IPv6 Deployment in Malaysia: The Issues and Challenges

The IPv6 was developed to replace and improve the existing Internet Protocol (IP), the IPv4 in many ways. Among the improved areas are addressing space, routing efficiency, header format, auto-configuration, Quality-of-Service (QoS), security and mobility. Although IPv6 promises enhancements to IPv4 standards, its deployment is rather slow in Malaysia. Even with the existence of MANIS -- the Malaysian IPv6 test-bed, still not many local network operators are concerned in deploying it and not many individuals are intere...

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Abstract

The IPv6 was developed to replace and improve the existing Internet Protocol (IP), the IPv4 in many ways. Among the improved areas are addressing space, routing efficiency, header format, auto-configuration, Quality-of-Service (QoS), security and mobility. Although IPv6 promises enhancements to IPv4 standards, its deployment is rather slow in Malaysia. Even with the existence of MANIS -- the Malaysian IPv6 test-bed, still not many local network operators are concerned in deploying it and not many individuals are interested in experimenting with it.

This paper examines the IPv6 prominent features in details, discusses on the IPv6 deployment around the world and studies some of the transition mechanisms available today. The author will also discusses on some of the contributing factors towards the slow IPv6 deployment phenomenon in Malaysia which include lacking of awareness among the public, unclear differentiating benefits to network operators, uncertain risk to the network operators and lacking of IPv6 applications. Finally, the author will provide some possible potential solutions to improve the rate of deployment and experimentation of IPv6 in Malaysia.

Introduction

Due to the rapid growth and limitations on the design of the Internet, it is estimated that the Internet address will be depleted somewhere between 2005 and 2015 [Huitema, 1997]. This has prompted the Internet Engineering Task Force (IETF)[1] to find a solution towards this problem.

Over the years, several approaches have been made to solve this problem. A very popular approach is to not assign a worldwide unique address to every user's machine, instead assign them "private" addresses, and hide several machines behind one official, globally unique address. This approach is called "Network Address Translation" (NAT) or also known as "IP masquerading". However, this approach has its own drawbacks such as the NAT filtering reduces Internet access performance and IP Security (IPSec[2]) cannot be successfully deployed in the NAT environment [Srisuresh & Holdrege, 1998].

[1] IETF: Internet Engineering Task Force, the main standards organization for the Internet. The IETF is a large open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet.

[2] IPSec: Short for IP Security, a set of protocols developed by the IETF to support secure exchange of packets at the IP layer through encryption and authentication.

A different approach to this problem is to abandon the old Internet protocol with its limited addressing capabilities, and use a new protocol with more IP addresses. This resulted into the development of the new Internet protocol that not only does it fulfill future demands on address space, but also addresses other features such as routing, auto-configuration, QoS, security and better support for mobile computing. This better and newer version is called the version 6 of the Internet Protocol (IPv6).

IPv6 Features

The IPv6 prominent features have been standardized in the RFC[3] 2460 and the following paragraphs explain each of them in details.

i) Expanded Address

In improving the address space, IPv6 extends the address space from 32-bit to 128-bit. With that, it provides four times larger address space than current IP does. While IPv4 limits the number of addresses to about 4 billions, IPv4 provides billions of billions of addresses or to be exact, 340, 282, 366, 920, 938, 463, 463, 374, 607, 431, 768, 211, 456 IP addresses [Deering & Hinden, 1998]. This should be sufficient enough to accommodate the IP demands in the foreseeable future. Table 1 shows the comparison of IPv4 and IPv6 address representation.

IPv4	IPv6
192.228.34.56	4080:ff4:0:0:89:200c:23:90

Table 1: Representation text of IPv4 and IPv6 addresses

ii) Efficient Routing

The conventional IPv4's address classes also imposed another problem, which was the Internet backbone routing table size explosion. To curb this problem, CIDR[4] was then introduced several years ago to allow for address aggregation. The CIDR allows flexible use of variable-length network prefixes and thus permits considerable "route aggregation" at various levels of the Internet hierarchy [Huitema, 1997]. This means backbone routers can store a single routing table entry that provides reach ability to many lower-level networks. The CIDR is used since the day one in IPv6 and with the address space expansion, more levels of addressing hierarchy are possible. The IPv6 address assignment was also designed in such that the maximum backbone routing table size will not exceed ten thousands routes -- that is based on the allocated number of highest level aggregators, as opposed to today's routing size which is more than 100 thousands routes [Sidin, 2002]

[3] RFC: Request for Comments, an Internet formal document or standard that is the result of committee drafting and subsequent review by interested parties.

