GLOBAL INFORMATION TECHNOLOGY INFRASTRUCTURE FOR A GLOBAL NON-PROFIT ORGANISATION

A thesis presented in partial fulfilment of
the requirements for the degree of
Master of Technology at
Massey University

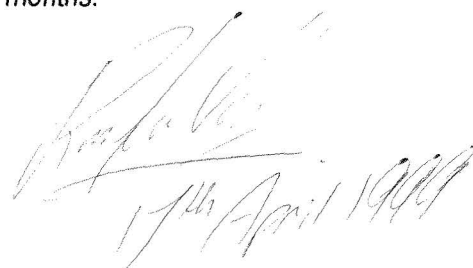## Richard M. van Laar-Veth

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Abstract

With the recent worldwide growth of the Internet, computers are becoming interconnected in a global communications network. Most people view the Internet as a universal communications medium that can replace telephone, television, and radio.

Historically, for organisations and enterprises that could afford to do so, expensive telecommunication lines and Wide Area Network technologies were used for global communications, which allowed computers to communicate using proprietary protocols.

For non-profit organisations in particular, the Internet has made it possible to connect offices and individuals, using open standard protocols, at a fraction of the cost of other alternatives.

This study focuses on the investigation and development of a global communication system and information technology (IT) infrastructure that uses the Internet as its communication platform for a particular non-profit organisation, OMF International.

Without a clear understanding of the limitations of the technologies involved, the development of an IT project is likely to be flawed or fail. (Standish Group, 1995)

The findings from this investigation revealed that a global communication system and IT infrastructure, suitable for OMF International, needed to overcome limitations in the use and access of the Internet, the unreliability of different email systems to deliver email messages, and financial and human resource constraints.

The study found that methods used in 'for-profit' organisations for the development of an IT infrastructure, were applicable to this non-profit organisation, resulting in the successful implementation of a global communication system and IT infrastructure.

The choice of IT solutions and technologies within OMF was often based on functionality rather than feasibility, and its global IT infrastructure requirements were overlooked. The study found that by comparison Lotus Notes' client/server IT infrastructure requirements were considerably less than that of Microsoft Exchange client/server, however, alternative low-cost open standard messaging options were more affordable. Conclusively, open standard IT solutions for global communications are better suited that for this non-profit organisation, than proprietary solutions.

The study also highlighted the need for an IT architecture, that would provide a plan and strategic context for future IT development within OMF International, which would overcome problems with concurrent IT projects using different technologies.

Acknowledgements

I would like to thank Professor Don Barnes and Dr. Huub Bakker for their guidance throughout this project.

I am grateful to my wife Johanna, and mother-in-law Patricia for their support and assistance in proof-reading.

My gratitude also goes to OMF International for the opportunity to develop and implement a global communication system that provided the subject and purpose for this project.

``I can do everything through [God] who gives me strength."

(Philippians 4:13)

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Chapter 1

Introduction

In the past few decades, computers have begun to play an increasingly larger role in education, business, and entertainment, and in the way that we communicate with other people. Nicolas Negroponte's (1995) statement, "computing is not about computers....it is about living" is becoming more of a reality everyday.

With the recent worldwide growth of the Internet, computers are becoming interconnected in a global communications network. Most people view the Internet as a universal communications medium that can replace telephone, television, and radio. Governments that promote technology such as United States of America (USA), Japan and Singapore are building national communication infrastructures to make this possible.

The term "Internet" derives from "internetwork" and refers to a worldwide collection of computers and networks that have agreed to interconnect and communicate using a common, non-proprietary protocol suite called TCP/IP[1]. This means computers with different hardware and software can communicate with each other.

Many organisations using computer technology that have historically been entrenched in proprietary software and hardware solutions for information technology needs are moving towards open and non-proprietary standards. For example, both Microsoft and Apple

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[1] TCP/IP, Transmission Control Protocol / Internet Protocol.

developed computer systems using software, hardware and communication protocols specific to its own environments. More recently, these two companies are developing computer systems using open standards.

Similarly, the software and hardware vendors are being forced to comply with open standards to remain competitive, and much is being said about "Open", "Internet-ready" and "Web-centric" products and computer solutions in advertisements and reviews.

For non-profit organisations in particular, i.e. organisations whose strategy is not driven by profit or revenue making, the Internet has made it possible to connect remote offices and individuals at a fraction of the cost of other alternatives such as direct telephone.

Although there seems to be a common trend to move to open standards and Internet technologies, there are significant differences between the way in which larger 'for-profit' and 'non-profits' International organisations deal with issues surrounding the use of the Internet.

Most other research on global computer communications and IT infrastructures are written for larger Multinational or International corporates and organisations. (Bradley, 1993, Chen, 1995, Hawryszkiewycz, 1997, Higginbottom, 1998, Keen, 1996, Luftman, 1996, OTG, 1998) This study focuses on the needs of a particular non-profit international organisation, OMF International. OMF, as an organisation has recognised that it needs to improve its effectiveness in achieving its goals, and communication is an important part in the effectiveness of an organisation.

1.1 OMF International, a Non-profit Global Organisation

OMF International is an organisation, which is not profit or revenue generating.

OMF International is a Christian Mission Organisation, founded in 1865 as the China Inland Mission (CIM) by James Hudson Taylor, with its focus on China's inland provinces. In the two years after the Communists took power in 1949, the CIM had to leave China. At that stage, it became the Overseas Missionary Fellowship, and moved its headquarters to Singapore, from which base its missionaries are sent to many countries in East Asia. In 1993, it adopted its current name of OMF International (OMF).

As well as sharing the Christian message with peoples of East Asia, and establishing churches where there is a need, OMF also addresses certain areas of academic, social and medical work.

What is an OMFer?

Although OMF has various categories of membership consisting of employed staff and of organisations and individuals holding informal relationships with OMF, essentially there are only two major categories of people: "OMFers", and the Public.

OMFers who work in an OMF office have different needs from those working away from an office environment. In this investigation therefore, the following two categories are used: OMF - Remote, and OMF - Office.

1.2 OMF International as a Global Organisation

OMF Membership is open to Christians of every nation and race. Currently there are about 1,000 OMF members drawn from many churches and denominations from twenty-one countries, working in mainly in East Asian countries, and amongst Asian diaspora.

The following can be said about the geographical distribution of OMFers and OMF Offices

OMF - Office

OMF has thirty-five offices in twenty countries. Although most offices are located in East Asia, every continent has one or more OMF Office.

OMF - Remote

Similarly, most people working within OMF work in East Asia. The make-up of OMF members comes from twenty-one nationalities.

1.3 Importance of Communication within OMF

Multi-cultural, multi-national and multi-generational lines of communication exist within OMF, and between OMF and the public. Missionaries may communicate with hundreds of people in their country of work[2] (field) and in other fields, as well as in their sending (home) country. One could imagine the links of communication with people as a complex web.

Good communication is therefore important in enabling OMF to work effectively with so many different people, churches and organisations around the world.

Hudson Taylor, founder of China Inland Mission (as OMF International was formerly known) understood the importance of communication when he wrote: *"Communication is the lifeblood of the Fellowship, second only to prayer"*. The importance of communication is no different today from a century ago when he wrote these words.

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[2] For more information on country and area notation used within OMF refer to Appendix E.

1.4   Information Technology Architecture in OMF

Although no one has defined an information technology (IT) architecture (i.e. a definition about an information system and IT infrastructure) for OMF International, there is substantive information from previous work and observations to describe components of OMF's IT Architecture.

Defining OMF's IT architecture, and consequentially its needs for a Global IT infrastructure, is as much about planning and strategy as it is about information technology itself.

According to Microsoft (1, 1998), Enterprise Architecture is a framework composed of four architecture perspectives: business, application, information, and technology:

Source: Microsoft
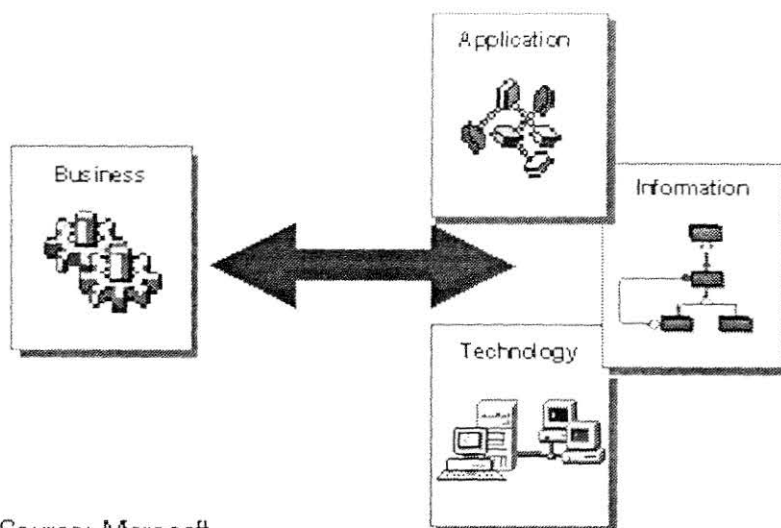
Figure 1:   Four Architecture Perspectives

Four Perspectives, One Architecture

Although there are four perspectives, there is only one architecture. The value of the enterprise architecture is not in any one individual perspective but in the relationships, interactions, and dependencies among perspectives.

The development of four architecture perspectives, and the examination of their individual and collective interactions, reveal the information that the organisation requires to make rational decisions about its IT priorities, projects, policies, standards, and guidelines. This information is critical for IT implementation and purchasing decisions, and provides a powerful communication tool between the IT and business units of the organisation. (Microsoft (1), 1998)

Business

The business perspective describes how the business works. It includes:

- The enterprise's high-level goals and objectives.
- The enterprise's products and services.
- The functions and the cross-functional activities the organisation performs, embodied in business processes.
- Major organisational structures.
- The interaction of all these elements.

The business perspective includes broad business strategies along with plans for moving the organisation from its current state to its future state.

OMF International strategy documents include: Purpose and Principles (OMF, Nov 1998), OMF Internal Communications Review (ICR) (Beauchamp, April 1996), The Way Forward for Computers (Ellis, October 1995).

Application

The application perspective defines the enterprise application portfolio. It includes:

- Descriptions of the automated services that support the business processes presented in the business architecture.
- Descriptions of the interaction and interdependencies (interfaces) of the organisation's application systems.
- Priorities for developing new applications and revising old applications based directly on the business architecture.

The application perspective represents the services, information, and functionality that cross organisational boundaries, linking users of different skills and functions to achieve common business objectives.

OMF International Finance System (IFS) is one example of such an application that crosses organisational boundaries. Other OMF applications include OASIS donation accounting system, Candidate Processing System, and a Personnel Database System (PDS).

Information

The information perspective describes what the organisation needs to know in order to run its business processes and operations. This includes:

- Standard data models.
- Data management policies.
- Descriptions of the patterns of information consumption and production in the organisation.

The information perspective also describes how data is bound into the workflow, including both structured data stores such as databases, and unstructured data stores such as documents, spreadsheets, and presentations that exist throughout the organisation.

OMF is traditional in its approach to data storage and archiving. Apart from data that is stored in the Personnel Database System (PDS) and various stand-alone directory or address-book systems,

most of OMF's critical information is printed and stored in filing cabinets.

Technology

The technology perspective lays out the hardware and software supporting the organisation. It includes:

- Desktop and server hardware.
- Operating systems.
- Network connectivity components.
- Printers.
- Modems.
- Other necessary peripheral devices.

The technology perspective provides a logical, vendor-independent description of infrastructure and of system components that is necessary to support the application and information perspectives. It defines the set of technology standards and services needed to execute the business mission. These standards and services include, but are not limited to:

- Topologies.
- Development environments.
- Security.
- Network services.
- Technical specifications.
- Database management system (DBMS) services.
- Application Programming Interfaces (APIs).

OMF does not have a concise description of OMF's Technology architecture. Guy Beauchamp (April 1996), discusses the need for an IT Infrastructure project that "will provide the technological capacity to communicate and share information.... that will provide a foundation for all of the Internal Communications System's information management needs".

An OMF document, "The Way Forward for Computers for OMF" written by Mark Ellis (October 1995), provided guidelines and standards for offices computers and networks, and recommendations for establishing global IT support and training. This document has recently been updated, as a result of the investigation of this study and discussions on IT within OMF. (OMF, Sept 1998)

1.5   OMF's Needs for a Communication System

In the history of CIM and OMF, it has had to adapt to political and economic changes in East Asia. David Pickard (1996), General Director for OMF asks, "What is the major reason for the change... we are embarked upon? - The compelling reason is the necessity of ensuring our mission's effectiveness in the 21st Century".

OMF International recognised that it needed to improve its communication, and initiated a review of its internal communication.

Beauchamp (April 1996) researched and analysed business communication for a period of two years and writes in his summary statement: "Communication within OMF is effective along traditional lines. OMF has established a communication system that meets many of the organisation's needs. However, the system is geared towards traditional organisational structures — structures that are now changing within OMF". He recommended that "OMF should continue to work towards improving its internal communications by developing a new system to deal with all aspects of communication in a changing organisational structure.

Acceptance of the proposal provided the motivation and general direction for the development of a communication system consisting of several IT projects based on a communications infrastructure or global IT infrastructure.

Beauchamp (April 1996) describes the Communications Infrastructure "that deals with the human aspect of the system, and an information technology (IT) infrastructure that provides a technological foundation for all of the Internal Communications System's information management needs." An earlier description for OMF's IT infrastructure was described as "a global Wide Area Network (WAN) to facilitate e-mail, conferencing, workflow and groupware between 35 offices in 20 countries". (OMF, Dec 1995)

An investigation was therefore needed to determine suitable methods and technologies for the implementation of a communications infrastructure or global IT Infrastructure that would become the foundation for other IT projects within OMF.

Such methods for the development of information technology architecture are well researched and documented, and are used in 'for-profit' organisations. (Luftman, 1996, The Open Group, 1998, Microsoft 1998) These references however, do not specifically say that they are applicable to 'non-profit' organisations.

The aim of this investigation therefore, is to apply previously researched and documented methods and technologies for the development of a global communications infrastructure to a specific non-profit organisation. The study seeks to support a theoretical model for a global information technology infrastructure. One notable difference between this study and one of a similar nature, applicable in an enterprise or for-profit organisation, is that the study is conducted and implemented within the financial and human resource constraints of a non-profit organisation.

Since many people within the OMF network of people, and those associated with OMF, have access to computers and the Internet, it seems reasonable to use the Internet as a communication platform. A global communications infrastructure in OMF therefore, could provide an effective way for people to communicate, thereby enabling the organisation to be effective. The premise is that OMF will in fact

be provided with a reliable, dependable and available global IT infrastructure that enables its users to communicate effectively.

Measurable Effectiveness of Communication in OMF

In seeking to address an organisation's communication needs, an appropriate global communications infrastructure and information technology infrastructure is required to provide an effective communications system that will enable people within the organisation to be able communicate.

One could surmise that improving the quality and reliability of communication mechanisms would therefore improve OMF communication. However, improving technology does not necessarily improve the effectiveness of an organisation. As Beauchamp (1996) points out "The new communications system will not solve all of OMF's problems, but it will make a significant impact on the Fellowship's ability to achieve its mission and maintain its values". The focus of this study, therefore, does not deal with human efficiencies (or inefficiencies) but rather with the effectiveness of a global communications infrastructure.

The outcome of this study will give the reader a better understanding of the issues in using the Internet as a Global Communications Infrastructure and will show how a non-profit can deal with these issues.

To OMF International, the benefits of a reliable and dependable global communication infrastructure are immediate: its members will be able to communicate effectively within the organisation.

Other non-profit organisations and small to medium enterprises (SME) that have similar communication needs and financial restraints would also benefit from this study.

Chapter 2

Background

2.1   The Development of Modern Communications Technology

Over the entire world, people communicate with other people in some form or another. Traditionally, communication from a distance has been carried out using a stamped envelope and conventional post, be it land, sea or airmail. Global postal communication consists of a network of national postal delivery systems that have unilateral agreements on charges and delivery conditions.   In principle, everyone has a postal address, and therefore there should be no reason why correctly labelled mail cannot be delivered. Most people have an address book with the names and contact details of their friends and relatives. Almost every organisation has address lists of people to whom it distributes information or advertisements.

Increasing Development of Technologies

With the continuing development of technology, global telecommunication infrastructures linking national telecommunication networks have enabled people to communicate with others around the world using telephone, facsimile and more recently via the Internet with electronic mail (email). Richard Hsu writes, "each new development in computer technology promises a

new degree of storage, connectivity, or portability that seems to diminish the dominance of the printed press". (Hsu, 1997).

Telephone Systems Worldwide

One may imagine that with over 575 million telephone lines available worldwide, most people will have access to a telephone line. (Mody, 1995) However, as Mody points out, there is an uneven distribution of telephone lines in the world. Within Organisation for Economic Co-operation of Development (OECD) countries there is an average of forty-nine telephone lines for every one hundred people, compared with an average of less than one telephone line for every one hundred people in some Third World countries.

Email Systems Worldwide

As an alternative to conventional mail and facsimile, email has also been adopted by most organisations. It would be most unusual to receive a business card with no email address or at least the company's web site address printed on it. Once sent, email is immediately delivered, ready to be collected by the recipient. Email therefore, is much more responsive than conventional mail.

Nua Internet Surveys, an authoritative source online for information on Internet demographics and trends, estimates the number of users of the Internet worldwide to be 151 million people as of December 1998[3]. This is approximately 3% of the world's estimated five billion population.

2.2   History of the Internet, and Its Implications

There are many documents describing the origins of the Internet. For example, "A Brief History of the Internet", edited by Barry M. Leiner

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[3] Nua Internet Survey http://www.nua.ie/surveys

(1998), is one such written account by those who were part of the history of the Internet.

