IMPROVING INTERNET ACCESS IN THE UNIVERSITY OF MALAYA MEDICAL CENTRE: A NADI IT INNOVATION

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ABSTRACT: In early 2001, Nadi IT (the IT department of the UMMC) migrated the UMMC leased line from its old 64 kbps line to the 34 Mbps University of Malaya leased line. The migration was a new learning experience for Nadi IT and many lessons were learnt along the way. This paper describes the idea behind the migration process, the reason for the migration, problems and solutions to all these problems as well as the benefits derived from the migration. The experience of this process may be useful to others wishing to improve IT facilities without resorting to expensive solutions. (JUMMEC 2000; 2:93-97)

KEYWORDS: Internet, leased line, migration

Introduction

The Internet (also known as the Net), is a worldwide network of computers[1]. It connects thousands of inter-connected computer networks. In other words, the Internet is a network of networks. Though it started out as a means of communication, today the Internet provides several services such as information retrieval, as a forum for discussion and as medium for which to conduct commerce. The Internet is no stranger to many of us, having experienced the World Wide Web at one time or another. So many of us depend on the Internet now as a means of communication and as a source of quick reference. Some of us access the Internet from the office while others do so from home. We normally do not bother to take notice of how we access the Internet but as long as it serves our needs.

The means of access can broadly be divided into two main categories namely dial-up and always-on connections[2]. Examples of dial-up connections are the PSTN (public-switched telephone networks) and ISDN (integrated services digital networks), which in Malaysia, charge according to the time used. Always-on connections on the other hand, charge according to flat rates (per month or year) regardless of the amount of time the connection is used[3]. The cost of maintaining a leased line in Malaysia depends on the bandwidth of the line and up until now is quite prohibitive, typically ranging from RM 38,000 per year for a 64 kbps line to RM 200,000 per year for a 2 Mbps line (inclusive of access fee and line rental). Because of the high costs involved, always-on connections are usually used by large organisations or businesses. Examples of always-on connections are leased line connections, DSL (digital subscriber line) and cable modems. Since DSL is still in its infancy in Malaysia in 2001, it is not widely available and thus most always-on connections are leased lines.

The Internet is really a very large network. As with any type of network, it must conform to a set of rules called a protocol. A protocol defines how the software running on one computer will communicate with another software running on another computer[4]. The Internet is based on a suite of network protocols commonly referred to as Transmission Control Protocol/Internet Protocol or TCP/IP. Computers on the Internet are identified by something called an IP or Internet Protocol address. This consists of a number which is unique e.g. 161.142.2.17. There are basically two types of IP addresses: public and private. Public IP addresses are strictly governed as no two computers on the Internet may use the same IP address. Users accessing the Internet using dial-up accounts via an Internet Service Provider (ISP) are usually assigned a temporary public IP address, which is taken back by the ISP after the dial-up session is over[5]. Thus their IP addresses will differ each time they log onto the Internet. Permanent public IP addresses, on the other hand, have to be applied for by a person or organisation and are applicable for always-on connections such as leased line or DSL. These have to be strictly governed to prevent chaos and to make sure that whatever Internet traffic arrives safely at its destination. The organisation controlling these addresses on the worldwide level is INTERNIC while in Malaysia, MYNIC has been entrusted with this function[2].

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Private IP addresses are used for internal networks of an organisation[6]. An organisation can decide to have its own internal IP address without applying for permission. As long as it can organise its IP addresses properly and makes sure that no two computers have the same IP address, this will work fine within its internal local area network (LAN). It thus does not have to depend on a finite number of IP addresses that has to be applied for. It also improves security, as none of its computers are visible to others on the Internet. However, this means that the IP address of such a computer is no longer unique once it gets connected to the Internet as it is possible that some other computer in the world has the same IP address. It does not mean however, a computer on a private network cannot get connected to the Internet. It can use a dial-up connection to get connected (whereby it temporarily borrows a real public IP address from an ISP) or it can share a public IP address with another device to get connected. The former approach is familiar to us as it is what many of us use to get onto the Internet (via phone connections). The latter is what is used in many organisations with a leased line connection but does not have many public IP addresses.