[4] CIDR: Classless Inter-Domain Routing, a new IP addressing scheme that replaces the older system based on classes A, B, and C. With CIDR, a single IP address can be used to designate many unique IP addresses. A CIDR IP address looks like a normal IP address except that it ends with a slash followed by a number, called the IP prefix. For example: 172.200.0.0/16.

iii) Streamlined Header and Optional Extensions

In IPv6 header, some IPv4 header fields have been dropped or made optional. This is to reduce the processing cost of the packet handling and keep the bandwidth cost as low as possible despite the increased size of the IPv6 addresses (refer Figure 1).

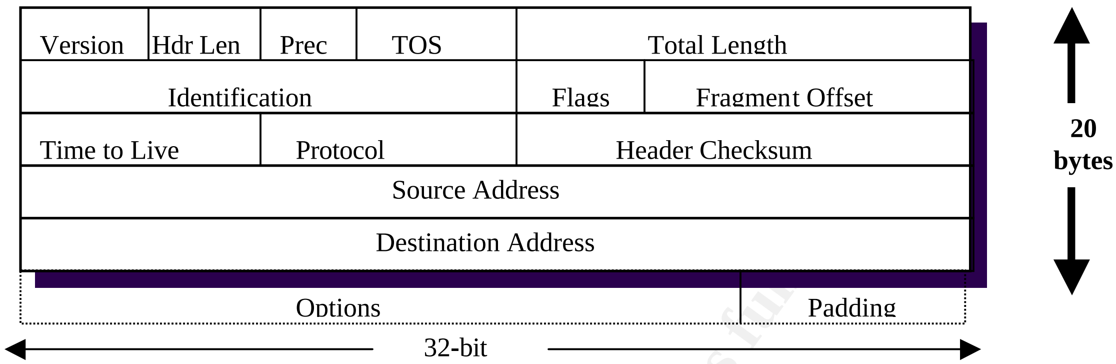

Figure 1: IPv4 header format

The changes made include moving the fragmentation and options fields into the extension headers, deleting checksum and length fields, and adding a new type of field, the 'flow label' field (refer Figure 2). The deletion was done on obsolete items while addition is done in order to improve IPv6 features, such as adding flow label field for better QoS. The rest of the fields are kept and renamed; Time To Live was changed to Hop Limit, Protocol was changed to Next Header and Precedence and Type Of Service (TOS) was changed to Traffic Class [Deering & Hinden, 1998].