J.C.R. Licklider (1962) of Massachusetts Institute of Technology (MIT) wrote a series of memorandums discussing his "Galactic Network" concept. Licklider envisioned a globally interconnected set of computers through which everyone could quickly access data and programs from any site. His concept was very similar to what the Internet is today.

Licklider was appointed as the first head of the computer research program funded by the US Defense at the Defense Advanced Research Projects Agency (DARPA), which resulted in the formation of a computer network called ARPANET. (Leiner et al. 1998).

Robert E Kahn, who joined the DARPA team in 1972, introduced the idea of open-architecture networking called "Internetting". Kahn developed a communication protocol that could maintain effective communication in the face of adverse nuclear war conditions. This communication protocol was eventually called the Transmission Control Protocol/Internet Protocol (TCP/IP). (Salus, 1995).

Authorities in Internet Standards

The Internet Activities Board (IAB) has assumed the mantle of leadership for the direction of the Internet and standardisation since 1983. The IAB set up the Internet Engineering Steering Group (IESG) to approve protocol specifications. In 1992, the Internet Activities Board was re-organised and re-named the Internet Architecture Board operating under the auspices of the Internet Society. The IAB and IETF work closely on a more "peer" relationship, with the IETF and IESG taking a larger responsibility for the approval of standards.

Evolving Internet Applications - Email - Web

From 1972 onwards, Internet applications and other communication protocols such as electronic mail were developed to utilise the TCP/IP protocols that enabled communication between computers and devices, and this has been the primary application for the use of the Internet since.

History and Growth of WWW

In 1990, Tim Berners-Lee, a CERN computer scientist, invented the World Wide Web (Web or WWW), a new Internet application. The Web, was originally conceived and developed for the large high-energy physics collaborations which demanded instantaneous information sharing between physicists working in different universities and institutes all over the world.

The popularity of this new Internet application in academia and the commercial world is evidenced by the rapid growth of the Internet.

The Internet Domain Survey conducted biannually by Network Wizards,[4] attempts to gauge the size of the Internet by recording the number of computers (or hosts) on the Internet worldwide. Using this criterion as a measure, its findings show that the growth of the Internet has continued to almost double every year for the past five years. The July 1998 survey shows 36,739,000 hosts are permanently connected to the Internet. This did not include hosts or computers hiding behind firewalls in corporate networks.

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[4] Network Wizards Internet Domain Survey http://www.nw.com/zone/WWW/top.html

