Next Generation Internet Protocol – Test6-I Deployment

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Abstract

Internet Protocol version six (IPv6) is the next generation internet protocol. It is not yet possible to completely migrate to IPv6, but several transitions mechanisms are available to allow IPv6 and IPv4 coexist together in the same network infrastructure. The main benefit of this protocol is a larger address space and enhanced security options. In transition from current Internet Protocol version four (IPv4) to Internet Protocol version six (IPv6) is not easy as "Plug n Play" since both are incompatible protocol. For smooth integration between these protocols, native IPv6 testbed (TEST6) was deployed in UTeM. In other hand, this gained an experience and confidence before fully integrating it with an existing Internet protocol. This paper describes how TEST6 was setup in intranet environment (TEST6-I) through numerous of process and the network test performed to verify the connectivity.

Keywords: *IPv6, TEST6-I, deploy, intranet*

1. Introduction

The version of IP currently being used on the Internet is IPv4. IPv4 has been around for twenty-odd years and has not been substantially changed since RFC 791 was published in 1981. IPv4 has proven to be robust, easily implemented and interoperable, and has stood the test of scaling an internetwork to a global utility the size of today's Internet. This is a tribute to its initial design.

However, the initial design did not anticipate in the recent exponential growth of the Internet and the impending exhaustion of the IPv4 address space. An action has been taken in 1991, where the Internet Architecture Board (IAB) started studying the growth of the Internet and the number of addresses needed. In 1994, Request For Comments (RFC) 1752, entitled "The Recommendation for the IP Next Generation Protocol", was issued then the Internet Engineering Task Force (IETF) has developed a suite of protocols and standards known as IP version 6 (IPv6). This new version, previously named IP-The Next Generation (IPng), incorporates the concepts of many proposed methods for updating the IPv4 protocol.

IPv6 uses a 128-bit address instead of the 32-bit address of IPv4. This benefit not only gives 4 times the addresses of IPv4 but rather the number of IPv4 addresses squared twice. A couple of articles out there have stated that this works out to billions of billions of addresses for every square meter on the planet.

IPv6 offer numbers advantages over IPv4 and the most prominent such as:

- Larger address space for global connectivity and scalability
- Simplified header for routing efficiency and performance
- Enhance multicast support with increased addresses and efficient mechanism.
- Mandatory IP Security (IPSec) support for all IPv6 devices.
- Auto configuring, easier renumbering and improved plug and play support.
- Efficient support for routing

2. Implementation

The deployment of intranet IPv6 testbed (TEST6-I) takes several steps. One of them was designing an infrastructure which had IPv6 compatible. The TEST6-I was setup with sequences techniques in basic networking which started with stand alone, peer-peer connection under single network and ending by internetwork connection.

These can be illustrated as shown in figures below.