As any Internet-savvy person can tell you, if your computer is connected to 100 million computers on the Internet, then 100 million computers are connected to your computer. That means anyone with the right tools could theoretically try to break into your computer. While this is less likely with dial-up connections (owing to the short time the computer is connected to the Internet), it is a real and distinct possibility for computers with permanent Internet connections. There are a few ways to minimise these and thwart these efforts. One way is to install and manage a good firewall[7]. A firewall is basically a hardware device or software, which sits between the user's computer and the rest of the world. The firewall acts as a guard and watches over Internet traffic coming into and going out to the Internet. It thus filters that traffic and ensures that only certain types of traffic are allowed past based on certain predetermined conditions. The firewall also can act as a proxy for computers using private IP addresses and thus shares its public IP address with those computers, thus enabling those computers to access the Internet. Firewalls (as with many other things) are only as good as how it is configured. As a matter of fact, a supposedly good firewall, which is badly configured, is worse than having no firewall as it just provides a false sense of security.

The UMMC network

The University of Malaya Medical Centre (UMMC) is a new entity made up of the amalgamation of the Faculty of Medicine and the University Hospital. Gazetted on 25th May 2000, the UMMC is a fully government-owned corporatised entity. In addition, the University of Malaya Specialist Centre also provides services to private patients within the UMMC complex.

The UMMC has a unique computer network. It is divided into two parts that are physically connected to each other but use different configurations. The hospital side (UHNet) uses private IP addresses while the faculty side (FOMNet) uses public IP. There are seven Virtual Local Networks (VLANs) used for operations in UHNet while one VLAN is used for academic staff who have offices in the hospital complex. Private IP makes it easier to manage and control the network as well as access to the Internet. Public IP on the other hand makes it easier to gain access to the Internet but at the same time limits the size of the network as well as the control over Internet access. Mixing the two makes a network more difficult to manage so it is usually easier to keep private and public IP networks separate.

Because of the nature of the configurations of the two networks, access to the Internet is achieved differently for both networks. Users in the seven VLANS of the hospital use a 64 kbps leased line to get to the Internet. Every year, the UMMC pays rental of RM 20,000 to the telecommunications provider and RM 18,000 to the ISP for Internet access. Thus the annual payment for this Internet access totals RM 38,000. On the other hand, academic staff use the University of Malaya (UM) leased line (via the faculty) which has a much higher bandwidth of 34 Mbps (upgraded from 2 Mbps to 34 Mbps in October 2000). Rental of the UM leased line is borne by the university and the faculty does not need to contribute anything to this regardless of the number of users utilising the line. This rather strange state of affairs may have started because of the different times the networks were developed in the hospital and the faculty. Because of this, there are obvious differences in the speed of Internet access by the two groups of staff. To enable staff in the hospital to gain access to the mail server (in order to check mail), a limited trust relationship exists between the two networks.

For UHNet, a firewall sits between the network and the Internet. This firewall acts to translate the private IP addresses of the hospital to a public IP address when a user surfs the Internet. The firewall of course on the other hand acts to prevent access from Internet to the UHNet network. Academic staff on the other hand access the Internet directly as their computers utilise a public IP address.

E-mail addresses for the hospital and academic staff also differ even though the e-mail server used is the same. Hospital staff use addresses ending with "uhkl.edu.my" while faculty staff use addresses ending with "medicine.med.um.edu.my". This unique situation can happen because of the use of a domain name server (DNS) in the hospital that would redirect incoming

external mail to the mail server located in faculty. Figure 2 shows how this is achieved.

Reasons for migration

Many problems were faced before the migration of this leased line was carried out. Among these were:

1. E-mail access

The mail server is located within the faculty premises while there are two possible routes for incoming mail. This complicates maintenance and problems with the hospital route may even go unnoticed for some time until someone complains. Simplifying the route makes the maintenance and troubleshooting less difficult.

2. Speed of Internet access

The old leased line used by the hospital utilised a bandwidth of only 64 kbps which makes it rather difficult to add more users. The UM leased line, on the other hand has a bandwidth of 34 Mbps which is some 500 times the bandwidth of the hospital leased line and runs on fibre-optic cables as compared to the copper line used by the hospital (fibre-optics are less susceptible to lightning strikes and are generally viewed as being more stable than copper). It was deemed rather incongruous that hospital staff could not enjoy the same sort of Internet experience as academic staff even though both work in the same complex.