Number of Hosts

```
40,000,000
35,000,000
30,000,000
25,000,000
20,000,000
15,000,000
10,000,000
 5,000,000
         0
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Source: Nua Ltd.

Jan-91 Jul-91 Jan-92 Jul-92 Jan-93 Jul-93 Jan-94 Jul-94 Jan-95 Jul-95 Jan-96 Jul-96 Jan-97 Jul-97 Jan-98 Jul-98

Date of Survey
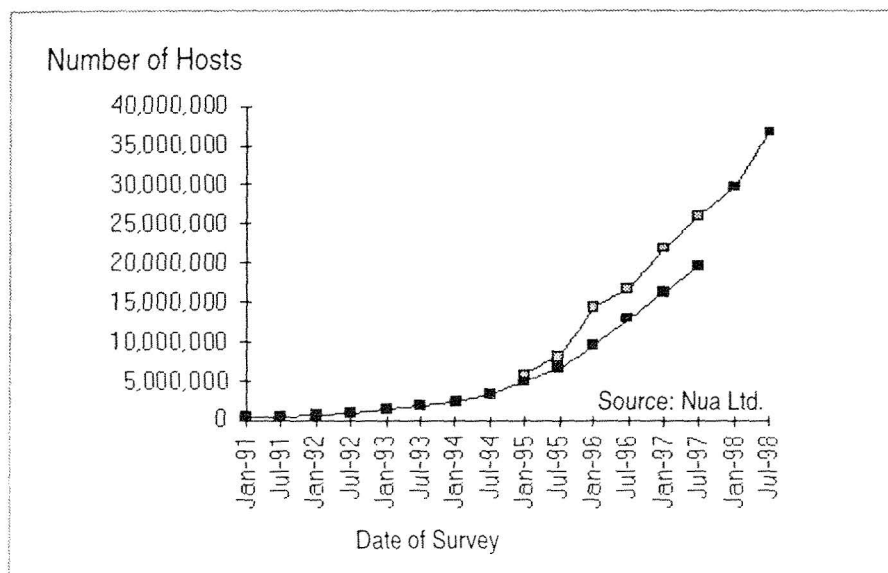
Figure 2:   Internet Domain Survey Host Count

The spread of the Internet has been aided by organisations such as the Network Startup Resource Center (NSRC)[5] and the Advanced Network Technology Center (ANTC[6]) of the University of Oregon, US. The NSRC, a non-profit organisation, that is partially supported by the US National Science Foundation (NSF[7]), has for the past decade been involved in international networking initiatives throughout Asia, Africa, Latin America, and the Middle East to providing access to the public Internet. (NSRC, 1999)[8]

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[5] More information on the NSRC can be found at http://www.nsrc.org/
[6] More information on the ANTC can be found at http://antc.uoregon.edu/
[7] More information on the NSF can be found at http://www.cise.nsf.gov/anir/
[8] Information about the international networking developments and Internet connectivity providers throughout the world can be at http://www.nsrc.org/networkstatus.html

World Wide Web (W3C) Standards

The widespread use of the World Wide Web amongst the millions of Internet users, has created a new community of people who are not primarily network researchers and developers.

The World Wide Web Consortium (W3C) was therefore formed and has the responsibility for evolving the various protocols and standards associated with the Web.

Currently the IAB, IETF, IESG, and W3C all have areas of responsibility for the development and approval of standards. A broad community is represented on all working groups so that the standards process is fair and open.

2.3   The Internet: An Open-Architecture Internetwork

Kahn's idea of open-architecture networking was that individual networks, even if designed and developed separately according to their own unique requirements, should still be able to communicate with other networks using a standard network communication protocol that has been agreed by relevant authoritative bodies. (Kahn, May 1974)

Request For Comments (RFC)

Many Internet standards are often referenced by their Request For Comments (RFC) number, a series of notes established by S. Crocker in 1969. The RFCs were intended to be an informal and fast distribution method of sharing ideas between other network researchers. (Leiner et al. 1998) The effect of the RFCs was to create a positive feedback loop, with ideas or proposals presented in one RFC triggering another RFC with additional ideas.

When a consensus had been reached, a specification document was prepared, approved and subsequently defined as the standard.

Research teams subsequently used these open standards as a basis for the development and implementation of applicable technologies.

All RFCs are freely and openly available via the Internet, governed by the various authorities[9], allowing actual specifications to be used, for example in college classes and by entrepreneurs developing new systems.

2.4   Globalisation of the Internet

The globalisation of the Internet, i.e. its global expanding availability and accessibility, follows from the globalisation of the international and national telecommunication infrastructures.

The globalisation of the Internet empowers organisations to re-develop and improve their existing infrastructures by providing a less costly common communications platform, for both internal and external communication needs.

For example, many international companies and organisations offer free subscription to electronic mailing lists for information relating to current events, and for news of product updates.   These may be offered to both members and interested parties.   The cost of distributing information using electronic mail is fractional compared with the cost of printing and conventional postage charges.

Most importantly, the internetworking of 'on-line' organisations makes communication with other on-line individuals and organisations virtually unlimited, forming a web of communication.

Whilst national governments and major global telecommunications players continue to invest in national and international information technology (IT) infrastructures, the growth and capacity of the Internet will continue to increase.

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[9] Internet Standards Authorities, IAB, IETF, IESG, W3C

2.5 History of LAN WAN and Its Implications

Local Area Network (LAN) / Wide Area Network (WAN)

To set-up a Wide Area Network (WAN)[10], would usually mean installing expensive long distance leased or privately owned telecommunication lines. Often Leased lines were used to connect directly office networks in order to provide organisational WANs.

National Politics and Telecommunications

During the 70s and 80s, transmitting electronic information across national borders was often made difficult by government and telecommunication restrictions. According to Kosynski and Karimi (1993), "regulations [were imposed] that restrict the use of leased lines and public telephone networks, on the use of dial-up data transmission or the use of electronic mail systems for communications....It is not unusual for a company to build its own 'phone company' to reduce dependence on government-run organisations". Multinational corporations continue to operate their own "phone company" and dial-up Remote Access Services (RAS) to office networks in each country.

During the early 90s these restrictions were being lifted. Roche commented that "Nations have for a variety of reasons taken actions at the economic and policy level that have tended to hinder the rapid development of telecommunication systems, particularly privately-held systems such as those operated by multinational corporations". He lists eight strategies for improvement, one of which is titled "Strategy #6: Exploit the Coming Liberalization in International Telecommunication." (Roche, 1992).

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[10] A Local Area Network (LAN) is a network of computers covering a small geographic area, usually not larger than a building, and a Wide Area Network (WAN) in general terms is a a network of LANs connected via long distance telecommunication lines.

Possible Benefit of Using Internet for WAN

An alternative to setting up privately owned leased lines is to use the publicly owned open architecture networks such as the Internet.

According to the Network Wizards (July 1998), the Internet grew over 2000 percent from November 1989 to November 1994. There are significant cost saving and other potential benefits for corporations to use the Internet to connect office networks instead of private leased-lines. As Prakash (May 1995) points out, "The global nature of the Internet, its low cost of access, and its composite set of services, make it an ideal tool for global strategic information systems...The question of the 1990s for organisations desirous of competing in the global economy is not "Is your company on the Internet?" but "To what extent is your company an Internet-based organisation?".

Proprietary Protocols

One may be led to think that both vendors and buyers would benefit from having open standards. This however, is not the case as Barry Leiner shows: "Many [vendors] saw [TCP/IP[11]] as a nuisance add-on that had to be glued on to their own proprietary networking solutions: SNA[12], DECNet[13], NetWare[14], and NetBios[15]". (Leiner et al. 1998). Although Leiner refers to experiences relating to the earlier commercialisation of the Internet Protocols, vendors continued to develop proprietary protocols and solutions.

Issues in using the Internet

Some of these proprietary network protocols cannot be used via the Internet, or have special requirements to enable this. For example Microsoft Windows 95 uses Microsoft's NetBEUI protocols to

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[11] TCP/IP - open standard network protocol
[12] SNA - proprietary IBM network protocol
[13] DECnet - proprietary Digital Electronics Company network protocol
[14] NetWare - proprietary Novell network protocol
[15] NETbios - proprietary Microsoft network protocol

communicate with other Windows 95 or Windows NT computers, and cannot be used via the Internet, unless a Microsoft Point-to-Point Tunnel Protocol (PPTP) connection is established first. There is therefore a requirement that all network components involved supports Microsoft PPTP.

Therefore, issues of security and functionality surrounding the use of open architecture network, that are found in using the Internet, compared with private corporate networks.

It is perhaps for these reasons that some organisations choose to use proprietary IT solutions instead of open standards based solutions, and therefore a decision where functionality has greater importance than interoperability of the technology in question.

2.6   Open Standards and Interoperability

Issues of Interoperability: Roadblock and Bulldozers

A consequence of using proprietary solutions is the lack of interoperability between different systems. Michael Dertouzos, Director of Massachusetts Institute of Technology (MIT) Laboratory for Computer Science argues that "one of the biggest roadblocks to building an Information Marketplace is the inability of interconnected computer systems to easily relieve us of human work. This roadblock exists because today's networked computer systems have no way of understanding one another, even at a rudimentary level... It's time to shed the high-tech shovels with fancy names and build the bulldozers of the Information Age." (Dertouzos, 1997).

Emerging Standards

Deborah De Voe, in her October 1996 InfoWorld Tech Update article titled "Vendors to Improve Security", states, "implementing a complete solution is a challenge because interoperability among products is still limited. Standards are emerging ... however, due to

the complexity of security and often high expense of single-vendor solutions, companies are currently often better served by a set of technologies from varying vendors." (De Voe, 1996)

Market Pressure for Open Standards and Interoperability

In Fritz Schulz's presentation, "Foundation for Interoperability", he showed how the US Defense Information Systems Agency is developing a Defense Information Infrastructure that complies with open standards to enable interoperability between various systems. Technology selection must comply with open standards and interoperability. (Schulz, 1998)

The Open Group quotes John Warner, president of Information Support Services at Boeing: "If I could instantly transform our computing environment, I would have every system, every application and every network protocol completely compatible and interoperable. The user would have access to exactly the tools they needed." (The Open Group, (1), 1998)

Due to this sort of market pressure, vendors are beginning to develop products using open standards to ensure that their products are interoperable with other vendors.

Interoperability: Compliance with Open Standards

Interoperability between systems requires that systems are compliant with standards that are applicable to the technology or sets of technologies that are involved or used.

Many standards organisations such as the International Organisation for Standardisation (ISO) are authoritative and recognised by governments and industry throughout the world. Compliancy and certification with ISO standards ensures safety, interoperability and effectiveness in all areas of industry and business.

The Open Group: An Authority for Standards in IT

Some of these standardisation organisations deal specifically in areas of telecommunication and computing. The Open Group is one such international standardisation body that is vendor-neutral with an international consortium of over 200 members, and which works with both suppliers and users to establish interoperability requirements.

Specifications for technologies developed in collaboration with several other vendors will most often not be recognised as a standard until it is given to an independent standards body. Such was the case when the network computer (NC) reference profile, which was originally released by Oracle, Sun, IBM, Netscape and Apple, was handed over to The Open Group. (NC World Magazine, Sep 1997)

The Open Group and Other Standards Bodies

The Open Group (TOG) and Web Standards Project (WSP) work in collaboration to ensure support for standards on the World Wide Web. A TOG press announcement quotes James DeRaeve, Director of Testing for the Open Group, as saying: "The promise of the web is that through the use of agreed industry standards, web content can be accessed by users from any browser on any platform. The WSP and TOG have recognised that the lack of consistent support for these essential standards across all browsers creates unnecessary cost and usability barriers." (The Open Group, (2), 1998)

These open standard bodies are facilitating and ensuring the development of better interoperability in future hardware and software solutions.

Defacto Standards

Although open standards exist to provide order in a computer world of interoperability, one must recognise that because Microsoft and JavaSoft[16] that are widely used in may organisations, have developed their own interoperable standards they have become defacto standards for operating systems, office desktop applications and application development software.

Organisational In-house Standards

Many organisations have standardised on the use of a particular brand of software. For example, The UK Defense technical architecture has specified that Microsoft products are to be used for desktop applications. Organisations that have standardised on a particular brand of software, can be vulnerable to changes and directions of the makers of that software. The cost of changing software in widespread use within an organisation can be considerable, both in the cost of the software and in the cost of training those who will use it. (Chuodhury, October 1998)

Although open standards and standardisation may resolve lack of interoperability, software and protocol standards do not provide direction and guidelines for the development and subsequent success of IT projects.

Strategic IT Management

Jerry Luftman and others (1996) argue that an "organisation's business and information systems strategies and its organisational and information technology infrastructures must all be in alignment for it to benefit fully from [its] investments in information technology."

An IT infrastructure therefore, which supports existing applications while remaining responsive to changing business requirements,

becomes a key to long-term enterprise competitiveness. (MIS Quarterly, June 1996) "The management challenge is to make sure that business processes, people, and technology are meshed, instead of being dealt with as separate elements in planning and implementation." (Keen, 1993)

One could suppose that these statements regarding IT management would be applicable to both profit and non-profit organisations. However, Pappas (1996), author of "Re-engineering Your Non-profit Organisation: A guide to Strategic Transformation" has recognised different IT management needs for profit and non-profit organisations.

Foundation Building Blocks

Houses are normally designed to be built on foundations that will support their structure. The foundation becomes a reference on which walls and other parts of the building are fixed.

Similarly, one could imagine that the design of an information infrastructure architecture is built on a foundation of open Standards and interoperability. The specifications for open Internet standards and interoperability constitute that foundation on which a global information technology infrastructure is built. It is these specifications therefore, that become a reference point for all tests and analysis.

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[16] JavaSoft, an operating company of Sun Microsystems, Inc. (NASDAQ:SUNW

2.7 Information Technology Architecture

Any complex computer-based information system needs an architecture (a definition about an information system and IT infrastructure), to provide a strategic context for its development and evolution. Examples of architectures for distributed computing environments are CORBA[17], IT DialTone, and DCE[18].

Benefits of an IT Architecture

The following summarises the benefits of an IT architecture:

- The structure of the system is clearly defined.

- It reflects real-world constraints, capabilities, and lessons learned.

- Having a better-defined structure and modularity can lead to lower support and maintenance cost.

- It avoids "analysis paralysis" - the huge cost in time and resources required to identify all the details at the start of architecture planning enterprise/organisation-wide and project-deep.

- It validates elements or building blocks of the system through actual use, resulting in greater confidence in the value of the strategies that are outlined.

- It brings together individual project teams and architecture (or systems) teams to ensure the architecture actually gets built.