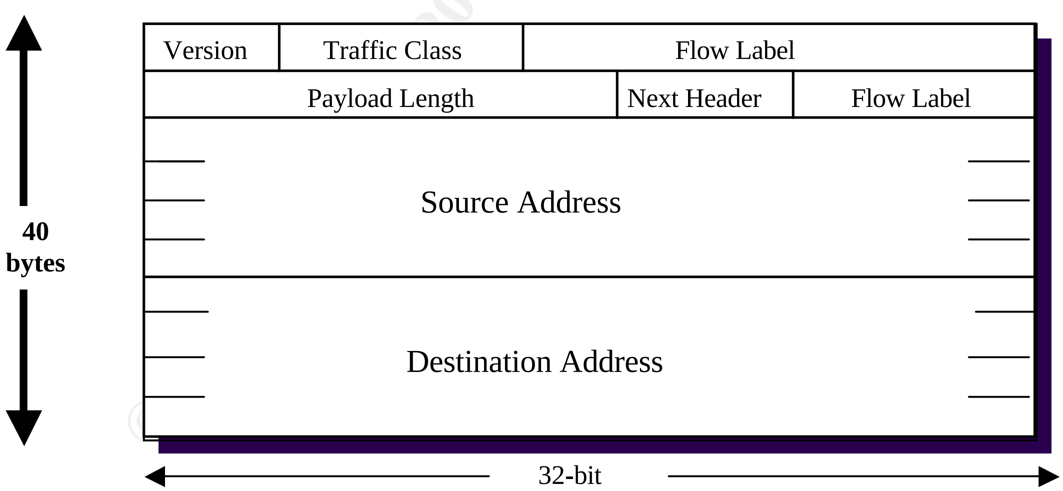

Figure 2: IPv6 header format

IPv6 includes options that are placed in separate extension headers located between the IPv6 header and the transport layer header in a packet (refer Figure 3). The IPv6 extension headers that are currently defined include routing, fragmentation, authentication, security encapsulation, hop-by-hop option and destination option, which can be inserted at an arbitrary number [Huitema, 1997]. These extension headers are not examined or processed (except for hop-by-hop option) by any router along a packet's delivery path until it arrives at its final destination. This phenomenon is different from that in IPv4, whereby intermediate routers are to examine all options present and thus degrades the router performance.

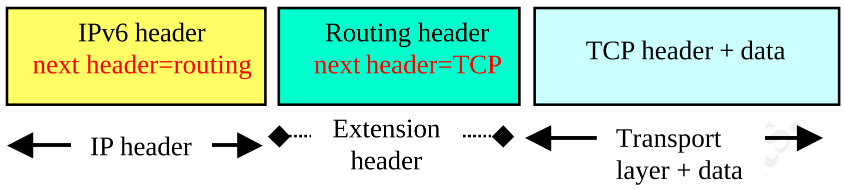

Figure 3: IPv6 packet with routing extension header

iv) Stateless Auto-configuration

In the IPv4 network, Dynamic Host Configuration Protocol (DHCP) is often deployed to reduce the efforts of managing and administrating address assignments. DHCP is a "stateful" address configuration tool that maintains static tables to determine which addresses are assigned to which nodes. The new DHCP version for IPv6 will provide similar stateful address assignment, but adding to it a new feature, auto-configuration. Through the "stateless" address auto-configuration service, no configured server is required. Stateless auto-configuration makes it possible for workstations to configure their own addresses with the help of a local IPv6 router. This is done by combining its 48-bit MAC address, known as the link-local address with a network prefix learned from a neighboring router (refer Figure 4)[Goncalves & Niles, 1998].

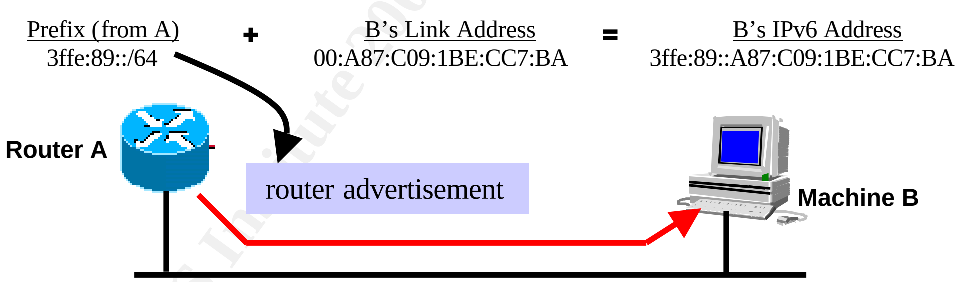

Figure 4: IPv6 stateless auto-configuration

v) Improved Quality-of-Service

A new capability is added in IPv6 to enable the labeling of packets belonging to particular traffic flows for which the sender requests special handling. This is done through the "flow label" component in the IPv6 header (refer Figure 2) [Deering & Hinden, 1998]. This feature is rather crucial in real-time services; to minimize delay, such as in video-conferencing. Flow-label allows the IPv6 packet to be routed through specified network and therefore hinder it from straying in the unnecessary networks. This would guarantee fast delivery of IPv6 packets and therefore improve its performance.

vi) Built-in Security

IPv4 has a number of security problems and lacks effective privacy and authentication mechanism below the application layer. IPv6 remedies these shortcomings by having two integrated options that provide security services. These two options may be used singly or together to provide differing levels of security to different users. The first mechanism, called the Authentication Header (AH) is an extension header that provides authentication and integrity (without confidentiality) to IPv6 datagrams. Meanwhile, the second security extension header provided with IPv6 is the Encapsulating Security Payload (ESP) header [Deering & Hinden, 1998]. This mechanism provides integrity and confidentiality to IPv6 datagrams.

vii) Mobility

When mentioning mobile devices and IP, it's important to note that a special protocol is needed to support mobility, and implementing this protocol – called "Mobile IP" -- is one of the requirements for every IPv6 stack. This means IPv6 has support for roaming between different networks, with global notification when you leave one network and enter the other one. Support for roaming is possible with IPv4 too, but there are a number of hoops that need to be jumped in order to get things working. With IPv6, there's no need for this, as support for mobility was one of the design requirements for IPv6 [Goncalves & Niles, 1998].