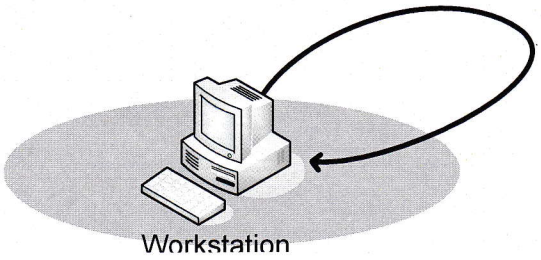

Figure 2.1: Standalone workstation

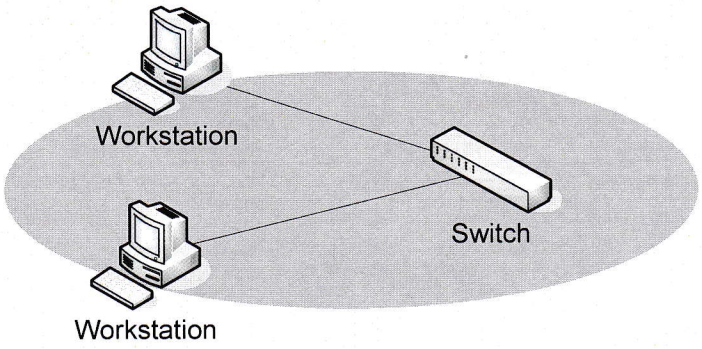

Figure 2.2: Peer-to-peer in single network

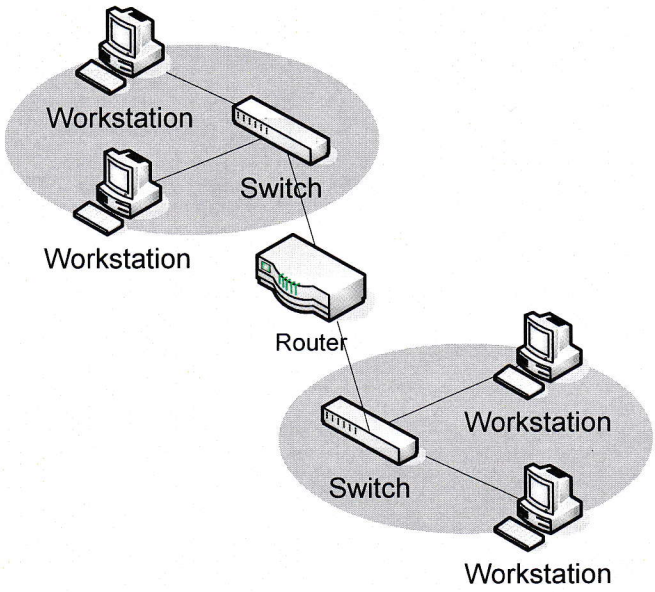

Figure 2.3: Internetwork connection

3. Inventory

All processes were supported by multi platform of operating system with several selected software and hardware. This selection was inventory that determined from the analysis and observation done.

Taking the inventory of the current infrastructure gives an outline of which software and hardware is part of the project. It is important that every part of the current situation is being described in detail [4]. A detailed description of the infrastructure gives a good insight in which hardware and software is to be IPv6 enabled. Table 3.1 gives an overview of which aspects to take into account when making an inventory.

Table 3.1: Inventory list

System	Hardware	OS	IPv6 capable
Network device	IPv6 compatible	Version	Y or N
Client	IPv6 compatible	Version and Patches	Y or N

For the TEST6-I an inventory has been made and found kinds of software would be able to implement IPv6. The results of the inventory taken in TEST6-I was outlined in table 3.2

Table 3.2: Inventory TEST6-I

System	Hardware	OS	IPv6 capable
Cisco Router 2811	IPv6 compatible	IOS 2.XX	Y
MS Windows	IPv6 compatible	XP, SP2	Y
	IPv6 compatible	Vista	Y
Linux	IPv6 compatible	Fedora 9	Y
	IPv6 compatible	RedHat Enterprise Linux5	Y

4. Infrastructure

IPv6 network infrastructures has been designed by considering several aspects such as distribution an IP addresses, hardware considerations and network testing.

4.1 Distribution an IP addresses

An IPv6 address has 128bits or 16 bytes. The address is divided into eight 16 bit hexadecimal blocks, separated by colons. An example of an IPv6 unicast address as

follows:

2001:610:158:1500:20a:95ff:fede:d038

If there are zeros in the address then it can place a double colon, under the condition that uses it only once. IPv6 has prefix lengths, it specify how many bits of the address specify the prefix. RFC 2374 [5] shows the 128 bits divided in three groups, table 4.1 shows these groups. RFC 2374 also explains how subnets and host addresses are constructed. The bits representing the Site Topology are to be used for designing subnets, the Interface identifier bits are used to identify interfaces of different systems (one per interface) [2] . This means a total of 65536 subnets can be created each containing up to approximately 20 trillion nodes.

Table 4.1: IPv6 Address Scheme

Name	bits
Public Topology	1-48
Site Topology	49-64
Interface Identifier	65-128

The IPv6 prefix assigned to the TEST6-I is 2002:660:1111:: /48. Bits 49 to 64 are to be used for creating subnets see table 4.1. Table 4.2 gives a number plan for the TEST6-I. All devices were configured with static addresses.