3. Security

The different ways of accessing the Internet also exposed the network to a potential security loophole. A hacker could theoretically seize control one of the academic staff computers (which utilises a public IP address) and use it to launch attacks on servers within the hospital complex. This is because academic staff computers are not protected by any firewall and are accessible to anyone on the Internet with the right tools and determination. Figure 3 illustrates the loophole in the network.

Methodology

The migration of the Internet access was achieved in three phases.

Phase 1

The aim was to ensure that all e-mail meant for the uhkl.edu.my address need not go through the hospital leased line. Two things were done in this phase.

a) We applied to MYNIC (organisation responsible for registering all Internet domain names in Malaysia) for a change in the Internet traffic bound for "uhkl.edu.my"
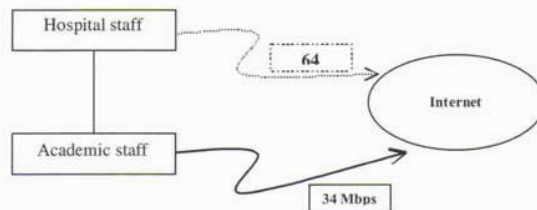

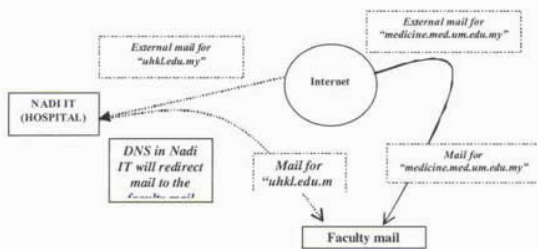**Figure 1.** Different Internet access speeds for hospital and academic staff

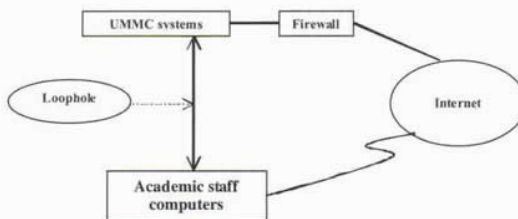**Figure 2.** How the mail service functions for the two different domains

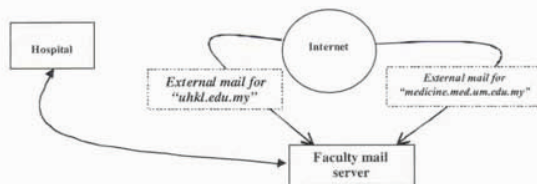**Figure 3.** Loophole in the UMMC network before migration

Figure 4. E-mail system after Phase 1

to be directed to the faculty's DNS (domain name server). During that time we shut down the external DNS in Nadi IT to allow MYNIC to refresh its database and avoid confusion. This resulted in users in the uhkl domain not being able to receive mail from external sources for several days but could not be avoided as it had to happen sooner or later.

b) We moved Nadi IT's external DNS to the faculty and reconfigured it as well as the faculty's DNS.

c) We made changes to the DNS record in the University of Malaya's DNS.

Work on this started on 31 January 2001 and it was completed on 15 February 2001.

Phase 2.

The aim was to ensure that all traffic to the Internet from the UMMC went through the University of Malaya (UM) leased line. It would also close the loophole illustrated in Figure 3. This was accomplished in three steps:

a) We applied for and obtained permission from the Centre of Information Technology in UM to use the university's leased line.

b) We upgraded our firewall software and changed the direction of Internet-bound traffic from the original leased line to the UM leased line.

c) We revamped our network gateways and reconfigured our network switches to reroute the traffic and close the loophole in Figure 3. This took a lot of doing and many unexpected problems occurred along the way, which necessitated the reconfiguration of the VLANS in the network.

As a result of this work, the network configuration was changed and this can be seen in Figure 5.

Phase 3

The aim was to ensure that all UMMC staff had the same domain name i.e. ummc.edu.my

The steps involved were:

a) We registered a new domain name for the UMMC i.e. ummc.edu.my.

b) We changed the UM DNS records to reflect the change.

c) We applied to the UMMC management to change all e-mail addresses to the new domain name.

d) We changed all e-mail addresses from uhkl.edu.my and medicine.med.um.edu.my to ummc.edu.my.