Transition Mechanisms

For the transition to IPv6 to be successful, there must be compatibility with large installed base of IPv4 hosts and routers. The following paragraphs introduce techniques that IPv6 hosts and routers can use to interoperate with IPv4 hosts and employ the existing IPv4 routing infrastructure.

The dual-stack hosts or also known as "IPv4/IPv6" hosts are hosts that are capable of running in dual-stack mode. In other words, these hosts are able to send and receive both IPv4 and IPv6 packets. This technique allows co-existence of IPv4 and IPv6, and thus permits gradual application-by-application upgrades into IPv6 environment without much disruption [Gilligan & Nordmark, 2000].

By definition, tunneling is a technology that enables one network to send its data via another network's connections. Tunneling works by encapsulating a network protocol within packets carried by the second network. Thus, IPv6-over-IPv4 tunneling means encapsulating IPv6 packets within IPv4 packets [Gilligan & Nordmark, 2000]. It simply appends IPv4 headers to IPv6 packets and sends them as native IPv4 traffic. This techniques is required since majority of existing network is based on IPv4 infrastructure and thus, the only way for IPv6 LAN[5]s to talk to each other is through this tunneling method.

[5] LAN: Local Area Network is a group of computers and associated devices that share a common

The translator translates the address, protocol or sometimes applications from IPv6 to IPv4 and vice versa [CISCO Systems, 2002]. This technique is used when IPv6-only network wishes to communicate with IPv4-only network. Over the years, a number of translators were introduced, standardized and deployed all over the world that include Network Address Translation - Protocol Translation (NAT-PT[6]), Stateless IP/ICMP Translation (SIIT[7]), Bump-in-Stack (BIS[8]) and Bump-in-the-API (BIA[9]).

Worldwide Test bed – The 6bone

Since 1994, people around the world, especially stack and routers vendors have been implementing and experimenting with this new version of IP. As a result, an IPv6 test-bed, known as 6bone was established in 1996. The 6bone is a world wide informal collaborative project that works hand in hand with the IETF. The 6bone is a virtual network layered on top of portions of the physical IPv4-based Internet to support routing of IPv6 packets, since that function has not yet been integrated into many production routers. The network is composed of islands that can directly support IPv6 packets, linked by virtual point-to-point links called "tunnels"[6bone, Mar 2002]. The number of organizations connected to this test-bed increases rapidly each year. In July 2000, there were only about 200 organizations connected to this network [Mohd Fadzil & Raja Mahmood, 2000]. And as of February this year, there were altogether 933 organizations [6bone2, Feb 2002], which is more than 200 percent increment in less than 2 years time. The Figure 5 shows the number of organizations per continent; 574 from Europe, 210 from North America, 97 from Asian, 36 from South America, 14 from Oceania and lastly 7 from Africa.

Obviously, the European countries are leading in the IPv6 deployment compared to the other countries. The European Union's (EU's) involvement has contributed a lot in the increment of the IPv6 deployment growth in these countries. The EU has encouraged research on IPv6 especially on mobility issue, by funding most of these projects such as BRAIN (Broadband Radio Access for IP Based Network), DRIVE (Dynamic Radio for IP Services in Vehicular Environments), 6INIT (IPv6 Internet Initiative) and 6WINIT (IPv6 Wireless Internet Initiative) projects [daSilva, 2001]. These research are rather crucial for these nations as they are the leading countries in mobile network and their determination to stay in that position. As a result of these research, the upcoming rollout of the 3G[10]'s network in these countries has incorporates the excellent IPv6 mobility features.

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communications line and typically share the resources of a single processor or server within a small geographic area.

[6] NAT-PT: Network Address Translation - Protocol Translation is a straight forward solution based on transparent routing and address/protocol translation, allowing a large number of applications in V6 and V4 realms to inter-operate without requiring any changes to these applications.

[7] SIIT: Stateless IP/ICMP Translation, details can be found in RFC 2765.