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[17] The Object Management Group's object management architecture (OMA), often loosely referred to as the CORBA architecture, is an object-oriented application architecture centred on the concept of an object request broker (ORB).

[18] Distributed Computing Environment that provides services and tools that support the creation, use and maintenance of distributed applications in a heterogeneous environment. (The Open Group, 1997)

- It can be incomplete without being a showstopper for an individual project. Missing pieces or building blocks can be investigated, validated, built, and refined as needed by individual projects, and leveraged into the architecture.

(The Open Group, 1997) (Microsoft (1), 1998)

Any enterprise or organisations therefore, whether for-profit or non-profit would benefit from having a well-defined architecture for its organisation.

Architecture Framework

An **architecture framework** is a tool to help define an architecture for a current or planned information system. The use of an architecture framework should lead to:

- the use of common principles, assumptions and terminology within architectures.
- the definition of a single structure for architectures.
- development of information systems in accordance with common principles, and thus promotion of better integration and interoperability

An **architecture framework** is a tool that describes a whole family of related architectures, allowing an individual architecture to be created by selection from and modification of the framework components. It describes an information system in terms of a model. (The Open Group, 1997)

Architecture frameworks that are developed by open consortiums or standardisation groups are more generic in their application and can be used as tools by different organisations to define their own

architecture. Examples of such open models or frameworks include TOGAF[19] and IEEE POSIX[20]

The Microsoft Solutions Framework[21] (MSF) is a suite of models, principles, and guides for building and deploying distributed enterprise systems. Although written by Microsoft from its own experiences in software development and information, the development processes described are easily understood and are intended to be vendor-neutral. (Microsoft (1), 1998)

Towards an Open Global IT Architecture

The Open Group is an international standardisation body comprised of a membership from a wide range of international consortium of buyers and vendors of technology. Accrued cost of technology procurement by these buyers exceeds US$22 billion each year. The Open Group provides an open forum where organisations can influence the delivery of standard specifications and future product development to ensure conformance to the basic features of an agreed open environment. Its mission is "to cause the development of a viable global information infrastructure that is ubiquitous, trusted, reliable and as easy to use as the telephone. The essential functionality embedded in this infrastructure is what the Open group has termed the IT DialTone™." (The Open Group (3) & (4), 1998)

Building the IT DialTone™ Infrastructure

The Open Group currently runs seven Program Groups covering all essential aspects of the IT infrastructure. Members and suppliers collaborate on developing the requirements for the infrastructure elements needed for today's business environment, which will evolve into the IT DialTone™. The Open Group then works closely with

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[19] TOGAF - The Open Group Architecture Framework
[20] IEEE Guide to the POSIX Open System Environment, or POSIX.0
[21] Microsoft Solutions Framework web site http://www.microsoft.com/solutionsframework

software suppliers to develop innovative products that enable open computing.

The seven program (or discussion) groups are Architecture, Interoperability, Security, Distributed System Management, Desktop, Distributed Computing Environment, and Information Superhighway. (The Open Group (3), 1998)

IT DialTone™ Initiatives

According to the Open Group, the IT DialTone initiative addresses two related but distinct challenges:

a) The need to reduce the level of complexity that an IT user has to cope with and to enable the level of investment in business applications to be increased.

b) The need to plan for a global integrated infrastructure without imposing the costs of major reengineering on early pioneers.

The IT DialTone initiative focuses on the commercial needs of both suppliers and customers for a global, ubiquitous, robust, and easy to use distributed communications infrastructure for the deployment of business applications.

IT DialTone™ Architecture

Architecture Board members, and partners of the Open Group define the IT DialTone Architecture as the structure required to realise the potential of the IT DialTone Initiative.

Through use of the IT DialTone Architecture and compliant products and technologies, Internet-based business applications will become as reliable and easy to use as the telephone, and also as secure as mission critical electronic commerce requires.

According to The Open Group (1997), an Internet business environment has three entities: the enterprise and its internal departments (intra-enterprise), partners (inter-enterprise), and

customers (global internet). The diagram below illustrates how such an Internet business environment can exist.
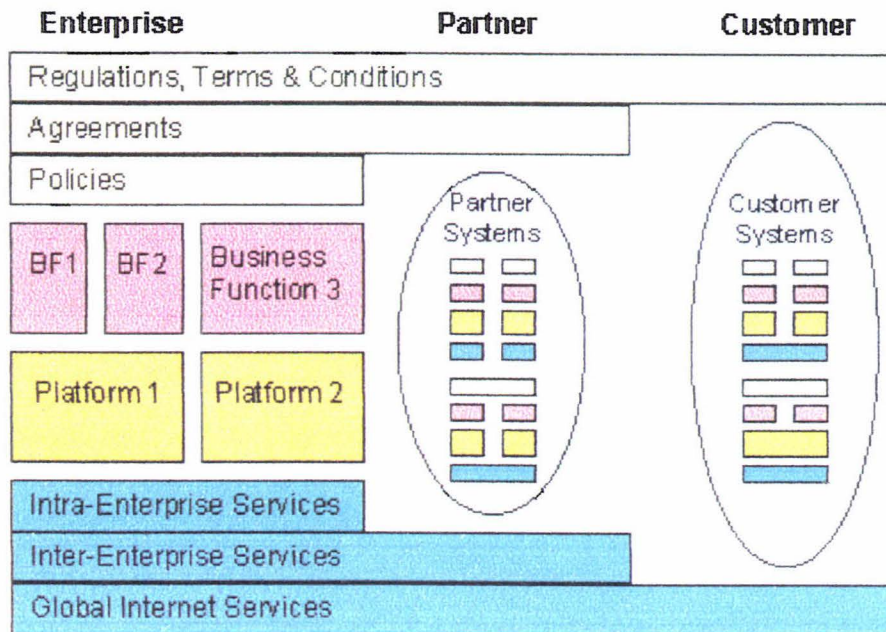
Source: The Open Group

Figure 3:   The Internet Business Environment

Figure 3 shows that an enterprise can establish and implement policies to maintain control over its own systems and possibly through contractual agreements, with business partners. However, an enterprise or organisation must rely largely on broadly accepted standards and regulations when dealing directly with individual customers.

This is also true for a non-profit organisation such as OMF International whose members or partners are independent of any office or enterprise system, and where the public arena has no contractual arrangement with OMF.

The IT DialTone Architecture is intended to address global business needs, and also addresses any business application or issue that wants

to use the Internet as part of its solution: intranet, extranet -- scalable to global solutions. (The Open Group (4), 1998)

Pioneering days for Global IT Infrastructure Implementers

According to the Open Group (4, 1998) the IT DialTone Architecture is useful:

- for architects, and other specialists who are planning systems that will rely on the Internet as their communications platform.

- for technologists involved in selecting products today that will carry them into the future.

- in identifying technology gaps, compromise and risks in early days of change.

In moving towards an Open Global IT Infrastructure, the Open Group is continuing its work in identifying useful specifications and standards that exist today, identifying any gaps, and expanding upon existing standards or developing new ones, as needed.

The Open Group uses the introduction of the railway in the nineteenth Century as an example of the need for standards in developing a Global Internet Technology Infrastructure. Early railway systems were built at a time when there were no worldwide standards for the width of the track, the size of the carriages and clearances in tunnel and stations. The result of this incompatibility meant that some railway systems had to be rebuilt entirely in order to be able work with other countries. Had there been system standard at the onset of implementation, no reengineering would be needed.

The IT DialTone Architecture will provide specifications towards an Open Global IT Architecture. This means that enterprises and organisations wanting to use the Internet as their communications platform, must ensure systems comply with IT DialTone specifications and standards so as to be compatible and interoperable with other systems.

2.8   Information Technology Development Methods

After selecting the architecture for the system, the next step is to develop or implement the system.

Developing an IT Projects without a Framework

Some people develop a small project in a logical fashion, and do not use any kind of development model. However, if the infrastructure is not deployed well, certain problems or obstacles to success can be expected. Examples of such potential problems or obstacles are that:

- Important business projects may be on hold until underlying technology issues are resolved.

- New technology must be evaluated, but no criteria may exist for making decisions.

- Deployment timeline could be determined by whether or not the application works as planned.

- Project teams may be developing applications that require different infrastructures.

IT Project Failure / Success

There is a risk therefore, that without an adequate framework and plan, the development of an IT project may not be fully realised.

According to a Standish Group Report (1995), over the last 20 years, organisations worldwide have spent billions of dollars and expended centuries of human effort on information technology (IT). The results delivered by a majority of these IT projects are less than expected, and in many instances, significantly less than needed. This occurs in spite of the increased technical understanding of business managers,

business process reengineering or other organisational "fixes", or implementation of the latest technology.

Cancelled
31%

Successfully
Completed
16%

Source: Standish Group

Challenged
53%
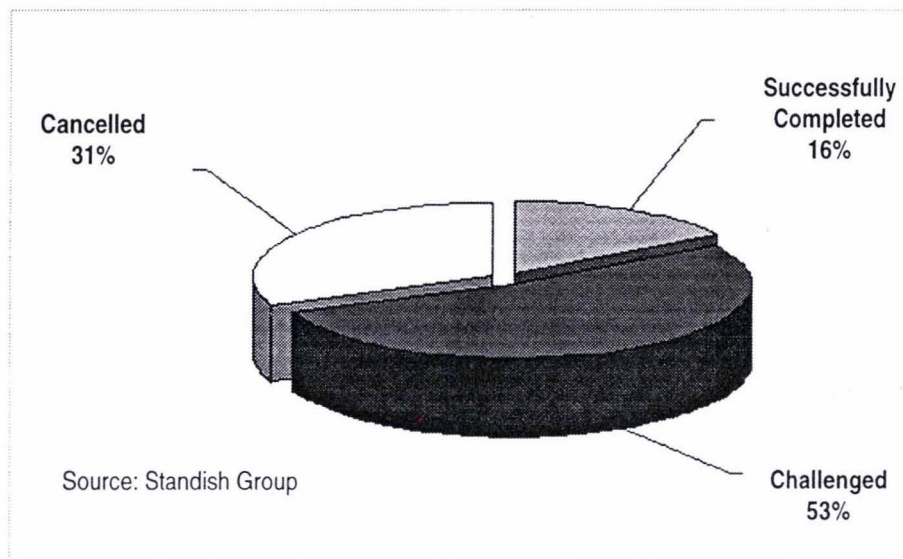
Figure 4:   IT Project Failure / Success

According to Microsoft (2, 1998), a project that takes more than one year to complete may lose its value due to the rapid rate at which technology is evolving. Microsoft points out that on large projects the deployment of any single version of technology may never be complete; as soon as one wave of deployment is nearing completion, another wave will be in the planning stages.

Possible Development Methods for Non-profit Organisations

There are a number of models available that may be suitable for the development of information technology applicable to non-profit organisations. Two example of such development models are the Microsoft Solutions Framework (MSF)[22] and The Open Group Architecture Framework (TOGAF)[23].

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[22] Further information can be found at the Microsoft Solutions Framework web site http://www.microsoft.com/solutionsframework

[23] TOGAF documentation freely available at http://www.opengroup.org/architecture/

Although different in emphasis, both development models used by TOGAF and MSF have merit in that they are developed from *'best practice'* in business and are tested and proven by many organisations.

The Open Group - Architecture Development Method (ADM)

According to the Open Group (4, 1998), an architecture is a set of building blocks depicted by an architectural model, and a specification of how these building blocks are connected to meet the overall requirements of an information system. The Open Group Architecture Framework[24] (TOGAF) emphasises defining an architecture based on open standards and specifications.

As shown in the diagram below, TOGAF's Architecture Development Model (ADM) is universally applicable for system architecture. The development cycle consists of seven phases. Although TOGAF primarily focuses on phase C (the creation of a target architecture), the seven phases of the cycle are clearly described, and address both technical and organisational issues.

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[24] TOGAF documentation available at http://www.opengroup.org/architecture/
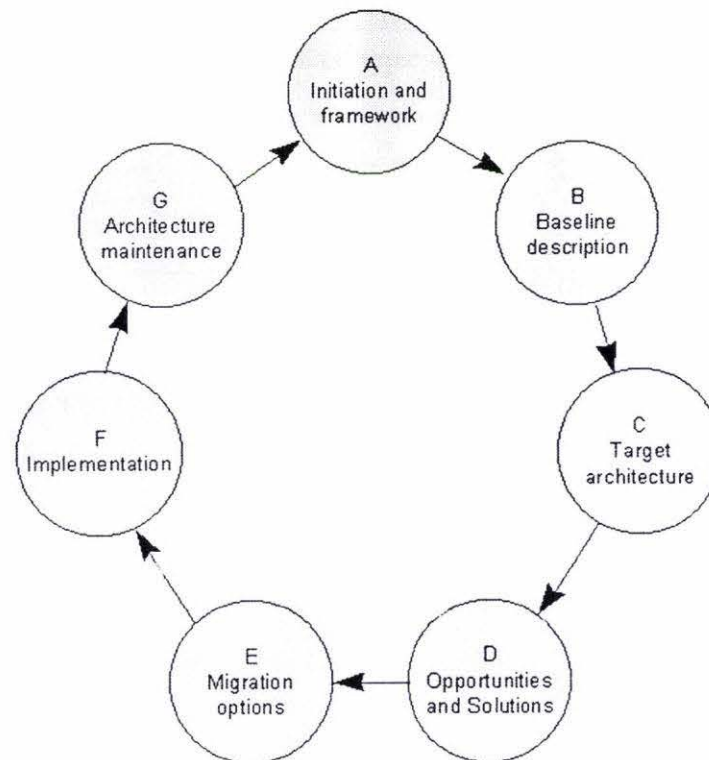
Source: The Open Group

Figure 5:   TOGAF Architecture Development Model (ADM)

The phases of the development cycle are iterative, both within each phase and among phases. Throughout the cycle's phases there needs to be frequent verifications of the results against the original motivation to take the architecture through a new cycle (business requirements and their specific criteria, financial and timing constraints).

TOGAF - The Open Group Architecture Framework

The diagram below shows an overview of a development process. Information about the benefits and constraints of the existing implementation is combined with information on the requirements for change, using a process model or architectural framework, resulting in an architecture (i.e. a definition about an information system and IT infrastructure). The 'New Requirements' box lies partly within the

scope of the Architectural Framework, because although Requirements Definition is typically initiated as part of a wider business review process, the requirements need to be refined within the architecture development process. Similarly, the 'Existing Implementation' lies partly within the scope of the framework, because the benefits and constraints of the existing implementation will need to be documented during the initial stages of architecture development.
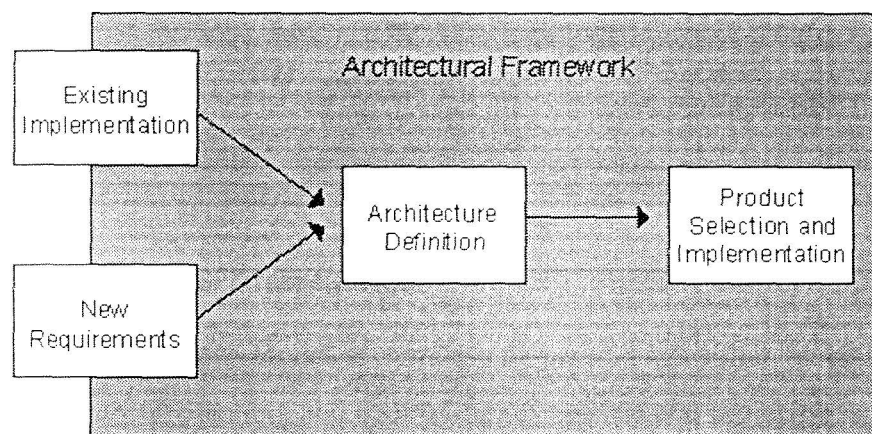
Figure 6:   Architecture Development Process

Microsoft Solutions Framework (MSF) Process Model

The Microsoft Solutions Framework has a series of development models for developing and deploying Microsoft technology in an enterprise. These models are all based on the Microsoft Solutions Framework Process Model.

The process model consists of four phases: Envisioning, Planning, Developing, and Stabilisation. Each phase culminates in a major milestone.
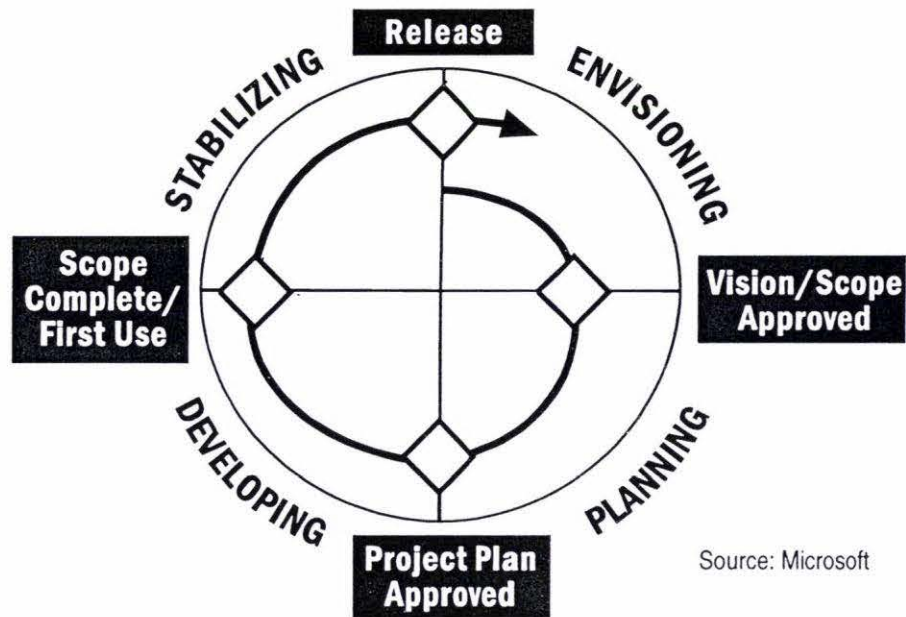
Figure 7:   MSF Process Model

The MSF Process Model is a milestone-based model that provides guidelines on planning and controlling results-oriented projects based on their scope, the resources available, and the schedule.

Comparison of Development Models

The focus of TOGAF is primarily on creating a target architecture (definition about an information system and IT infrastructure), whereas MSF is a goal-driven, milestone-based model that provides guidelines on planning and controlling results-oriented projects.

TOGAF has merit for developing OMF International's (OMF) IT Architecture and IT Infrastructure based on specifications and open standards, and would provide a clearer understanding of the needs and limitations for those developing projects within OMF. The goal-driven and results-oriented emphasis of the MSF Process Model would provide a clearer focus for smaller project teams developing applications within OMF.

2.9 Development Trade-off: Resources - Features - Schedules

In order to develop and implement a global IT infrastructure, the users and project team must collaborate to prioritise and make trade-off decisions on the following three project management parameters:

- Schedule
- Scope
- Resources

For example, for a project to be developed and deployed within a short timeframe in an organisation that has limited resources, the scope (or features) of the project must be constrained within reason.

McCarthy (1995), a leader in software development at Microsoft, argues that: "As development manager, you're working with only three things: resources (people and money), features (the product and its quality), and the schedule. This triangle of elements is all you work with. There is nothing else to be worked with. And changing one side of the triangle has an impact on at least one other side, usually two."
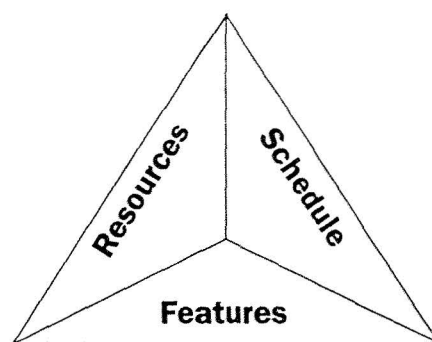
Source: Microsoft

Figure 8:   Project Elements in Triangulated Relationship

Microsoft (2, 1998) suggest that "the relationship between elements of the triangle tends to be hazy at the beginning of the process. At this point, the team has an estimate of what it wants to build, an estimate of available resources, and a high-level target delivery date. As the development team moves forward through the planning process, the triangle solidifies and the project elements become more distinct. By the time planning is complete, the team should know exactly the nature of available resources, the product features, and the fixed ship date".

This may be true for an enterprise or multinational organisation where resources (people and money) do not change during project development cycle. Usually features or schedules are adjusted in order to complete the project before a given deadline.

Development Trade-off in a Non-profit Organisation

Many authors have focussed on the area of management and finance within a non-profit organisation, and indicate a concern for the lack of financial and human resources in an organisation which is not profit or revenue generating. (Butler, 1990, Embley, 1993, Grace, 1997, Henke, 1993, Hodgkinson, 1989, Osborne, 1996, Setterberg, 1985, Shim, Smith, 1994, 1993, Young, 1993).

As a non-profit organisation with considerably fewer resources than a 'for-profit' organisation or enterprise, OMF International must ensure that the scope and schedule of the projects are possible.

Lessons from Previous Developments in OMF

In determining appropriate timelines for OMF projects, there are lessons that can be learnt from previous application and system developments within OMF.

An example is the International Finance System (IFS) that an applications development team took over six years to develop and implement, and which is now used by almost every OMF office. IFS was based on Timeline and Microsoft (MS) Access version 2