Table 4.2: TEST6-I IP Addresses distribution

Category	Prefix	Site	Interface	Mask
Network 1	2002:660:111	5100	ON	/64
Network 2	2002:660:111	5200	ON	/64

4.2 Hardware Consideration

Hardware that is part of the infrastructure (routers and switches) has to be IPv6 compatible. For internetwork connection, the router is the most important component, because it is dealing with routing IPv6 traffic between the different (sub) networks. The TEST6-I run IPv6 in normal operation use CISCO 2811 router and CISCO 2950-24 switch.

4.3 Network Testing

After implementing the IPv6 infrastructure, the next step is for hosts to be able to make IPv6 based connectivity.The network testing process done within small scale, because the impact on the new IPv6 environment can not be predicted. The process performed with usual network testing procedure such as 'ping' and 'tracert' to verify connectivity status.

First, to confirm the functionality, IPv6 has been activated on every host and network devices. Next, the process start with loopback testing on standalone node, followed by consisting of two nodes testing (host-to-host testing on single network and host-to-gateway or router interface testing on internetwork) and the rest is internetwork testing. Two interfaces of the router were configured for different IPv6 networks (Figure 4.1) and each network consists of hosts attached to it (Figure 2.3). Figure 4.2 shows an example of configuration have been made on the router.

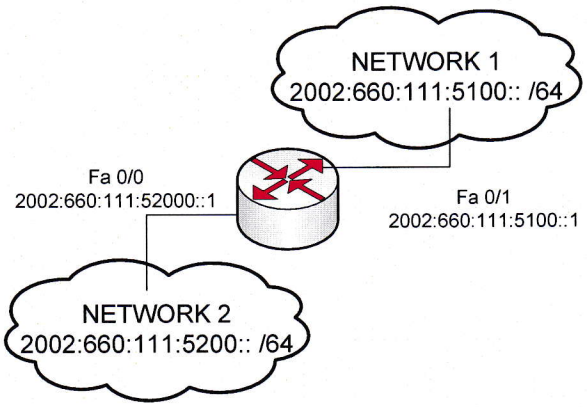

Figure 4.1: Two interfaces of the router were configured with IPv6 addresses

```
Router>
Router>
Router>en
Router#conf t
Enter configuration commands, one per line.  End w
Router(config)#int
Router(config)#interface fa 0/0
Router(config-if)#ipv6 address 2002:660:111::1/64
Router(config-if)#no shutdown
```

Figure 4.2: Example of configuration made in CLI form.

Migrating different services to IPv6 depends on the possibility of the software version whether this is possible or not. Most new software versions have IPv6 implemented.

5. Result

These network connectivity testing (*ping* and *tracert*) done with differences kind of network connection and gained results as follow.

5.1 Ping

All connectivity testing uses *ping* command were gained a successfully result as shown on figure below.

```
PC>ping ::1

Pinging ::1 with 32 bytes of data:

Reply from ::0.0.0.1: bytes=32 time=4ms TTL=128
Reply from ::0.0.0.1: bytes=32 time=15ms TTL=128
Reply from ::0.0.0.1: bytes=32 time=16ms TTL=128
Reply from ::0.0.0.1: bytes=32 time=16ms TTL=128

Ping statistics for ::0.0.0.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 4ms, Maximum = 16ms, Average = 12ms

PC>ping 2002:660:111:5100::10

Pinging 2002:660:111:5100::10 with 32 bytes of data:

Reply from 2002:660:111:5100::10: bytes=32 time=0ms TTL=128
Reply from 2002:660:111:5100::10: bytes=32 time=0ms TTL=128
Reply from 2002:660:111:5100::10: bytes=32 time=16ms TTL=128
Reply from 2002:660:111:5100::10: bytes=32 time=16ms TTL=128

Ping statistics for 2002:660:111:5100::10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 16ms, Average = 8ms
```

Figure 5.1: Stand alone *ping* connectivity testing

```
PC>ipv6config

IPv6 Address.....................: 2002:660:111:5100::11/64
Default Gateway..................: 2002:660:111:5100::1

PC>ping 2002:660:111:5100::10

Pinging 2002:660:111:5100::10 with 32 bytes of data:

Reply from 2002:660:111:5100::10: bytes=32 time=125ms TTL=128
Reply from 2002:660:111:5100::10: bytes=32 time=62ms TTL=128
Reply from 2002:660:111:5100::10: bytes=32 time=63ms TTL=128
Reply from 2002:660:111:5100::10: bytes=32 time=62ms TTL=128

Ping statistics for 2002:660:111:5100::10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 62ms, Maximum = 125ms, Average = 78ms
```