[8] BIS: Bump-in-Stack, details can be found in RFC 2767.

[9] BIA: Bump-in-the-API, details can be found in the BIA Internet Draft.

[10] 3G: is an International Telecommunication Union specification for the third generation (analog cellular was the first generation, digital PCS the second) of mobile communications technology

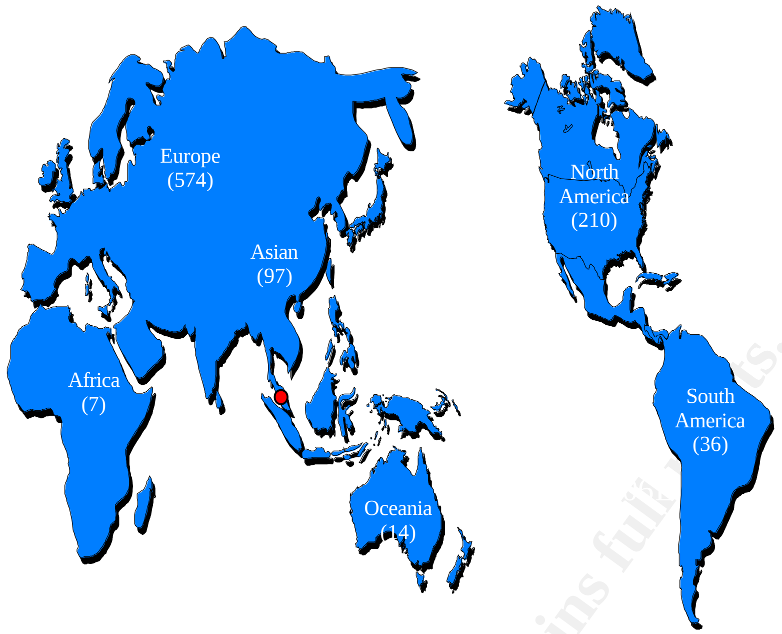


Figure 5: 6bone network

Meanwhile in Asia, Japan is the leading country in IPv6 deployment with 48 organizations altogether. This is due to the former Japanese prime minister, Yoshiro Mori demanded IPv6 research in his policy speech of the 150th session of Diet in July 2000 [Yoshiro, 2000] and since then many IPv6 research has been embarked on. And as a result, Japanese are the most active IPv6 developers with a lot of their work have been recognized worldwide such as the IPv6 KAME stack, which has been used in almost every BSD flavor.

The second active country in Asia is Korea with 18 organizations. The government of Korea is basically following the Japanese's footstep and currently encouraging more IPv6 research to be carried out. As a result of this support, the Koreans have just recently developed the latest translation tool, known as the Bump-in-the-AP1 (BIA) [ETRI, 2002] and have got themselves worldwide recognition.

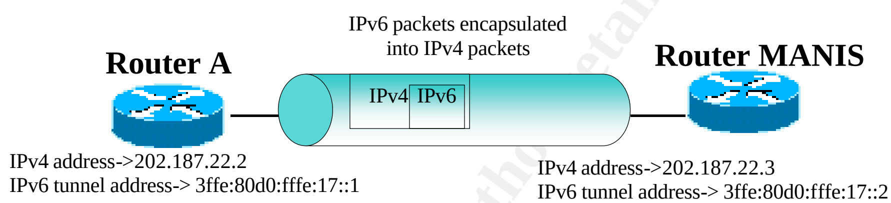
The other Asian countries that are listed under the 6bone network are China (12 organizations), Singapore (5 organizations), Hong Kong (3 organizations), Malaysia (2 organizations), India (1 organization), Taiwan (1 organization) and Thailand (1 organization) [6bone2, Feb 2002]. Meanwhile the other Asian countries such as Brunei, Philippines and Vietnam are not yet part of the 6bone network.

Malaysian Test Bed – The MANIS

The ***M***alaysian ***A***dvanced ***N***etwork ***I***ntegrated ***S***ystem or known as ***MANIS*** is the local test-bed that was set up in year 2000 by MIMOS Berhad for the purpose of experimenting IPv6 [MIMOS Berhad1, 2002]. This test-bed provides local organizations the connection to the 6bone and allows research to be carried out on this network.