software. Currently many OMF offices now use MS Access 95 or 97. The time duration to complete this project, and the rate of change in Microsoft software, resulted in the use of out-of-date software even before the project was completed.

Implications of Global Development within OMF

The development team members and implementers of various projects within OMF are located in many nations around the world. Communication and collaboration is restricted due to geographical distance. and language and knowledge differences. This means that schedules must allow sufficient time for communication and understanding.

Implications of Changing Level of Resources

Within OMF, human and financial resources may change significantly from year to year; thus it may not be possible to determine an accurate schedule for projects that are to be developed over one or more years.

Effective and realistic scheduling and scope of large projects within the limited resources of a non-profit organisation is an important factor to the success of IT projects.

Chapter 3

Methodology

For The Development of a

Global IT Infrastructure

3.1   OMF IT Infrastructure Development Model

A suitable development model or framework was needed to provide a direction and method for the development of a global information technology (IT) infrastructure for OMF International, a global non-profit organisation.

An IT development model was developed by adapting methods used in both TOGAF[25] and MSF[26] development models. This resulted in a simpler model that focuses on a target IT Infrastructure and has five steps or phases to the development cycle.

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[25] TOGAF - The Open Group Architecture Framework
[26] MSF - Microsoft Solutions Framework

The development model and phases are described below:

Phase A. The overall development must be initiated or envisioned from out of organisational needs. There must be a clear understanding for the need for change.

Phase B. The development framework or model for developing OMF's global IT infrastructure is to establish a description for the existing, desired, and target infrastructure. This process is similar to that described in the TOGAF Architecture Development Model.

Phase C. Once the target architecture for organisations has been determined, opportunities to improve processes and appropriate hardware and software solutions are sought. Consensus and commitment from OMF leadership and people involved with IT is then established, to enable the implementation of various components or building blocks of the infrastructure. This part of the process must have sufficient response mechanisms and reiterations to determine whether technologies supporting new infrastructure requirements can be implemented within financial and human constraints.

Phase D. Using available resources, global implementations of the necessary changes to existing infrastructures are planned and carried out. In some instances, entire computer or network systems may need to be replaced.

Phase E. The final stage of this development process is to stabilise and maintain the infrastructure, and establish international and local technical IT support.

The development model and phases are shown in the diagram below:
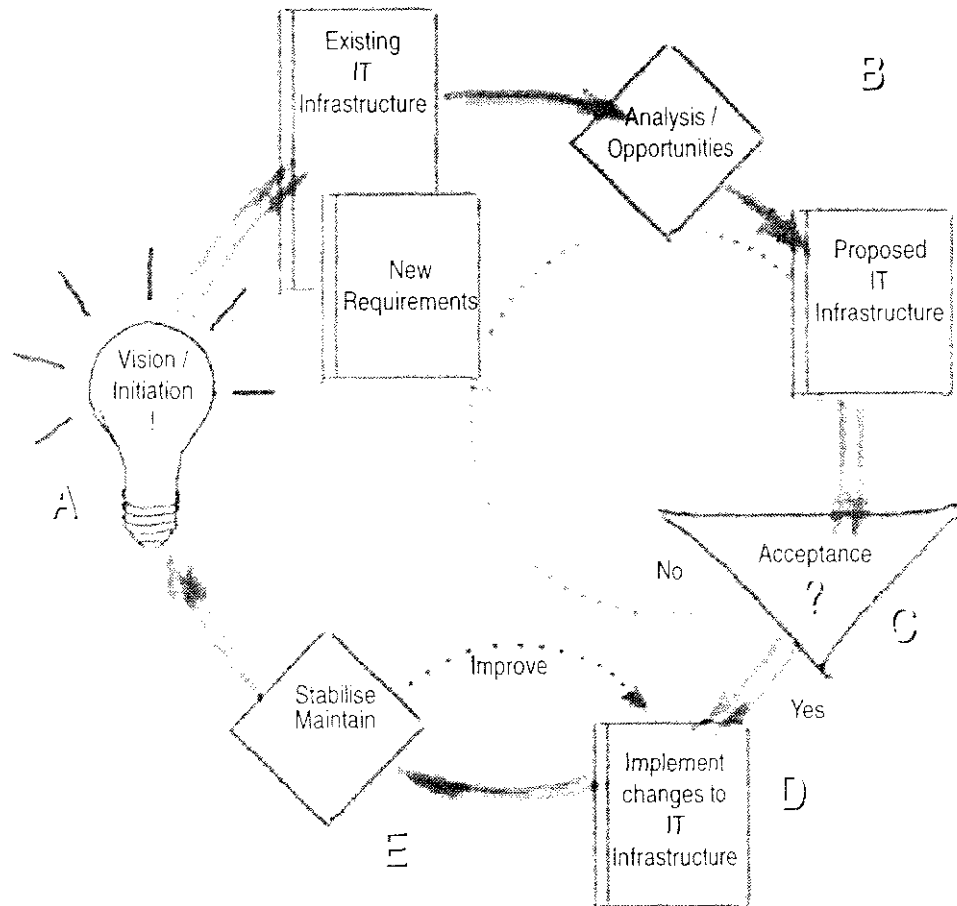
Figure 9:   OMF IT Infrastructure Development Model

The use of the development model should lead to a definition of a global IT Infrastructure for OMF International and its components or building blocks. This infrastructure should enable the development of information systems in accordance with common principles, and so promote better integration and interoperability.

3.2   Methods for Defining an Existing IT Infrastructure

The premise of change is that one has an understanding of the existing situation and need for change. It was found however, that although several attempts had been made in the past to document the status of computer equipment within OMF offices, no investigation ever included the entire organisation.

Therefore, in order to determine the status of OMF's IT Infrastructure as well as provide additional and possibly useful information, a questionnaire was developed and distributed to individuals within OMF. The questionnaire therefore, was intentionally designed such that answers given to a wide range of questions would influence decisions in determining suitable communications and IT infrastructures.

Questionnaire Methodology

As the questionnaire was to be sent as an email message, a plain text email message was designed with both questions and instructions, and was similar to other questionnaire used for determining the status of information technology within an organisation.

The questionnaire was first sent to a list of email addresses belonging to a group of people who were to act as co-ordinators for further distribution. They then forwarded the questionnaire via email or as printed matter, to others within OMF. The results of this questionnaire were analysed, and relevant data, graphs and observations are made in Chapter 3 and in Appendix A of this document.

Other Methods used to Determine Existing IT Infrastructure

Apart from the questionnaire, other methods such as interviews and individual discussion were used to determine the status of the existing OMF global IT infrastructure. These observations are recorded in Chapter 3 and Appendix E of this document.

3.3   Methods for Defining New Requirements

Interviews, discussions, and analysis of various proposed systems were carried out to determine new requirements for a global IT infrastructure. In particular an analysis was made of the OMF communication requirements.

Communication Requirements

The results of the Communication Requirements analysis are found in Appendix B of this document and are summarised in Chapter 3.

3.4   Gap Analysis

Once the existing IT infrastructure and new requirements for information technology within OMF are determined, a gap analysis could be made to determine areas of uncertainty that would need to be further investigated to provide information about these areas. By comparing the existing and new requirements for IT infrastructures in the various building block or components of the systems, one is able to determine gaps and uncertainties.

3.5   Method for Global Email Analysis

An important requirement of the OMF communication system was that it must be reliable and dependable.

Methodology for Testing

A series of tests were designed to provide a better understanding of the reliability of different email systems[27] to deliver email messages containing two different types of email attachments.

Email messages were sent to people within OMF, requesting them to respond accordingly. Subsequent messages would then be sent to them containing two different file attachments; the first a Microsoft Word document (.doc) file attachment, the second a Program (.exe) file attachment that could run on a Microsoft Windows 3.1 or 95 computer.

There were three tests:

- Test 1 (plain text message)
- Test 2 (MS Word.doc file attachment)
- Test 3 (Program.exe file attachment.

Test 2 and 3 consisted of two parts:

- part a - response: Could they open the file attachment?'
- part b - response: reply with file attachment

Expected outcome from tests:

- response from participant
- no response from participant
- receive error message or Notification of Delivery Failure

For a 'no response' outcome, the original message was resent, and if necessary, sent several times. No response meant that no delivery failure notification was received from any email system, and no message was received from the participant in response to the message sent. In such circumstances, one could still not be certain that the message was actually received by the recipient.

Success meant an email response had been received.

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[27] Email Systems, meaning the complete messaging system, including hardware, related software, and other infrastructure products that enables the delivery of messages.

Participants

Participants were selected people within OMF, working in different countries, most of whom used different Internet Service Providers for sending and receiving email. As many future users of the Candidate Processing System (CPS) as possible were included, to ensure that the OMF communication system could cope with the specific requirements of CPS.

The results and discussion of this analysis are found in Chapter 3 and Appendix C of this document.

3.6   Method for the Design of Global IT Infrastructure

The above email analysis provides the requirements for a global messaging system and subsequently its global IT infrastructure requirements. These, and other IT infrastructure requirements are then taken into consideration for the design of a global IT Infrastructure for OMF International.

Method for Approval and Implementation

The result of the above analysis and design is a target IT Infrastructure for OMF International, that must be accepted and approved by OMF leadership in different areas.

Development Trade-off: Schedule - Scope - Resources

As discussed earlier, trade-off decisions are often needed to be made in order to implement IT projects in one of three areas of IT management:

- Schedule
- Scope
- Resources

For example, for a project to be developed and deployed within a short timeframe in an organisation that has limited resources, the scope (or features) of the project must be constrained within reason.

Scope: Building Block Approach

Due to the size and complexity of the project, the implementation of OMF's global IT infrastructure is broken up into components or building blocks. For example, in an office environment, the installation of a computer network precedes the setting up of a new email system.

An information technology infrastructure is therefore built from building blocks, starting from foundational system components, then adding communication and application components.

Scheduling

Due to the nature of the organisation and lack of resources, sufficient time must be given to this phase of the development cycle. Some of the issues of implementation are discussed in Chapter 7.

Chapter 4

Global IT Infrastructure Needs Analysis

The results of a needs analysis of a global communication system and a global information technology (IT) infrastructure for OMF International, followed by a gap analysis and subsequent global email analysis are described and discussed in this chapter.

Additional information related to some of the observational work and analysis can be found in later appendices.

4.1   Results of Questionnaire

The following three questions were aimed at identifying the types of computers, operating systems, and applications in use within OMF.

What type of computer do you use? (Q1)
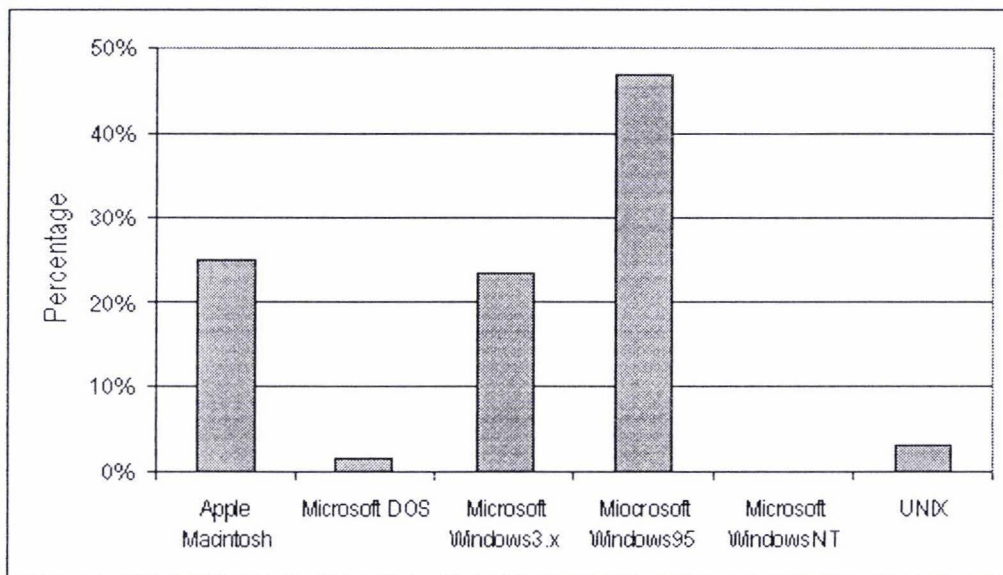
Figure 10:   Types of Computers used within OMF

The study found that predominantly Personal Computers (i.e. Microsoft DOS and Windows (72%)), were used within OMF, but Apple Macintosh (25%), and UNIX (3%) computers were also used.

Microsoft Windows 95 (47%) and Microsoft Windows 3.x (23%) operating systems were predominantly used on Personal Computers.

From previous data, it was observed that there was a trend toward an increase in the use of Microsoft Windows 95 and a decrease in the use of both DOS and Windows 3.x.

The ratio of Macintosh to PC computers was also expected to decrease in favour of PC computers, due to an OMF strategy to invest in PC/Win95 computers for all OMF Offices.

For what function(s) do you use a computer? (Q2)
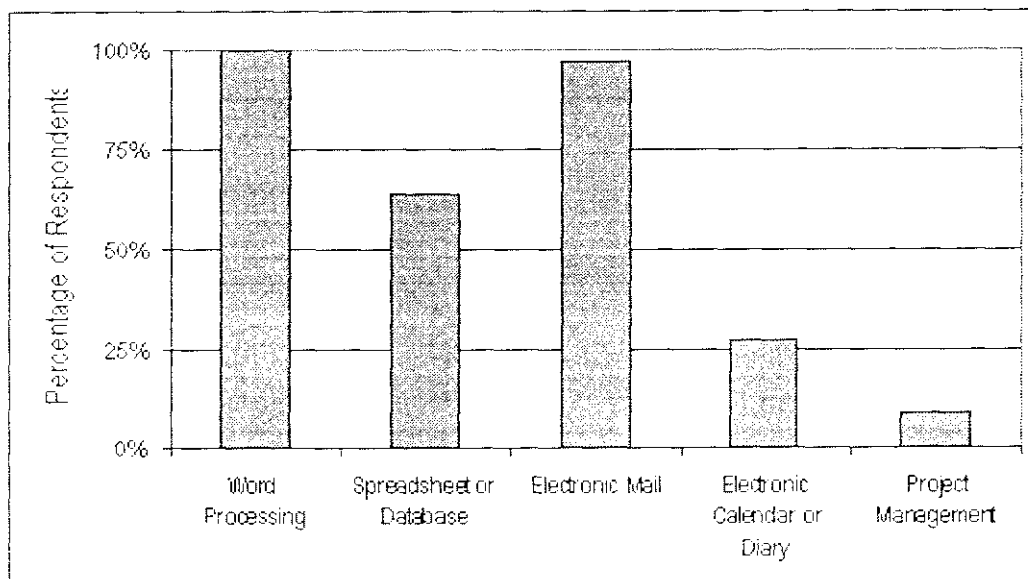
Figure 11:   Application of use of Computers within OMF

Word processing (100%), finance or database (64%) and electronic mail (97%) were the major applications used within OMF.

Fewer people used their computers to maintain an electronic calendar or diary (27%), or for project management (9%).

These results were similar to the results of the question on the importance of certain areas of computing, described later in this document[28].

The results showed that word-processing and email were the two primary applications used within OMF, followed by the use of spreadsheets or databases for maintaining financial and other information.

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[28] Refer to Figure 14

What email application do you use? (Q5)
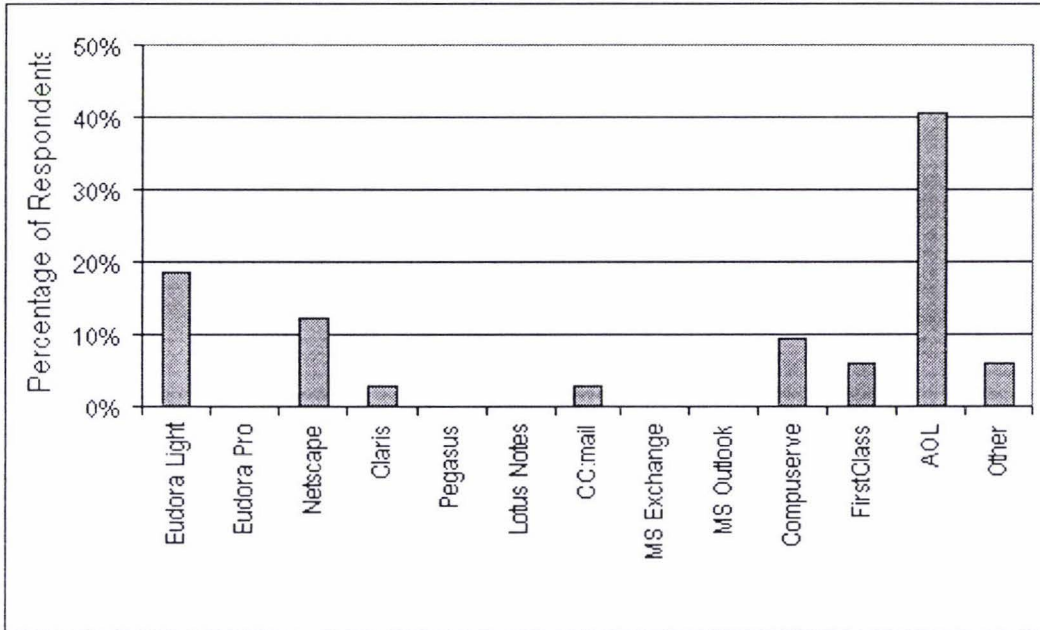
Figure 12:   Types of Email Applications used within OMF

The results of this question revealed that the email application most utilised by respondents was America On Line (AOL) (41%).

Significantly, a large number of different email applications were used within OMF. Not all of these email programs comply with open Internet mail standards, thus one would expect compatibility and interoperability problems when sending email attachments.

Have you ever received an email attachment, which looked like a long list of strange characters? (Q21a)

This question aimed at identifying how many people received encoded email messages which had not been decoded automatically by their email program, therefore providing an indication of the level of incompatibility between various email systems used within OMF.

If so, did you know what to do with it? (Q21b)

This question identified whether the user was able to decode an unencoded email attachment manually, which would require the person to understand the use of another application such as WinCode, or XferPro to decode such messages.
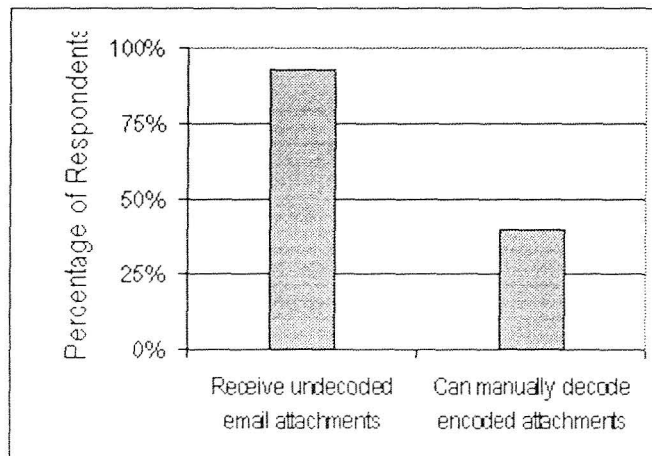
Figure 13:   Email Attachment Encoding Problems

The results of these two questions shown in figure 13, indicated that most (93%) of the respondents had at one time or another received an email message that had an undecoded attachment within the body of the message. For those who had received such a message, fewer than half (40%) were able to decode the attachment manually. This revealed that over half of the respondents had not received email attachments correctly.

Therefore, unless improvements were made to the OMF email system, email communication within OMF would be restricted to text only messaging. It was crucial that this issue be resolved in order for email messages with file attachments or with messages in other formats such as HTML[29] or Microsoft Rich Text to be sent.

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[29] HTML - HyperText Mark-up Language

How important are the following for you? (Q40)

The aim of this question was to provide some measure of importance of specific areas of electronic communication as considered by people within OMF. In order to compare the perceived importance of these areas, respondents were asked to give their responses on a scale of one to five; from not important to very important.
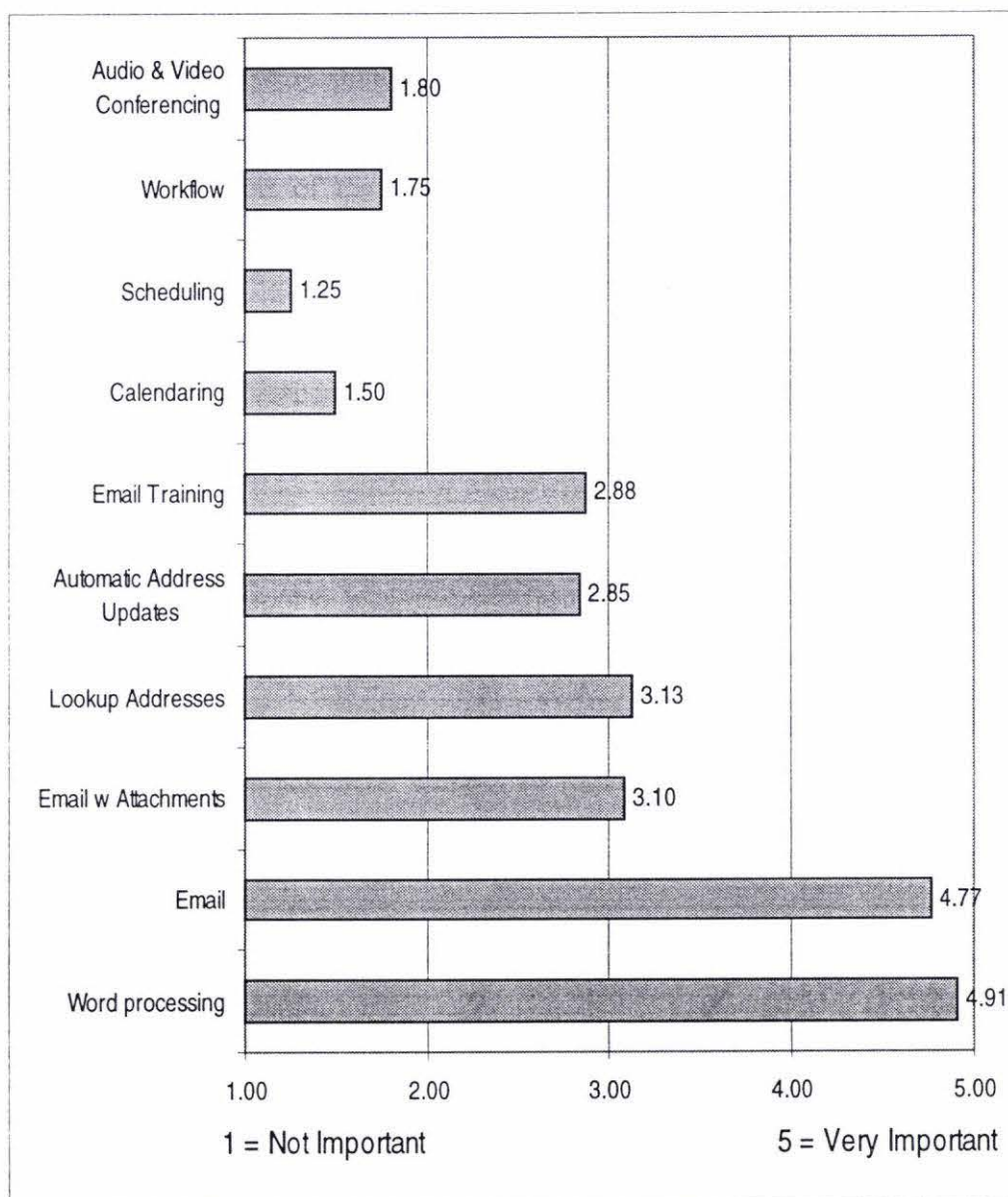
Figure 14:   Importance of Computer / Communications Functionality

Groupware type functionality such as scheduling, workflow, and calendaring, as well as audio and video conferencing, were

considered to be of low or no importance, whilst word-processing and email were considered very important.

Email training and the ability to look up or receive automatic email addresses of people within OMF, as well as the ability to send email attachments, were perceived to be of average importance.

Questionnaire Summary

Thirty-three respondents sent replies via email or post. Although people were required to read instructions which were clearly written at the start of the questionnaire, the following observations were made:

- Questions were misread or misunderstood.

- Some responses were partially completed.

- A single response was often given for where a number of people were concerned.

- No response was received from either the OMF United Kingdom (UK) office or the OMF United States (US) office.

The respondents, therefore, were largely a representation of those OMF members who worked in East Asia, and did not include the OMF US and OMF UK offices.

	OMF Office	OMF Remote	Public
Survey applies to:	?	✓	✗

4.2 Information Technology in OMF Offices

As mentioned earlier, 'The Way Forward for Computers' (Ellis, October 1995), provided recommendations and standards for OMF Office computers. If an OMF centre chose not to adopt these standards, it was their responsibility to ensure that they could communicate with others within OMF.

Although the standards for hardware and software for OMF Offices were known for approximately two years, most offices were not able to update their computer systems and software to meet standards, due to financial and human resource limitations. This was especially so in smaller OMF offices.

The following observations can be made about the IT Infrastructure in OMF Offices:

OMF Office Standards (Oct 1995)	OMF Office Observations (1997)
Hardware: Intel based PCs (ie 486, Pentium, Pentium Pro)	Mostly PCs either 486 or Pentium computers, some 386 computers. IHQ phasing out Macintosh.
Software: Microsoft products: DOS 6.22, Windows 3.1x or 95 Office Professional 4.3 or 95	Mostly Win95 and MS office 95 Some still on DOS, or Win 3.11 using MS Word version 2 or 6
Local Area Networks: Ethernet Windows NT	Larger offices have networks IHQ network unreliable Only UK has Windows NT server
Email: Currently basic text only. Recommendation CompuServe	Larger offices use Client/server Email systems (Exchange, Notes, and Firstclass email systems). All offices use CompuServe