(i) Between 2 workstations

```
PC>ping 2002:660:111:5100::1

Pinging 2002:660:111:5100::1 with 32 bytes of data:

Reply from 2002:660:111:5100::1: bytes=32 time=109ms TTL=255
Reply from 2002:660:111:5100::1: bytes=32 time=63ms TTL=255
Reply from 2002:660:111:5100::1: bytes=32 time=62ms TTL=255
Reply from 2002:660:111:5100::1: bytes=32 time=63ms TTL=255

Ping statistics for 2002:660:111:5100::1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 62ms, Maximum = 109ms, Average = 74ms
```

(ii) Between workstations to gateway

Figure 5.2: Two nodes *ping* connectivity testing on the same network

```
PC>ipv6config

IPv6 Address.....................: 2002:660:111:5200::11/64
Default Gateway..................: 2002:660:111:5200::1

PC>ping 2002:660:111:5100::10

Pinging 2002:660:111:5100::10 with 32 bytes of data:

Reply from 2002:660:111:5100::10: bytes=32 time=109ms TTL=127
Reply from 2002:660:111:5100::10: bytes=32 time=110ms TTL=127
Reply from 2002:660:111:5100::10: bytes=32 time=124ms TTL=127
Reply from 2002:660:111:5100::10: bytes=32 time=125ms TTL=127

Ping statistics for 2002:660:111:5100::10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 109ms, Maximum = 125ms, Average = 117ms
```

Figure 5.3: Internetwork *ping* connectivity testing

5.2 Tracert

All connectivity testing using *tracert* command also were gained a successfully result as shown on figures below.

```
PC>tracert 2002:660:111:5200::10

Tracing route to 2002:660:111:5200::10 over a maximum of 30 hops:

  1   16 ms     16 ms     15 ms     2002:660:111:5200::10

Trace complete.
```

Figure 5.4: Stand alone *tracert* connectivity testing

```
PC>tracert 2002:660:111:5100::10

Tracing route to 2002:660:111:5100::10 over a maximum of 30 hops:

  1   62 ms     33 ms     46 ms     2002:660:111:5100::10

Trace complete.
```

(i) Between 2 workstations

```
PC>tracert 2002:660:111:5200::1

Tracing route to 2002:660:111:5200::1 over a maximum of 30 hops:

  1   109 ms    63 ms     62 ms     2002:660:111:5200::1

Trace complete.
```

(ii) Between workstations to gateway

Figure 5.5: Two nodes *tracert* connectivity testing on the same network

```
PC>ipv6config

IPv6 Address.....................: 2002:660:111:5200::10/64
Default Gateway..................: 2002:660:111:5200::1

PC>tracert 2002:660:111:5200::1

Tracing route to 2002:660:111:5200::1 over a maximum of 30 hops:

  1    63 ms     62 ms     63 ms     2002:660:111:5200::1

Trace complete.
```

Figure 5.6: Internetwork *tracert* connectivity testing

Conclusion

After throughout the document and results shows it becomes clear that IPv6 networking can be implemented in intranet environment. On a Linux distribution, there is a lot of marketable software available that supports IPv6. It depends on the version and the platform it is installed on whether or not IPv6 can be enabled. While, on the other hand Microsoft has more software that hasn't IPv6 support. Therefore, with some alternative it is still can work on IPv4.

It will take some time before everything has IPv6 support, until than both IPv6 and IPv4 can coexist together without any problems. Therefore it is advisable to implement IPv6 as much as possible, because sooner or later the migration from IPv4 to IPv6 will become compulsory. Important when deciding to implement IPv6 is to plan everything very carefully. Especially when it comes to services it is important to know whether or not the services installed and configured in your situation are capable of handling IPv6.

As our concerns that stated before there is no difficulty in implementing an IPv6 network in intranet environment. Beside that, the report shows that migration could take place easily.

References

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