Currently there are few local research centers and Internet Service Providers (ISPs) that are already connected to this test-bed and since then few IPv6 research has been embarked on.

MANIS provides organizations as well as individuals with connection to 6bone through both router-to-router as well as host-to-host tunneling method. Through the router-to-router or known as “configured tunneling” method, both end routers will be configured to create tunnel between them. The following is the sample of the CISCO configuration in creating IPv6-over-IPv4 tunnel between two organizations, in this case MANIS and organization A (refer Figure 6). The first requirement in establishing the tunnel is to have CISCO IOS that supports both dual-stack and IPv6-over-IPv4 tunneling mechanisms in place. Then, both parties need to exchange some important information such as one’s existing IPv4 address and one’s IPv6 tunnel address. In the case where organization A is new and doesn’t have any global IPv6 address, MANIS would provide this address as well as allocating a /48 IPv6 subnet to it -- to be used by organization A’s new IPv6 network.




```
interface Tunnel3
 description Tunnel to Router B
 no ip address
 no ip directed-broadcast
 ip accounting output-packets
 ipv6 enable
 ipv6 address 3FFE:80D0:FFFE:17::1/127
 tunnel source 202.187.22.2
 tunnel destination 202.187.22.3
 tunnel mode ipv6ip
```

Tunnel configuration at Router A

```
interface Tunnel1
 description Tunnel to RouterA
 no ip address
 no ip directed-broadcast
 ip accounting output-packets
 ipv6 enable
 ipv6 address 3FFE:80D0:FFFE:17::2/127
 tunnel source 202.187.22.3
 tunnel destination 202.187.22.2
 tunnel mode ipv6ip
```

Tunnel configuration at Router B

Figure 6: CISCO configuration on establishing IPv6-over-IPv4 tunnel

Meanwhile, the host-to-host connection is achieved through the Tunnel Broker facility. The Tunnel Broker will automatically manage tunnel requests coming from the users through web-based interface and establishes IPv6 connection for them [Durand & others, 2001]. This approach is useful to individual especially for the dial-ups user whereby no IPv6 routers are required. The requirement to establish connection to 6bone via Tunnel Broker is that the user’s machine must be in the dual-stack mode. In order to get connected through the MANIS’s Tunnel Broker, first the client has to go to http://tbroker.manis.net.my and will be asked to choose the preferred Operating System (OS). Once the client chooses the OS, he/she has to enter the nickname and his/her machine’s IPv4 address information. Once the client has submitted the information, he/she will be asked to save the downloadable file to his/her machine. When the user has downloaded the script, he/she needs to execute it in order to establish connection to MANIS's Tunnel Broker. Having done that, an IPv6-over-IPv4 tunnel is established and the user is already connected to the 6bone network. The Figure 7 explains the process flow of Tunnel Broker implementation in details.

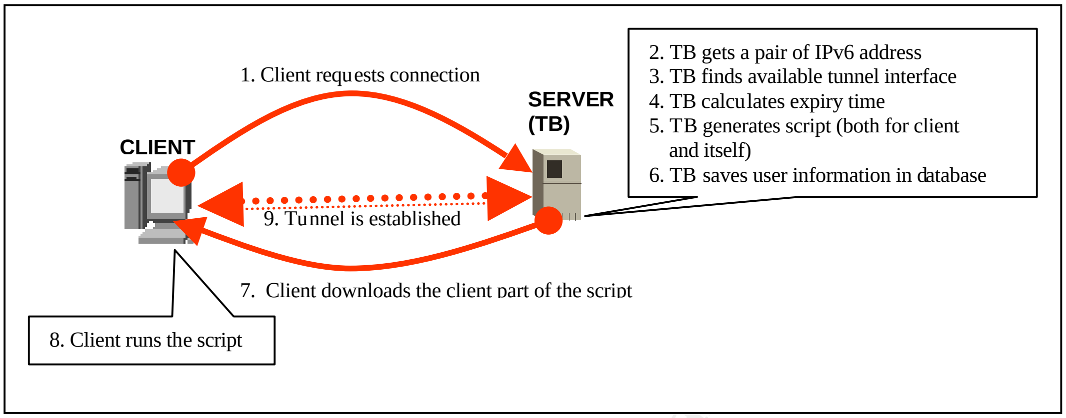


Figure 7: The Process Flow of the Tunnel Broker Implementation

IPv6 Progress in Malaysia

Although with these services available to the locals, the IPv6 deployment in Malaysia is still rather slow. The statistics result on both MANIS's configured tunneling [MIMOS Berhad4, 2001] and Tunnel Broker [MIMOS Berhad3, 2001] services shows that only few local organizations are connected to the test-bed and only few Malaysians are actually utilizing this Tunnel Broker service.