Other software: Anti-virus software Data backup (make yet to be decided)	Very few offices have use anti-virus software or backup procedures.

It was observed that computer equipment within OMF was often dated; partly due to constraints in financial resources, but also because individuals and offices within OMF only upgraded their computer system as and when they could afford it.

A variety of modern and dated systems therefore are used by individuals and offices within OMF.

Language Software

OMF Offices in Asia and Europe need to develop and produce materials in various languages. Special software is required to be able to use a computer in a non-English language. Keyboards and pen-mouse tablets made for specific languages are used.

Language versions of Microsoft Office are available for romanised texts such as German, Dutch, French, Spanish and Italian, which work on standard[30] (single byte) Microsoft Windows 95/98 or Apple Macintosh operating system.

Non-romanised texts such as Chinese (Simplified and Traditional), Japanese, Thai, Kmer, and Korean require a double-byte environment found in the Apple Macintosh Operating System (OS 7.5 or better), but not in standard Microsoft Windows 95/98 operating system.

Generally, there are two types of language software available: a software enabler that works within an English wordprocessor; and a language specific operating system and application environment.

Because the Chinese and Japanese versions of Microsoft Windows 95 are entirely rewritten to be able to cope with double-byte characters, stability and compatibility with other types of software is an issue with language versions of software. These language versions are often released one to two years after the release of the International

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[30] Standard Microsoft Windows 95 / 98 meaning US and International versions.

version of the software. For example, the Chinese version of Windows 95 was not available until late 1997.

The above issues also need to be considered in the development of IT projects to be used within OMF.

Electronic Messaging

In 1993, there were fifty email addresses on the OMF email address list; approximately five percent of the people of this organisation. By 1996 this had grown to over three hundred email addresses, with current figures being over 800, or approximately eighty percent.
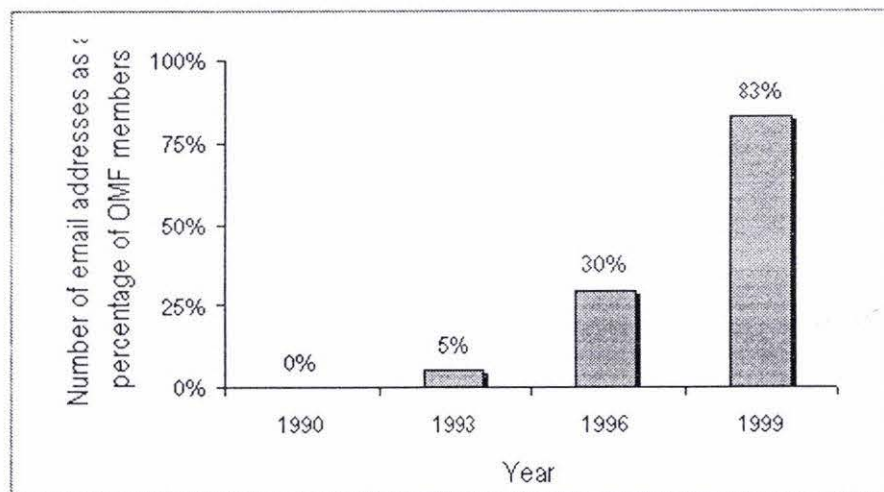
Figure 15: Growth of Email Addresses within OMF

The growth of email addresses in OMF is similar to the growth of the Internet[31]. (Nua Internet Survey, 1998).

OMF Office Email Systems, US, UK, IHQ

Since 1994, inter-office and member to office communications using electronic mail has increased dramatically. Some of the OMF offices set up their own email system, which also provided workgroup functionality. This meant people within the office could send

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[31] http://www.nw.com/zone/hosts.gif

electronic notices to each other or to groups of people within the office, and information could be organised in folders or databases using a proprietary client. It is perhaps unfortunate that three different email systems were implemented during 1994 and 1995, in three of OMF's larger offices:

1. A single SoftArc *FirstClass*[32] was implemented in the building that accommodates both OMF International Headquarters (IHQ) and Singapore National Office (SNO).

2. Lotus *Notes*[33] was implemented in the United States (US) office, (initially included OMF Canada (CA) Office).

3. Microsoft *Exchange*[34] was implemented in the United Kingdom (UK) office.

All three systems are based on client-server technology that differs from Open Standard Internet Mail[35].

OMF Canada Office Email System

During 1996, the OMF Canada (CA) office changed from using Lotus Notes to an Open Standard Internet Mail system, due to problems connecting to the OMF US office Notes server for their email. The @omf.ca domain and email are hosted by a Canadian Internet Service Provider. The office then used a local mailserver program called *FTgate* to send and receive office email.

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[32] SoftArc's FirstClass Client/Server application uses IPX network protocols and is available for both Apple Macintosh and Windows 3.x/95 computers.

[33] Lotus Notes Client/Server application uses Remote Procedure Call protocols (RPC) in TCP/IP, NetBEUI or AppleTalk network environment.

[34] Microsoft Exchange Client/Server application uses Microsoft Application Interface Protocols (MAPI) and NetBEUI network environment.

[35] Internet Mail is based on Post Office Protocol (POP), Simple Mail Transfer Protocol (SMTP) and Internet Mail Application Protocol (IMAP).

Other Email Systems in Use

Since these office email systems were only available within the office, individuals and smaller OMF offices needed to use other email systems.

During the early 90s, CompuServe and America On-Line (AOL) provided extensive international dial-up services from various countries in the world, and were commonly used. Since 1994, the growth and availability of Internet Service Providers (ISPs) has meant that many people choose to use ISPs in their country of work.

Smaller OMF offices used CompuServe and shared the use of a single account, due to financial constraints. This required a complex arrangement of shared folders and dial-up configuration.

IT Issues and Limitations within OMF

From these and other observations, it was found that a global IT Infrastructure for OMF must be able to cope with:

- Language software and double-byte character sets
- Lack of Internet access during working hours
- Different computer system software and hardware
- Lack of financial resources
- Lack of computer support
- Lack of IT training

Other observations about existing IT infrastructures and the use of information technology within OMF are documented in Appendix E.

4.3   New Requirements

Newer Technology has greater IT requirements

Although business processes may remain stable in an organisation, changes in Information Technology bring about new IT requirements. For example, a new release of Microsoft Windows operating system or Microsoft Office application may have greater hardware requirements (i.e. Random Access Memory (RAM) and free hard disk space) than previous versions of the software.

IT Projects

OMF Communications Review / Projects - (1996)

During 1995-1996, a review was made of OMF internal (or business) communication. As a result of this review, several IT projects were planned to be developed and implemented. These projects were to be based on a communications infrastructure including an IT Infrastructure as shown in the diagram below.
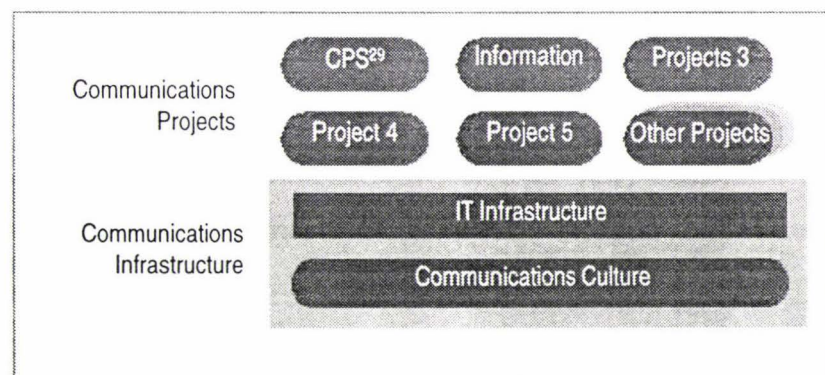
Figure 16:   ICR Project Framework

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[36] CPS - Candidate Processing System

Communications Infrastructure Project

The *Communications Infrastructure* project was broadly describes as: "The communications infrastructure [that] will establish the foundation for all of OMF's internal communications. It will deal with all types of communication, whether electronic or physical. It will create a framework for sharing information, discussion and workflow.

The *Communications Culture* will deal with the human side of the system. It will deal with the *why*, the *when*, and the *who* of our communications. It will establish strategies, policies and standards, and define responsibilities. It will provide guidelines and training to make the change in OMF's communications culture as smooth as possible.

The *IT Infrastructure* will provide a technological foundation for all of the Internal Communications System's information management needs." (Beauchamp, 1996)

Candidate Processing System (CPS) Project

The Candidate Processing System (CPS) project was to develop a system that would allow the distribution of up-to-date information on work opportunities in East Asia, as well improve OMF's candidate application processes.

The IT requirements for this project were quite specific in that the users of the CPS system were required to have a computer with Microsoft Windows 95, Office 97 professional and Microsoft Outlook installed. Email messages containing Microsoft Outlook Forms that have been custom programmed using Microsoft Visual Basic Script (VB Script) were to be sent within OMF offices and individuals. This required a global messaging system that ensured the delivery of email

messages containing Microsoft Outlook Form[37] information. Since earlier investigation showed that there were problems sending email with file attachments within OMF, this issue needed to be addressed.

During the initial requirements analysis, it was intended that CPS also utilise replication capabilities in Microsoft Exchange Server and Microsoft Outlook (Exchange Client) to synchronise information between off-line (client) folders and Exchange (server) Public Folders via an Internet connection.[38]. It was not fully understood whether such functionality, available only when using Microsoft Exchange Client/Server environment, was necessary for the CPS project.

Other CPS IT Infrastructure requirements were recorded and are listed in the requirement analysis described in Appendix B of this document.

OMF Information Project

The *OMF Information* project is described as "an OMF information network or "Intranet"...that is organised, indexed, categorised, accurate, up-to-date, on-line, and easily accessible [via the Internet] regardless of location". (Beauchamp, 1996)

Beauchamp developed a working example of an OMF Intranet using Microsoft Windows NT Server, Microsoft Internet Information Server (IIS), Microsoft Access and Microsoft Internet Database Connector (IDC). Although this example was not connected to the Internet, and did not use any authentication mechanism, it demonstrated that OMF Information could be accessed using a ubiquitous web browser. It also demonstrated the ability to query information that was stored in a database, using a web browser.

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[37] MS Outlook form messaging uses MIME X-Microsoft extensions and Microsoft Application Programming Interface (MAPI) commands.

[38] To use Microsoft Exchange Client/Server via an Internet connection, a Microsoft Virtual Private Network (VPN) connection that uses Point-to-Point Tunnel Protocol (PPTP) in addition to an Internet (TCP/IP) connection is required.

There was therefore, a requirement for a Microsoft NT server to have a permanent Internet connection so that it would be globally accessible via the Internet. In addition, OMFers who wanted access to the server would require authentication, preferably using better and more secure digital methods in addition to using just usercode and password methods.

General Communication Requirements

Resulting from interviews, questionnaires, and observations from other sections and departments within OMF regarding their needs for communication within OMF, a list of requirements was compiled and prioritised. This was then categorised into four sections: email, directory, discussion, and information; each section having subcategories: security, usability (ease of use), compliancy (with open industry standards), functionality, and management (expectation, regulation, or code of practice).

For completeness and correctness, the results of the needs analysis were presented to OMF leadership and directors for comments or changes. The resulting list of computer communication within OMF can be found in Appendix B of this document.

Summary of New IT Infrastructure Requirements

Below is a summary of OMF's most critical needs for an,

OMF Email system that:

- is compliant with Internet Mail standards
- can cope with MIME and Microsoft Outlook Form attachments
- is highly reliable, dependable, and available at all times
- supports Microsoft Exchange client/server environment

Email

OMF Directory that:

- is an email address list of names, functions and email addresses
- can be used by Microsoft Outlook and Outlook Express
- is available in a variety of formats on request by email or web
- is updated and kept up-to-date

Directory

OMF Discussion / Mailing Lists that:

- allow individuals to subscribe to and withdraw from mailing lists
- provide appropriate policy settings for subscription and messaging, to be applied to specific mailing lists

Discussion

OMF Information / Web and FTP services that:

- can authenticate and access control for OMF members
- are available via the Internet at all times

Information

Building Block Approach to Design

As shown above, each puzzle piece symbolises one of four parts of a communication system. Each part has it own IT Infrastructure requirements, but is part of an overall communication system. Like pieces of a puzzle, each piece or solution is a part of the total solution.

A building block approach to design therefore, implies that appropriate solutions are sought for specific areas in question, in consideration of overall system requirements.

4.4 Gap Analysis

The comparison of existing IT infrastructure and new requirements for IT Infrastructure is shown below. The aim of this gap analysis is to identify areas requiring upgrading, and highlight uncertainties.

Requirements	OMF IHQ	OMF Office	OMF Remote
Computer Hardware / Software			
Intel based PC - Pentium 90 or better	✔ - some	✔ - some	✔ - some
Microsoft Office 97	✔ - upgrades	✔ - upgrades	✔ - upgrades
Microsoft Outlook 97/98	✔ - required	✔ - required	✔ - required
Local Area Networks:			
Twisted Pair Cabling - CAT5	✖ - req. switch	✔ - some req.	Not needed
10/100baseT Hubs & Switch	hubs, cabling[39]	cabling & hubs	
Networking:			
Windows 95 Peer-to-Peer Networking	✔	✔ - some req.	Not needed
Print Server:			
Windows 95 print sharing	✔	✔ - some req.	Not needed
File Server:			
Windows 95 file sharing	✔	✔ - some req.	Not needed
Internet Mail Compliant Email			
Microsoft Outlook or Outlook Express	✖ - required[40]	✖ - required[41]	✖ - required[42]
Internet Access			
Modem & Local ISP Dial-up Account	✔ - required	✔ - some req	✔ - some req
Reliable Internet Access - availability		uncertain	uncertain
Reliable Internet Access - connectivity		uncertain	uncertain
OMF Global Messaging System			
Ensure delivery of email	uncertain	uncertain	Uncertain
Copes with MIME	uncertain	uncertain	uncertain
Copes with Microsoft Outlook Forms	uncertain	uncertain	uncertain
Supports Microsoft Exchange Client[43]	uncertain	uncertain	uncertain
IHQ Information "Intranet" System			
Permanent Internet Connection	✖ - required[44]	Not needed	Not needed
Reliable Internet Access - availability	uncertain		
Reliable Internet Access - connectivity	uncertain		
Reliable Internet Access - domain name	uncertain		
Firewall that supports PPTP	✖ - required[45]		
System Protection - power, backup	✖ - required		

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[39] IHQ Network cabling required to be replaced with redesigned topology

[40] IHQ FirstClass Email system to be replaced

[41] OMF Offices Email - most used CompuServe or Other System

[42] OMF Remote Email - a variety of different email programs & systems used

[43] To be able to use Microsoft Exchange Client via an Internet connection, a Microsoft Virtual Private Network (VPN) connection using Point-to-Point Tunneling Protocol (PPTP) to a Microsoft Windows NT Server hosting the Microsoft Exchange Server is required.

[44] Suitable Leased Line or ISDN (non-dial-up) connection, modem and Router required

[45] See note 29

Explanation of Terms

	Meaning
✓ .	Item already present
✓ - some req.	Item required, currently some present
✖ - required	Item required, currently not present
uncertain	Uncertain about exact details or understanding regarding requirement or item
Not needed	As stated, Item not required.

4.5   Questions of Uncertainty

The above analysis highlighted two main interrelated areas of uncertainty needing investigation:

- Internet Access Reliability
- Global Messaging System

OMF's global messaging system is dependent on the Internet to provide the transportation of messages.

The design of a global messaging system should therefore operate within the limitations of the Internet. This means that one must have a good understanding of the limitations of the Internet.

Reliable Internet Access - (availability)

For OMFers to be able to access the Internet to send and receive email, the Internet Service Provider (ISP) must be available at times that are acceptable to the user. However, when an ISP is oversubscribed beyond the capacity of its dial-in lines, its availability for users to dial-in is reduced. This is especially noticeable during busy periods when many people wish to connect to the Internet. There is an uncertainty therefore, regarding the availability of Internet Access.

Reliable Internet Access - (connection / performance)

The Internet has limitations such as unpredictable latency, response times and capacity, and suffers from dropped packets[46]. One cannot be certain therefore, about the reliability of the Internet in terms of its ability to transfer information between systems and computers connected to the Internet.

Previous work on the Analysis of the Internet and Wide Area Networks

