co.za/content/8OKdWMDJgXlvbnQ>
- RFC 2406. (2019). *IP Encapsulating Security Payload (ESP)*. Retrieved from <https://www.ietf.org/rfc/rfc2406.txt>
- RFC 2460. (2019). *Internet Protocol, Version 6 (IPv6) Specification*. Retrieved from <https://www.ietf.org/rfc/rfc2460.txt>
- Space.com. (2019). *How Old Is Earth?* Retrieved from <https://www.space.com/24854-how-old-is-earth.html>
- Tenouk.com. (2019). *Internet Protocol version 6 (IPv6)*. Retrieved from <https://www.tenouk.com/internetprotocolversion6ipv6.html>

IP addressing instructions



IP addressing scheme to support:

- a) School of Applied Computing: 20 staff, lab301 – 60 pcs, Lab302 – 30 pcs, Lab303 – 36 pcs, Lab 304 – 45 pcs, Lab306 – 40 pcs, Lab308 – 140 pcs, Lab309 – 50 pcs and Lab310 – 18 pcs.
- b) School of Automotive Engineering: 25 staff, lab101 – 40 pcs, Lab102 – 25 pcs, Lab103 – 35 pcs, Lab205 – 40 pcs, Lab206 – 48 pcs, CAD lab – 20 pcs and Lab301 – 50 pcs.
- c) School of Engineering: 18 staff, lab201 – 20 pcs, Lab202 – 80 pcs, Lab203 – 65 pcs, Lab205 – 25 pcs, Lab404 – 45 pcs, Lab408 – 28 pcs, Lab409 – 80 pcs, Lab410 – 45 pcs. Internet Protocols ACCC4002

A Test centre – 20 pcs, 1 IP phone, a printer

An Open Access lab with 245 pcs and 5 printers

Assign appropriate IPv6 address for 6 servers located at the University building. The servers are DNS, Email, Finance, Registry, File server and a Print server. Assign appropriate IPv6 address for the link between MP and ISP.

IPv6 Servers

Server	IPv6
MP	0:0:0:0:ffff:a945:0
DNS	0:0:0:0:ffff:a945:5e1
Email	0:0:0:0:ffff:a945:5e2
Finance	0:0:0:0:ffff:a945:5e3
Registry	0:0:0:0:ffff:a945:5e4
File	0:0:0:0:ffff:a945:5e5
Print	0:0:0:0:ffff:a945:5e6

IP addressing scheme

School of Applied Computing - Network Address: 169.69.0.0/22					
Room	Subnet mask	Network Address	First Host	Last Host	Broadcast
OA - 250 devices	255.255.255.0	169.69.0.0/24	169.69.0.1	169.69.0.254	169.69.1.255
TC - 22 devices	255.255.255.224	169.69.3.64/27	169.69.3.65	169.69.3.94	169.69.3.95
lab301 – 60 pcs	255.255.255.192	169.69.2.0/26	169.69.2.1	169.69.2.62	169.69.2.63
Lab302 – 30 pcs	255.255.255.224	169.69.3.96/27	169.69.3.97	169.69.3.126	169.69.3.127
Lab303 – 36 pcs	255.255.255.192	169.69.2.64/26	169.69.2.65	169.69.2.126	169.69.2.127
Lab304 – 45 pcs	255.255.255.192	169.69.2.128/26	169.69.2.129	169.69.2.190	169.69.2.191
Lab306 – 40 pcs	255.255.255.192	169.69.2.192/26	169.69.2.193	169.69.2.254	169.69.2.255
Lab308 – 140 pcs	255.255.255.0	169.69.1.0/24	169.69.1.1	169.69.1.254	169.69.2.255
Lab309 – 50 pcs	255.255.255.192	169.69.3.0/26	169.69.3.1	169.69.3.62	169.69.3.63
Lab310 – 18 pcs	255.255.255.224	169.69.3.128/27	169.69.3.129	169.69.3.158	169.69.3.159
Staff - 20 pcs	255.255.255.224	169.69.3.160/27	169.69.3.161	169.69.3.190	169.69.3.191
School of Automotive Engineering - Network Address: 169.69.4.0/23					
Room	Subnet mask	Network Address	First Host	Last Host	Broadcast
Lab101 – 40 pcs	255.255.255.192	169.69.4.0/26	169.69.4.1	169.69.4.62	169.69.4.63
Lab102 – 25 pcs	255.255.255.224	169.69.5.64/27	169.69.5.65	169.69.5.94	169.69.5.95
Lab103 – 35 pcs	255.255.255.192	169.69.4.64/26	169.69.4.65	169.69.4.126	169.69.4.127
Lab205 – 40 pcs	255.255.255.192	169.69.4.128/26	169.69.4.129	169.69.4.190	169.69.4.191
Lab206 – 48 pcs	255.255.255.192	169.69.4.192/26	169.69.4.193	169.69.4.254	169.69.4.255
Lab301 – 50 pcs	255.255.255.192	169.69.5.0/26	169.69.5.1	169.69.5.62	169.69.5.63
CADlab – 20 pcs	255.255.255.224	169.69.5.96/27	169.69.5.97	169.69.5.126	169.69.5.127
Staff – 25 pcs	255.255.255.224	169.69.3.192/27	169.69.3.193	169.69.3.222	169.69.3.223
School of Engineering - Network Address: 169.69.6.0/23					
Room	Subnet mask	Network Address	First Host	Last Host	Broadcast
Lab201 – 20 pcs	255.255.255.224	169.69.5.128/27	169.69.5.129	169.69.5.158	169.69.5.159
Lab202 – 80 pcs	255.255.255.128	169.69.6.0/25	169.69.6.1	169.69.6.126	169.69.6.127
Lab203 – 65 pcs	255.255.255.128	169.69.6.128/25	169.69.6.129	169.69.6.254	169.69.6.255
Lab205 – 25 pcs	255.255.255.224	169.69.5.160/27	169.69.5.161	169.69.5.190	169.69.5.191
Lab404 – 45 pcs	255.255.255.192	169.69.7.128/26	169.69.7.129	169.69.7.190	169.69.7.191
Lab408 – 28 pcs	255.255.255.224	169.69.5.192/27	169.69.5.193	169.69.5.222	169.69.5.223
Lab409 – 80 pcs	255.255.255.128	169.69.7.0/25	169.69.7.1	169.69.7.126	169.69.7.127
Lab410 – 45 pcs	255.255.255.192	169.69.7.192/26	169.69.7.193	169.69.7.254	169.69.7.255
Staff – 18 pcs	255.255.255.224	169.69.3.224/27	169.69.3.225	169.69.3.254	169.69.3.255