Apart from the statistics, the online survey at MANIS's website also shows that only few Malaysians are aware of the existence of such local IPv6 test-bed, let alone the services – this conclusion is derived from the number of participations been received. This online survey was conducted since six months ago at http://manis.net.my/vote/ipv6.htm and as of March 2002, the statistics is as followings:
- 273 participants have answered this survey with 93.3% of them are Malaysian.
- 76.5% have heard about IPv6
- 93.6% of them have knowledge on IPv6 and the level of knowledge varies (refer Figure 8)
- More than 50% have positive attitude towards moving to IPv6
- More than 50% believe that IPv6 is implementable in the next 3 to 5 years.

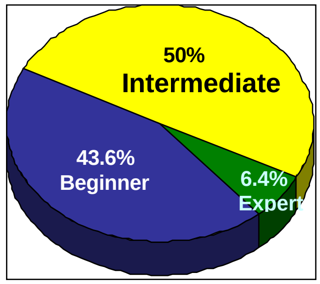


Figure 8: Level of IPv6 knowledge

The feedback acquired from this small number of participants indicated that many of them have faith in IPv6 and would like to see it being implemented in the near future. This is because they do have some knowledge on IPv6 and thus, understand what benefits can this technology provide (refer to Figure 8). Although the feedback is quite positive, it only represents a very small percent of the total Malaysian Internet users and thus the result is not justifiable.

Through the two-year's experience of promoting IPv6 in Malaysia and having met many people from the public, research institutes as well as industries, the author has discovered some factors that are contributing towards the slow rate of deployment in Malaysia. And they are:

1) uncertain risk to the network operators
Many network operators perceive that migrating towards IPv6 is a very complex process and require many resources in terms of manpower, time and money. In addition, with their hectic day-to-day business operation, they couldn't afford to meddle in this experiment process and rather wait until everything is finalized.

2) unclear differentiating benefits of IPv6 to the network operators
Besides providing more addresses to clients, many local network operators or Internet Service Providers (ISP) still couldn't comprehend the business value proposition of IPv6 just yet. This is because most of them are into Internet access and service business only, as opposed to their counterparts around the world that are into more diversified telecommunications service such as mobile service.

3) lack of IPv6 applications or no "killer applications" yet
Lacking of IPv6 applications occurs due to the limited participation from the Internet community in porting IPv4 applications to IPv6, with majority are only from Japan and European countries. So far, no killer applications have been introduced in IPv6 due to wide variety of applications that are already available today.

4) lack of technical know how in the research institutes
Lacking of practical experience, as opposed to theory is one of the weaknesses found in many local researchers. This results in slow growth of IPv6 network and thus hinders the development of IPv6 research in these institutions.

5) lack of public awareness
Since the Internet Protocol is transparent to the end users, many of them are no aware of the changes made on this protocol. Hence, the importance of IPv6 remains unknown and this creates lack of demand for IPv6 network.

Potential Solutions

The followings are some of the potential solutions in improving the IPv6 deployment rate and encouraging IPv6 research in Malaysia:

1) Keeping up-to-date on IPv6 activities around the world
The network operators should participate in world IPv6 conventions such as the IPv6Forum to gain more understanding on IPv6 market. Moreover, by keeping up-to-date with IPv6 community, they will gain knowledge on latest deployment strategy.

2) Produce more IPv6 developers among locals
Local universities should open up more courses on IPv6 technology and encourage application developments through competitions, grants and loans.

3) Develop technical competency among researchers
Researchers should undergo attachment with industries or pursue postgraduate programs to improve their technical skills.

4) Create more awareness program
Local media should publish more IPv6 related materials. Local universities should conduct lecture series on IPv6 technology. IT-related exhibitions should also include a section on IPv6 in their future road show.

5) Require government intervention
Policy makers should support and encourage IPv6 growth in Malaysia by proposing tax exemption on companies that undertake IPv6 research.