According to Higginbottom (1998), the analysis of Wide Area Networks (WAN) is more complex than for Local Area Networks (LAN). Since the number of elements in a LANs it known, it is possible to develop a quantitative methods for the analysis of such network. However, WANs involves communication over greater distances and between larger number of elements. Hence additional mechanisms are required, such as switching and routing, and these should be allowed for. The result is that a large number of system variables may be realised, and one has to either make general assumptions or consider the constituent parts of the whole system. Beyond basic calculations of the capacity, in terms of the properties of useful bandwidth occupied, most works on the subject are presented as qualitative discussions and simulations. Given a number of basic properties for specific designs and knowledge of the variety of algorithms, it is usually possible to provide an informed opinion.

The implication of this is that it is not feasible to conduct a quantitative analysis of the Infrastructure of the Internet or other such tests that accurately determine the responsiveness of the Internet.

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[46] Packets are sent when transmitting data over a TCP/IP network or Internet.

ISP Ranking - Lab Tests by Internet Magazines

There are however, a number of magazines whose focus is to provide its readers useful information about the quality of various ISPs in the country where the magazine is marketed. These consumer-oriented magazines periodically conduct surveys and tests of the service, availability, and speed of various ISPs. The results from these tests are used to rank ISPs.

Internet Magazine[47] (UK) for example, periodically tests the quality (availability) and speed (time to download a number of web sites located in various parts the world) of ISPs in Britain. The results of its December 1998 'Provider Lab Tests' indicated that ISPs in Britain had an average availability rate of more than ninety percent, and an average performance rate (speed) of less than thirty seconds to download a web site[48].

Observations from Published Works

Conclusive results provided by a number of such magazines show that it would be possible to download the contents of a web site (or page) from almost anywhere in the world on the Internet, and that the availability rate of most ISP in Britain, Singapore, and United States was very good.

None of these magazines however, sought to test the performance and reliability of email services, excepting for size of mail storage and number of email addresses permissible for a single account.

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[47] Details of how Internet Magazine performs such tests can be found at
http://www.internet-magazine.com/isp/tests/

[48] A typical web site (or page) contained less than eighty kilobytes of data.

Remaining Uncertainties

The results of the OMF Email Questionnaire,[49] showed that over half of the respondents could not receive email attachments correctly. The results also indicated that Internet Mail compliant email systems could cope better with email attachments than proprietary client-server email systems.

No published material could be found that reported the results of an investigation of an ISP's reliability and performance to deliver electronic mail of different formats and content. Further investigation was therefore required, in order to understand fully the nature of the problem of sending email attachments in a heterogeneous email system.

4.6   Results of Global Email Attachment Tests

Below are the results of a series of tests that aimed to provide a better understanding of the reliability of sending email messages between two different email systems.

Eighty-eight email messages were sent in Test 1 to people within OMF, working in a total of twelve different countries. Twenty-seven different Internet Service Providers (ISPs) were involved in this test. Further details of the ISPs and countries can are found in Appendix C.

Number of Countries Involved	Number of ISPs Involved	Number of Participants Involved
12	27	88

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[49] Refer to Chapter 3 and Appendix A

Number of Participants Involved in each Test

It was found that fewer participants responded as testing progressed. The number of messages sent, and responses received for each test are shown in the diagram below.
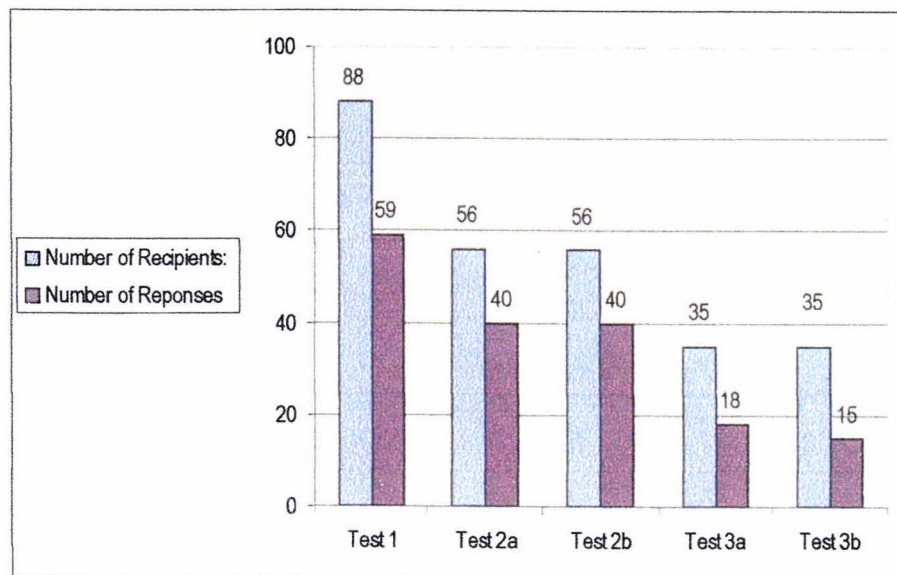
Figure 17:   Number of Messages Sent and Responses Received

In Test 1 eighty-eight plain text email messages were sent, and fifty-nine responses were received.

In Test 2a and 2b, fifty-six email messages containing an MS Word (.doc) file attachments were sent, and forty participants responded.

In Test 3a and 3b, thirty-five email messages containing a program (.exe) file attachment were sent, eighteen participants responded to part 3a and fifteen participants responded to part 3b.

Four response conditions were possible:
- pass   - participant responded with 'OK'
- fail   - participant responded with 'NO'
- fail   - received Notification of Delivery Failure (NDF)
- no response - no reply or NDF received

The results are summarised in figure 18, whilst details of responses received from tests can be found in Appendix C.

As shown in figure 18, a significant number of email messages had delivery failure.

	Test 1	Test 2a	Test 2b	Test 3a	Test 3b
☐ No Response	27	12	17	12	17
■ Fail	2	9	12	5	3
☐ Pass	59	36	28	18	15
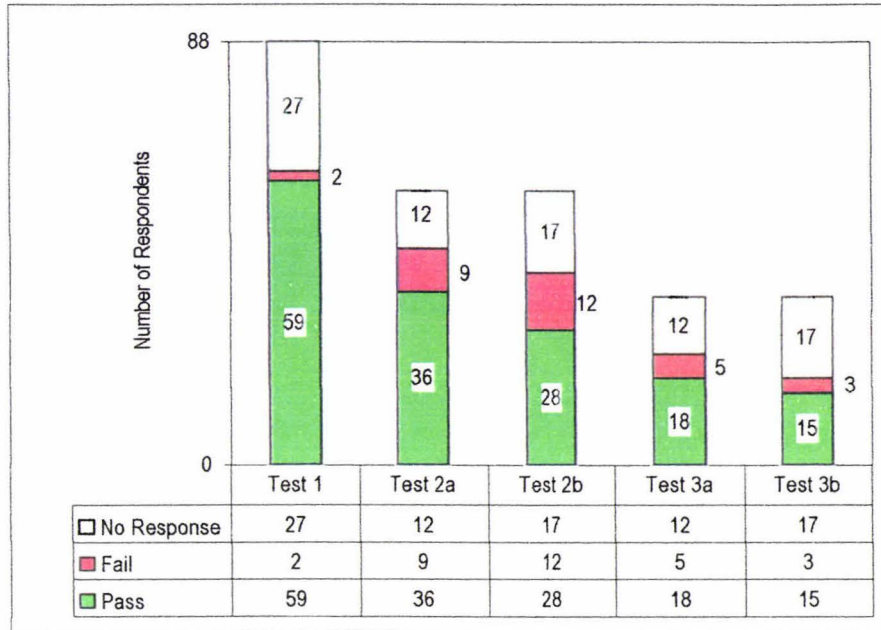
Figure 18:   Results of Email Tests in Number of Respondents

As shown below, sixty-three percent (63%) of participant responded that they could successfully open a Microsoft Word file attachment, but only fifty one percent (51%) were able to open a program (.exe) file attachment.

	Test 2a	Test 2b	Test 3a	Test 3b
☐ No Response	21%	30%	34%	49%
■ Fail	16%	21%	14%	9%
☐ Pass	63%	49%	51%	43%
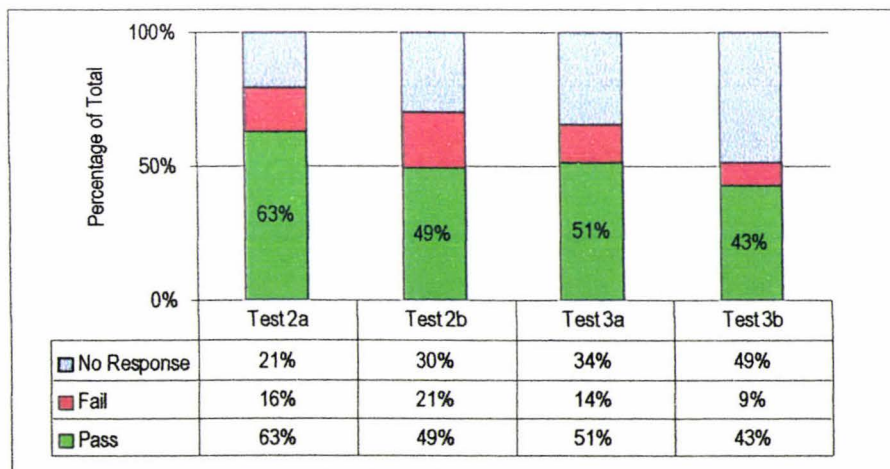
Figure 19:   Success Rate of Email Attachments Received

Conclusion of Email Attachment Tests

The results conclusively showed that email messages were not always delivered when using email systems from different ISPs. Email messages with file attachment had even less likelihood of being delivered successfully.

Delivery failure occurred for the following reasons:

- Computers store information in 8-bit bytes, but the email gateways (or mail servers) through which email often passes transmit information in 7-bit bytes. The various standards offer different ways to convert back and forth between 8-bit and 7-bit streams of information. Email programs and systems use different encoding methods to transfer email. Uuencode, Binhex or MIME[50]. Incompatibility meant attachments were received as encoded text within the body of message.

- Mail transfer between SMTP servers was not reliable or had too many hops, causing the email message to be returned to sender with Notification of Delivery Failure.

- The recipient's email address domain name (i.e. the part after the '@') was not found, causing the email message to be returned to sender with Notification of Delivery Failure.
  This was either due to problems with the Domain Name Server (DNS) involved, or that the server responsible for the recipient's domain was disconnected from the Internet for a period of time.

- CompuServe email system proved incompatible, with attachments often lost or corrupted.

- Participants did not understand instructions.

The results also showed that OMF Office systems need to comply with POP3/SMTP and MIME standards, to be able to receive email attachments correctly from other Internet standards compliant email systems.

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[50] MIME - Multipurpose Internet Mail Extension

Chapter 5

Design of a

Global IT Infrastructure

The above analysis has provided a better understanding of OMF's needs for a reliable and dependable global messaging system. The OMF Messaging System, therefore, needed to be designed to overcome or avoid these causes of delivery failure.

With the exception of the three larger OMF Office[51] email systems, and CompuServe email system, email communication within OMF is largely based on Internet Standard SMTP/POP3 protocols provided by ISPs in various countries.

Essentials of Internet Standard Email

To be able to connect to the Internet one needs:

- A computer with a modem and email software
- A telephone connection
- An Internet Server Provider (ISP) account

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[51] OMF US, UK and IHQ/SG had client/server email systems.

Email programs such as Eudora or Microsoft Outlook send and receive email messages as follows:

i) The computer uses the telephone number to make a local telephone call to the ISP

ii) It then uses the ISP account name and password, so that ISP charges will be made to the correct account

iii) The computer is now connected to the Internet

iv) The email program then sends email to the SMTP server of the local ISP and receives any new messages that have been collected in the mailbox on the local ISP's mail server

v) The computer disconnects from the Internet

vi) The user can read his/her email messages and prepare new messages whilst disconnected from the Internet

Figure 20 shows how an email program on a Personal Computer (PC):

1. uses Post Office Protocol (POP) to communicate with a mail server to check for, and retrieve any new email messages

2. uses Simple Mail Transport Protocol (SMTP) to send email messages that have been prepared and are ready to be sent.

Once a mail server or Mail Transfer Agent (MTA) has received an email message that is intended to go to another (recipient) mail server, the (sending) mailserver:

3. uses SMTP to communicate with other mail servers to transfer the email message.

It is possible that several MTAs are involved before an email messages reaches its recipient mail server and mailbox.
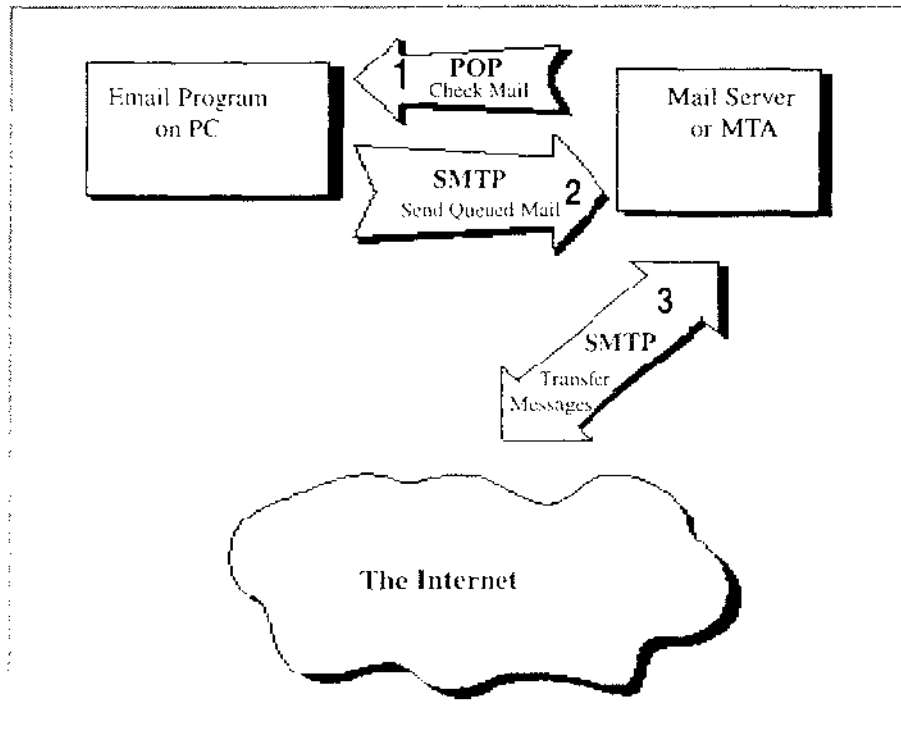
Figure 20:   How Internet Standard Email Works

A more detailed explanation of how email is sent can be found in Appendix D, (Email Explained).

Internet as Communications Network for OMF

By observation, it was found that telephones and Internet Service Providers were available in most areas where OMFers worked. Most people within OMF who had local ISP accounts reported that availability and reliability of Internet connections was acceptable. It seems reasonable therefore, that the Internet be the communications network that links all OMF email systems, and other email systems on the Internet.

5.1   Global Messaging System for OMF

If all email systems were compatible and compliant with Internet Standards, one would not expect any problems sending and receiving messages with file attachments.

Within OMF however, there are many different email systems in use. The Email Attachment tests showed that some messages had become corrupted during transmission between mail systems, or were never delivered due to unreliability or incompatibility of mail systems.

This meant that one could not guarantee the reliability and integrity of various email systems to deliver email messages to other email systems. This issue needed to be resolved.

Email Client Compatibility

For any two systems to be able to transfer email attachments, both the SMTP mail server (also known as a Mail Transfer Agent (MTA)) and email program must be compatible. An analysis was therefore made of the encoding methods used by email programs, details of which may be found in Appendix D, (Email Explained).

It was found that Multipurpose Internet Mail Extension (MIME) encoding is supported by most email programs, and was also better suited for the transmission of various types of file attachments.

OMF Standard for Email Systems

In order to make various OMF email systems compatible, recommendations were made to standardise the use of email programs within OMF to Microsoft Outlook 98 (internet version) or Microsoft Outlook Express (as installed with Internet Explorer 4.01).

IHQ as Messaging Hub for OMF

Although standardising an email client software may resolve the problem of different encoding methods used within OMF for sending

email, it does not deal with unreliability problems incurred when using many different mailservers within OMF.

One method of overcoming the problem of reducing the number of mailservers involved was for OMF to provide a globally accessible POP/SMTP mail server for its entire organisation.

Since the existing OMF IHQ SoftArc[52] FirstClass email system was not compliant with Internet Standards and the fact that OMF's headquarters relate to all OMFers, it was appropriate that the global messaging system for OMF be implemented at IHQ, Singapore.

Other OMF Offices that have email servers needed to ensure that their systems were compliant with Internet Standards and available at all times, to ensure delivery of email between IHQ and themselves.

@omf.net Domain Name

The domain name of a company or organisation usually contains the identity and nature of business. For example, the domain name for Microsoft is **microsoft.com** An International non-profit organisation or one based in the U.S. would normally be allocated a *.org* domain name.

Since the OMF US office had already registered and implemented the *omf.org* domain name so that email sent to @omf.org was delivered to its office mail server, it was decided that the *omf.net* domain name be registered for OMF International. This meant that *@omf.net* email addresses could be given to all OMFers.

The Domain Name Server (DNS)[53] in the U.S. responsible for the *omf.net* domain, provides authoritative address resolution. When a computer wants to make a connection via the Internet to the IHQ server using the *omf.net* domain name, this DNS server provides the

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[52] For more information on SoftArc products refer to http://www.softarc.com
[53] For more information on DNS refer to *DNS and BIND* (Albitz, 1997)

correct Internet Protocol (IP) Address for the server.   The DNS service has proved to be reliable.

@omf.net Addressing Schema

The IHQ communication system is intended for the 'OMF Network of People'[54].   Every person included in this group is entitled to an @omf.net email address, and will be provided with an email address on application, in the form of *LastnameFirstname@omf.net*

Those in administrative or leadership roles will be provided functional email addresses in the form of *field-function@omf.net*

IHQ Internet Connection

Since there is a need to provide a globally accessible communication system at all times, an analysis was made of various types and costs of permanent Internet connections available in Singapore.   From the results of this analysis, it was determined that a Leased Line telecommunications connection to Singapore Telecom (SingTEL / SingNET) a first-tier[55] Singapore ISP, was suitable.

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[54] See Section 3.1

[55] As a second-tier ISP has its Internet connection provided by a first-tier ISP, and is dependent on the upstream provider. The reliability and service of a second-tier ISP can be much poorer, depending on the bandwidth to its first-tier ISP and the number of other local connections the first-tier ISP must service.

The OMF IHQ Leased Line connection to the ISP and onward connection onto the Internet is shown in figure 21:
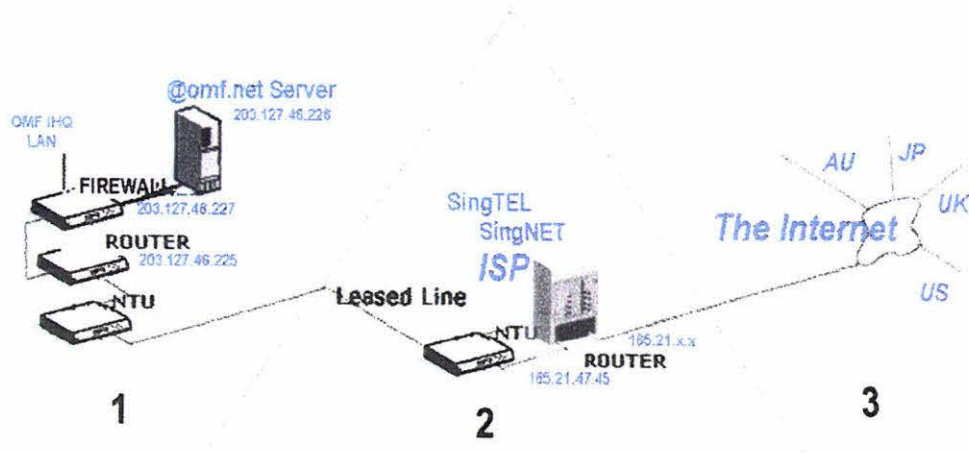
Figure 21: IHQ Internet Connection

As shown above, Leased Line technology requires that a dedicated telecommunications cable be installed and connected at both ends to a network termination unit (NTU). (i.e. The NTU at (1) the OMF office is directly connected to an NTU at (2) SingTel / SingNET with a permanent telecommunications cable). Each NTU is then connected to a router using a (serial) cable.

In this way, the OMF IHQ network (1) is connected to the global internetwork of computers, routers and telecommunication systems known as the Internet (3). Therefore, users of the IHQ (@omf.net) communications system were able to gain access via the Internet.

The Internet connection between the IHQ server and the Internet in other parts of the world was tested using a "PING" test. The response times between the IHQ system (1) and SingNET systems (2) was approximately 30milliseconds. The response times between the IHQ system (1) and other Internet systems around the world (3) ranged from 200 to 1400milliseconds. Such figures were considered adequate for email and web use.

IHQ Firewall

There are risks associated with connecting a communication systems to a publicly accessible network (i.e. the Internet). These risks and issues relating to internet security are well-researched and documented in a number of references[56]. Most of these references recommend that a system accessible from the Internet have adequate security methods and systems that reduce or illuminate these risks. (Diffie, 1998, Schneier, 1997, Stein, 1997, Cheswick, 1994).

Following are some of the requirements for a Firewall that enforces access control policies between networks[57]:

- Application level firewall
- Allow only permissible communication protocols to access certain computers
- Provide defence system against Denial of Service attacks and other Internet Security risks associated with on-line systems
- Network Address Translation (NAT) [58]
- Support Microsoft Virtual Private networking (VPN), MS Point-to-Point Tunnel Protocol (PPTP) and NT authentication services