The change was authorised by the UMMC management on 23 March 2001 and work to change the e-mail addresses were completed on 31 March 2001.

Benefits of the migration

Many benefits can be realised from the migration of Internet access from the UMMC leased line to the UM leased line. Among them are:

Cost reduction

The previous rental cost of RM 38,000 is no longer necessary as the UMMC now rides on the UM leased line. This is based on the premise of continued use of the 64 kbps line. Had the UMMC decided to upgrade its leased line to 2 Mbps, it would incur a recurring
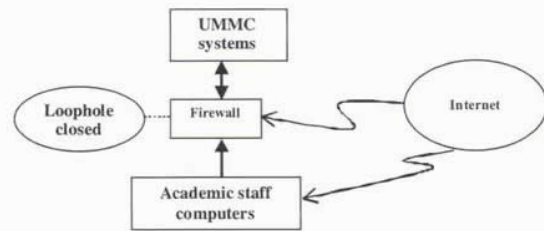

Figure 5. UMMC network after Phase 2

yearly expense of at least RM 166,000. In other words, we saved the hospital at least RM 38,000 per year or potentially RM 166,000 per year by avoiding the need to upgrade the leased line.

Increased productivity

The migration has resulted in better throughput access. Measurement of throughput before and after the migration was carried out showed tremendous increase in the throughput speed. We measured the throughput before and after migration using a standard Pentium-class PC with 64 MB RAM at similar times. Before the migration, average throughput for file transfer was around 2 KB/sec. This improved to 200 KB/sec for the same file transfer, indicating an improvement of 100 times. Improved throughput results in reduction in time spent on the Internet which is expected to translate into increased productivity as less time would be needed to surf the Web and download files.

Preparation for future increase in Internet usage

It was very difficult to increase the number of Internet users with the old leased line with a bandwidth of 64 kbps. The new arrangement makes it possible to double or triple the number of Internet users without affecting the speed of access.

Preparation for Telemedicine

The UMMC is preparing for Telemedicine in a big way. Telemedicine will certainly require a much bigger bandwidth than was presently available. The old leased line with a bandwidth of 64 kbps would not be able to support Telemedicine. Video-conferencing for example might require at least a bandwidth of 384 kbps to appear acceptable with a refresh rate of 15 fps (frames per second). The new arrangement makes bandwidth of up to 2 Mbps available to a single computer thus enabling real-time video at 30 fps possible.

Better network security

With the closure of the loophole in the network, it is expected that network security will be enhanced and this will make it more difficult for hackers to penetrate

the network (see Figure 5). This has been worrying system administrators in the UMMC for some time and the migration provided the opportunity to close this loophole.

Reduction in complaints

With the use of a bigger pipeline to the Internet, it is expected to result in fewer complaints regarding the Internet service. Most complaints from users regarding the Internet service are related to speed of Internet access. Thus we hope to reduce these complaints to a minimum. More stable access is expected with the use of the fibre-optic leased line used by UM as fibre-optic lines are less susceptible to lightning strikes compared to copper cabling.

Conclusion

Information technology (IT) is here to stay. It is touted to bring countless benefits to all of us and will radically change the way we work. Physical borders will be reduced with the use of IT and Internet technology. Unfortunately, many people associate the use of IT to increased cost, which in reality is only partly true. While it is true it costs money to implement IT solutions, there are ways to save money and innovation is the key. There may be trade-offs in some areas but generally, when the benefits outweigh the trade-offs, one can accept these.

Our efforts in migrating the leased line access was motivated by the need to improve service while saving money. In Malaysia, affordable broadband access is still some way off so we have to make maximum use of our resources. Where possible, Nadi IT believes in saving money, which can then be used to serve other needs. This exercise was an eye-opener for many of its staff and it augurs well for the future of the UMMC efforts that its staff was very enthusiastic about the project. We believe that Nadi IT's efforts in improving Internet access in the UMMC can be emulated by other organisations wishing to improve Internet access at minimum cost. Because of the cost-saving nature as well as its benefits in improving services to the UMMC, this project was nominated for the Civil Service Award for Innovation for the year 2001.

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