Conclusion

IPv4 days are numbered and IPv6 was developed to replace it. IPv6 provides expanded addressing space, efficient routing, streamlined header format, stateless auto-configuration, improved Quality-of-Service (QoS), built-in security and more support for mobility. However, its growth rate in Malaysia is considerably slow. Even with the existence of MANIS, many local companies are still in the dark on deploying IPv6 mainly because of unclear differentiating benefits of IPv6 to the network operators and lack of technical know how.

Perhaps the proposed solutions such as producing more IPv6 developers and government intervention could increase the growth rate of IPv6 deployment in Malaysia. Hopefully in the near future, Malaysians will begin to appreciate this new improved technology and perhaps participate, contribute and claim ownership to areas of technologies within IPv6.

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Data Breach Summit & Training	**Chicago, ILUS**	**Sep 25, 2017 - Oct 02, 2017**	**Live Event**
SANS Copenhagen 2017	**Copenhagen, DK**	**Sep 25, 2017 - Sep 30, 2017**	**Live Event**
SANS London September 2017	**London, GB**	**Sep 25, 2017 - Sep 30, 2017**	**Live Event**
Rocky Mountain Fall 2017	**Denver, COUS**	**Sep 25, 2017 - Sep 30, 2017**	**Live Event**
SANS SEC504 at Cyber Security Week 2017	**The Hague, NL**	**Sep 25, 2017 - Sep 30, 2017**	**Live Event**
SANS DFIR Prague 2017	**Prague, CZ**	**Oct 02, 2017 - Oct 08, 2017**	**Live Event**
SANS Oslo Autumn 2017	**Oslo, NO**	**Oct 02, 2017 - Oct 07, 2017**	**Live Event**
SANS October Singapore 2017	**Singapore, SG**	**Oct 09, 2017 - Oct 28, 2017**	**Live Event**
SANS AUD507 (GSNA) @ Canberra 2017	**Canberra, AU**	**Oct 09, 2017 - Oct 14, 2017**	**Live Event**
SANS Phoenix-Mesa 2017	**Mesa, AZUS**	**Oct 09, 2017 - Oct 14, 2017**	**Live Event**
Secure DevOps Summit & Training	**Denver, COUS**	**Oct 10, 2017 - Oct 17, 2017**	**Live Event**
SANS Tysons Corner Fall 2017	**McLean, VAUS**	**Oct 14, 2017 - Oct 21, 2017**	**Live Event**
SANS Brussels Autumn 2017	**Brussels, BE**	**Oct 16, 2017 - Oct 21, 2017**	**Live Event**
SANS Tokyo Autumn 2017	**Tokyo, JP**	**Oct 16, 2017 - Oct 28, 2017**	**Live Event**
SANS Berlin 2017	**Berlin, DE**	**Oct 23, 2017 - Oct 28, 2017**	**Live Event**
SANS Seattle 2017	**Seattle, WAUS**	**Oct 30, 2017 - Nov 04, 2017**	**Live Event**
SANS San Diego 2017	**San Diego, CAUS**	**Oct 30, 2017 - Nov 04, 2017**	**Live Event**
SANS Gulf Region 2017	**Dubai, AE**	**Nov 04, 2017 - Nov 16, 2017**	**Live Event**
SANS Miami 2017	**Miami, FLUS**	**Nov 06, 2017 - Nov 11, 2017**	**Live Event**
SANS Amsterdam 2017	**Amsterdam, NL**	**Nov 06, 2017 - Nov 11, 2017**	**Live Event**
SANS Milan November 2017	**Milan, IT**	**Nov 06, 2017 - Nov 11, 2017**	**Live Event**
SANS Sydney 2017	**Sydney, AU**	**Nov 13, 2017 - Nov 25, 2017**	**Live Event**
Pen Test Hackfest Summit & Training 2017	**Bethesda, MDUS**	**Nov 13, 2017 - Nov 20, 2017**	**Live Event**
SANS Paris November 2017	**Paris, FR**	**Nov 13, 2017 - Nov 18, 2017**	**Live Event**
SANS Adelaide 2017	**OnlineAU**	**Aug 21, 2017 - Aug 26, 2017**	**Live Event**
SANS OnDemand	**Books & MP3s OnlyUS**	**Anytime**	**Self Paced**