An analysis was made of the types and costs of firewall systems[59], resulting in WatchGuard Technologies Firebox Security System[60] being selected.

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[56] More information on Internet security is available ISCA's on-line library of white papers and articles at: http://www.icsa.net/library/

[57] A Frequently Asked Questions (FAQ) relating to firewalls edited by Marcus Ranum and matt Curtin can be found at http://www.clark.net/pub/mjr/pubs/fwfaq/

[58] Network Address Translation (NAT) - IP Masquerading can hide internal IP addresses from the external network. This adds another optional level of firewall protection by enabling one legal Internet IP address to serve as the gateway for all outbound traffic from the internal network. Return connections are re-mapped by the Firebox to the correct client machine based on port number.

[59] More information of various Firewalls and results of Data.Com Firewall lab test are available http://www.data.com/lab_tests/firewalls97_stats.html

[60] More information on WatchGuard Technologies products are available from: http://www.watchguard.com

As shown in the diagram below[61], the firewall provides a separation between the Internet, Local Areas Network (LAN) and the OMF communications server.
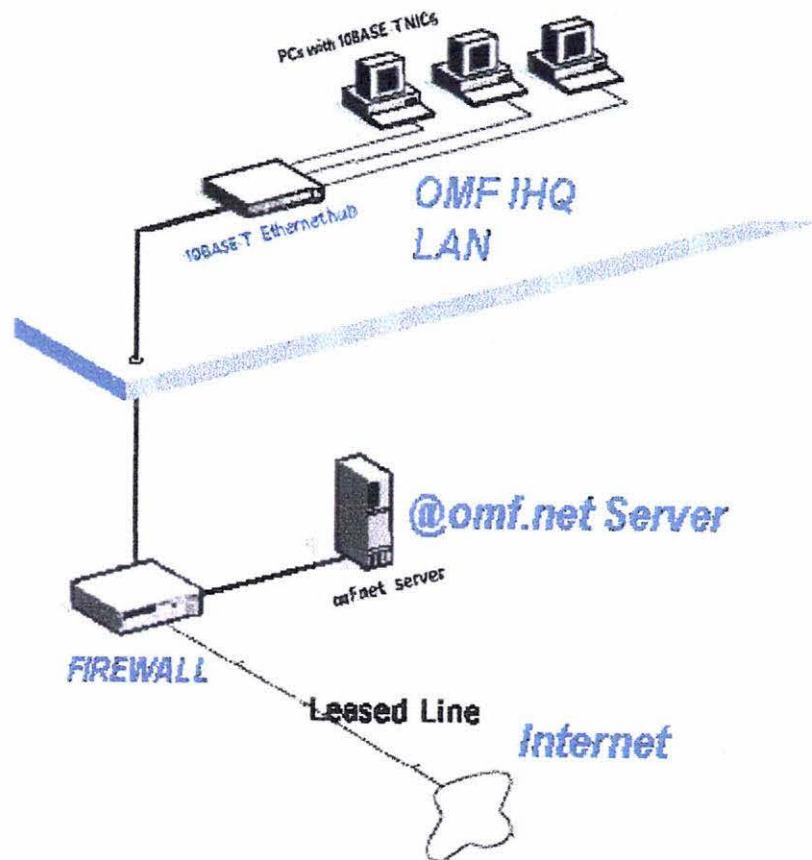
Figure 22:   Firewall Connections

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[61] For convenience and better understanding, NTU, routers, switch and hubs have been omitted.

IHQ Server

The following were some of the hardware and software requirements for the IHQ server:

- Highly reliable Windows NT Server hardware
- Intel Pentium II processor computer with 128MB RAM
- Backup media unit
- Microsoft Windows NT Server v4.0, Exchange Server v5.5
- Cheyenne ArcServe Backup and Disaster Recovery Software

The server is required to provide the following services:

- Microsoft Windows NT User accounts
- POP3 / SMTP Internet Mail services
- Domain Name Server (for local use)
- File Transfer Protocol and Web services
- LDAP Directory services

A Hewlett Packard NetServer series server was chosen based on a cost and service analysis. The implementation of the server and its software is discussed later in this document[62].

IHQ LAN Infrastructure

In order to comply with Ethernet standards for 10baseT[63] and 100baseT[64], the Local Area Network (LAN) cabling[65] and switching needed to be replaced.

An analysis was made of the network requirements and switching technologies. The installation of cabling and hubs were planned over two phases, as financial resources permitted.

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[62] Refer section 3.9 (Discussion).
[63] 10baseT - Ethernet using 10megabits per second, twisted pair cabling
[64] 100baseT - Ethernet using 100megabits per second, twisted pair cabling
[65] Both 10baseT and 100baseT requires cabling that complies with Category 5 twisted pair (shielded) network cabling.

The topology and structure of the OMF IHQ network is shown in figure 23.
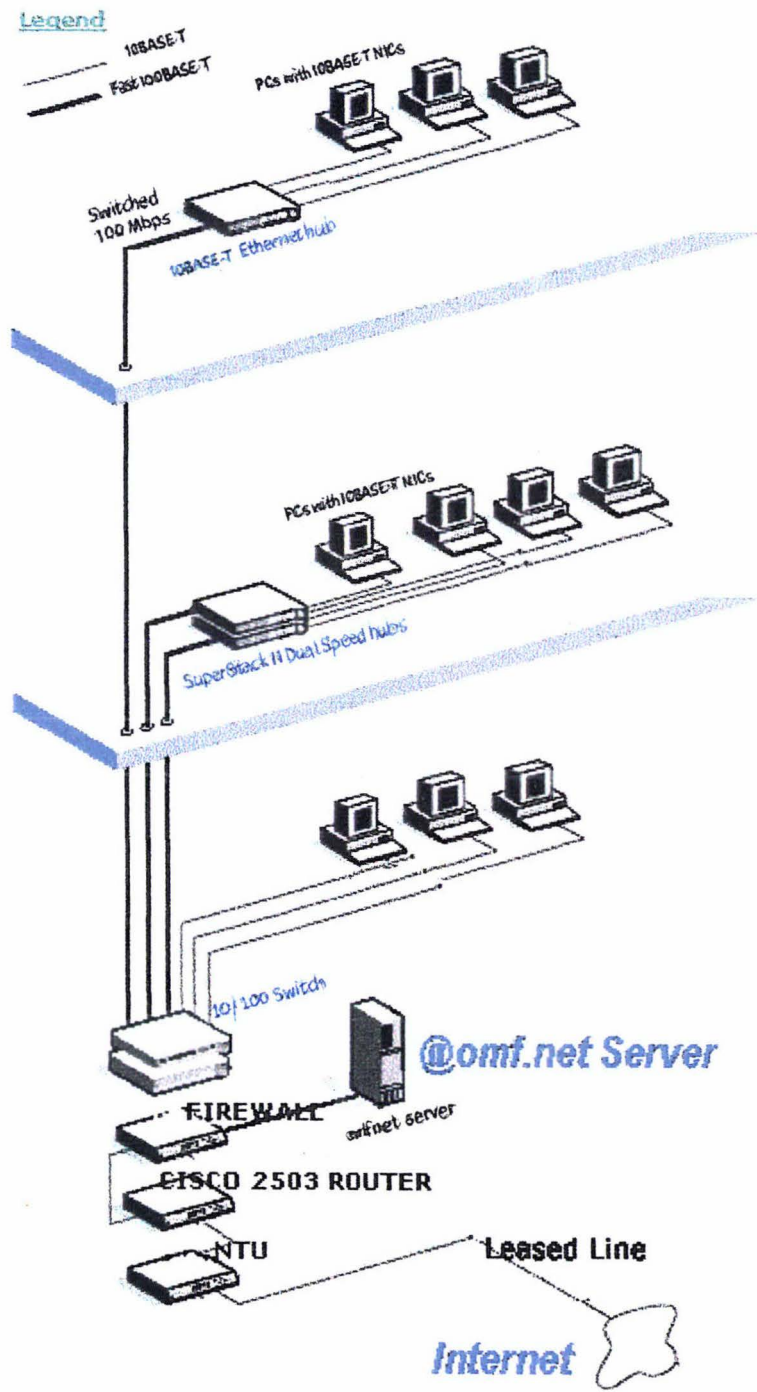
Figure 23:   OMF IHQ Network

5.2 OMF Remote Users

The @omf.net email system is to be a communication system that is globally accessible via the Internet.

As mentioned earlier, for someone to access the Internet they are required to have: a computer with modem and suitable software installed, a telephone connection, and an Internet Service Provider (ISP) account.

As shown in the diagram below, for an OMF remote user to access the @omf.net email system via the Internet, they must have configured their computer's:

- Dial-up network settings with their local ISP Internet Dial-up details: phone number, usercode, and password.

- Email program with their @omf.net mailbox account details: account name, password, and address of the @omf.net POP and SMTP server.
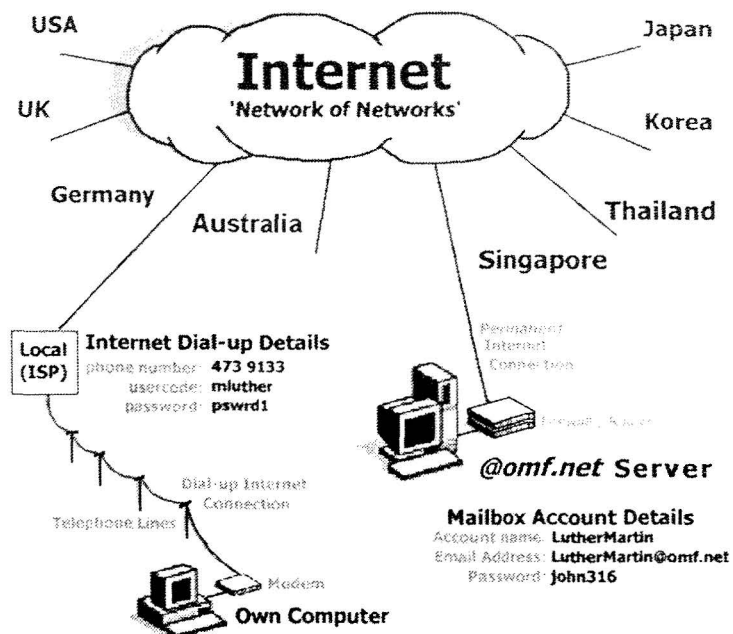
Figure 24:   OMF Remote User

Email Program

The recommended email program for use within OMF was Microsoft Outlook 98 (Internet version) or Microsoft Outlook Express (as installed with Internet Explorer 4.01).

To be able to install and use Microsoft Outlook 98, a computer must have a Windows 95 or 98 computer with at least thirty-two megabytes (32MB) of Random Access Memory (RAM). It must also have at least one hundred and forty megabytes (140MB) of free diskspace before installation, and the computer's processor must be of Pentium ninety megahertz (90Mhz) or better.

Recommended OMF Remote User System

To use Microsoft Outlook 98	Microsoft Outlook Express
Hardware:	
Pentium 90Mhz or better	Intel 486 DX 33 or better
minimum of 32MB RAM	Minimum of 16MB RAM
free disk space of 140MB	free disk space of 80MB
(before s/ware installation)	(before s/ware installation)
Software:	
Microsoft Windows 95 / 98	Microsoft Internet Explorer 4.01[67]
Microsoft Office 97[66]	
Microsoft Outlook 98	
Internet Service Provider:	
28.8 / 33.6 / 56kbps modem	28.8 / 33.6 / 56kbps modem
local ISP or	local ISP or
ISP Global Roaming account[68]	ISP Global Roaming account

Other computer systems, such as Apple Macintosh or Intel 386 computers, can also be used to access the @omf.net email system. The requirement is that such computers use email software that is compliant with Internet standards, and access the Internet using a dial-up Internet connection.

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[66] Microsoft Outlook 98 is free for use with licensed Microsoft Office 97.

[67] Microsoft Explorer 4.01 is free

[68] Some ISP's offer global roaming services; providing Internet access in overseas countries such that charges are transferred to a local ISP billing or Global Roaming account.

5.3 OMF Office Email Systems

Earlier investigations found that many office email systems used within OMF offices did not comply with Internet Standards, such as IHQ's FirstClass email system, and CompuServe version 2.x email system.

There was therefore, a requirement to update or replace these email systems.

Internet Access Limitations

It was also found that Internet access during normal working hours in Taiwan, Korea, and Indonesia was not always available, but was available only early in the morning or late evening.

In some offices, few telephone lines are available and so this limits the possible number of calls or dial-up Internet connections that can be made at any one time.

An OMF office email system therefore, must be able to cope with these limitations.

Extending the @omf.net Email System to the Office

Since only one local ISP account is required to access the @omf.net email system, any number of @omf.net email addresses could be provided to an OMF Office. This could be done at no additional cost, if an office already had an ISP account, or at an acceptably low cost if, a new local ISP account was needed.

This provides a much improved method of handling email in an office, compared with that of using one or two email addresses to provide email for the entire office, which was the situation of many offices.

Off-line Email System

A solution for an OMF office email system was sought that would overcome the problem of poor Internet access availability in some countries.

Such a solution must:

- be suitable for Windows 95 computers
- Comply with Internet Standards for POP3/SMTP and MIME
- Use a schedule to automatically send and receive office email at specified times, using modem and local ISP
- Automatically connect and disconnect to the Internet
- Provide a local POP/SMTP mail server so that other computers on the office network can send and receive email without requiring them to connect to the Internet.
- be of low cost so that it is within financial limitations.

An investigation was made of the cost and suitability of various email systems, and it was found that the FTgate email system, (already used in the OMF Canada), was best suited for use in OMF offices.

Essentials of using FTgate as an local office mailserver

As shown in figure 25, the local office mailserver (**2**) requires a modem, Internet access and FTgate to be installed. Each of the computers (**1**) in the office that are connected to the office network, are to be configured to send and receive email messages to or from the local office mailserver.

Sending Office Email

An email messages that is sent from one of the office computers (**1**) is first sent to the local office mailserver (**2**), and is temporarily stored there. Thereafter, the email message is sent by the office mailserver (**2**) to the @omf.net server (**3**), according to a schedule, and dependent on the availability of Internet access.

Receiving Office Email

The SmartPOP[69] feature in FTgate allows it to download email for any number of POP3 mailboxes from various ISPs (including @omf.net mailboxes) and be delivered to an appropriate local mailbox.

The local office mailserver (**2**) therefore, downloads office email from POP3 mailboxes on the @omf.net server (**3**) according to a schedule, and dependent on the availability of Internet access.

OMF office computers (**1**) download their email from the local office mailserver (**2**).
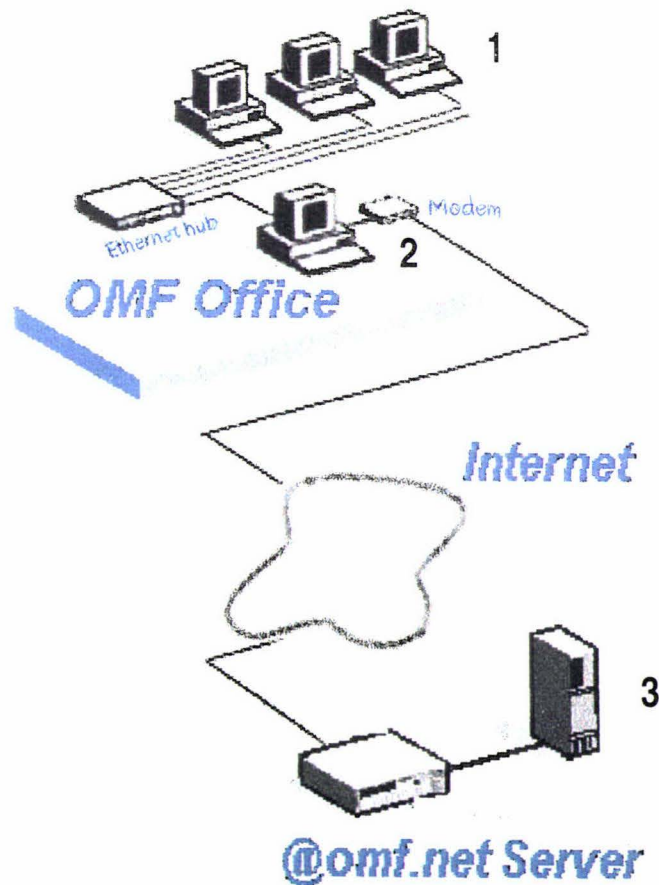
Figure 25:   OMF Office Email System

FTgate was found to be a cost-effective and reliable office email solution, which met the above requirements and had many other features, some of which are listed below:

- **Auto-responders**

  Allows an automated reply to be sent with the contents determined by the original message, including email attachments.

- **List-mailboxes**

  Allows a single message to be distributed to a large group of people

5.4   Acceptance

Having determined the target global IT infrastructure for OMF International, acceptance and commitment was sought from OMF leadership and those involved in its implementation and its use.

There are essentially three areas of acceptance, for:

i)   international systems,

ii)   office systems, and

iii)   remote or personal systems.

OMF International Systems

OMF had already recognised the need for a communication systems and its requirement for a global IT infrastructure, and had therefore made plans for its development. It was found that by having made appropriate communication to those involved, a consensus was reached for the direction and approval of the various stages and components of IT infrastructure and OMF Communication System.

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[69] For more information about the FTgate mail server can be found at http://www.floosietek.com

Richard van Laar-Veth

OMF Office Systems

Recommendations by IHQ for the implementation of IT infrastructure in OMF offices may not be accepted however, due to the autonomy of each OMF Office, as well as financial and human resources constraints. Cost and complexity of IT Infrastructure solutions were found to be major decision factors in the acceptance of proposed IT Infrastructure implementations for OMF Offices.

Since the proposed solution for the OMF office email system was based on low-cost software and hardware, it was widely accepted and implemented by most OMF offices.

OMF Remote Systems

Due to financial constraints, acceptance and use of the OMF communication system by OMF members was often based on whether their existing computer system was all that was required. Hence, cost was also found to be a major decision factor in the acceptance and use of the OMF Communication System by individual members.

Chapter 6

Implementation of a

Global IT Infrastructure

6.1   Development Trade-off: Resources - Features - Schedules

According to the Microsoft Solutions Framework (MSF), one would expect that the time required to implement information technologies (IT) depended on the gap between existing and target IT infrastructures, and of the resources available.

It was found that due to the lack of resources, both financially and of available computer support, implementation of IT infrastructures required a considerable length of time, often longer than was expected.

For example, updating computer systems, installing networks and email systems for a small OMF office of about six to eight computers required more than twelve months, due to lack of finances for new systems. Given sufficient resources, a similar task may require perhaps only one or two months to implement.

The schedule (i.e. the time required for implementation) of IT infrastructures within OMF therefore, depended on the following two factors:

- Features - (technology gap)

- Resources - (available money + people)

This agreed with other well-researched development models (MSF), and implied that such development models used in for-profit organisation are applicable to non-profit organisations.

6.2   OMF IHQ IT Infrastructure

Since implementation of the OMF communication system and IHQ IT infrastructure needed to be completed before others could use the system, sufficient resources were allocated so that its project schedule could be met.

Implementation problems

Some of the problems encountered during implementation, that were able to be resolved or avoided are as follows:

- The local Singapore domain name omfnet.org.sg, which was hosted by the IHQ server using Microsoft Domain Name Server (DNS) or other DNS software proved to be unreliable[70]. By using a US registered and hosted domain name (omf.net), this potentially serious problem was avoided.

- Similarly another problem[71] caused by Microsoft DNS was avoided by relaying all external (i.e. non @omf.net) email to another SMTP server that was better equipped to resolve domain names, and therefore more effective at sending email.

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[70] More information on Windows NT DNS problems can be found at The Unix versus NT organisation web site http://www.unix-vs-nt.org

[71] When using Microsoft DNS to send email messages it reported that it could not locate another mailserver on the Internet, returning the email message to the sender with a notification 'host not found'. The delivering failure rate for non-@omf.net addresses was approximately 2 to 5 % of all external messages sent by server.

- There are limitations on the maximum size of an email message that can be sent from different parts of the world to the IHQ server. In order to avoid oversized email message problems[72], an appropriate message size limit was determined by using the Leased Line utilisation information.

Other problems encountered during implementation that were not able to be resolved immediately and needed further investigation, are listed below:

- The Cheyenne Disaster Recovery Kit software was not able to recover the Microsoft Exchange Server entirely. Cheyenne has recognised this problem[73], but had not released any software updates that would resolve it.

- An earlier version of the Firewall software, provided during its initial implementation, did not fully support Microsoft Point-to-Point Tunnel Protocol (PPTP) and Microsoft Virtual Private Network (VPN). A later version of the firewall software does fully support Microsoft VPN and PPTP.

Some of these issues are discussed later in this document.[74]

6.3   OMF Office Email System

The OMF office email system using FTgate mailserver software was able to be implemented by those working in various offices using the instructions provided. According to the makers of FTgate, installation can be done in ten minutes. Most people however, needed a day or two to read instruction, then install and configure both the

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[72] An erroneous and cost-incurring condition occurs when an SMTP server repeatedly attempted to deliver a message containing a large (i.e. greater than 2 megabytes) file attachment for a long period (of possibly several days). Such message would begin to be sent to another mailserver but failed to be delivered completely, the sending mail server would then try sending the message again and again until either a time limit is reached or was successfully delivered.

[73] Microsoft Exchange Server Private Information store and Public Information Store cannot be restored using Cheyenne Disaster Recovery version 2.0 refer www.cheyenne.com for more information

FTgate mailserver and email programs (Microsoft Outlook) within the office.

Although the actual implementation of an OMF office email system may only require one or two weeks, it was found that much planning was required. Therefore, from observation most offices required at least three months to implement the system.

Office Local Area Network (LAN)

In order to access the local office mailserver, a Local Area Network (LAN) was required prior to installation. Many offices did not have a LAN and needed to implement this first. Some offices however, did not see the need for a LAN, and chose instead to have a separate modem fitted to each computer that needed to access the Internet and their mailboxes.

@omf.net addresses

In order to use the @omf.net email system, email accounts needed to be requested first, and were then created by the IHQ server administrator (or postmaster), and were subsequently used by the office. This required some co-ordination and several days in time.

Internet Service Provider

For those OMF offices that only had CompuServe email, an account with an Internet Service Provider (ISP) was recommended, to be able to access the @omf.net server using open Internet protocols.

CompuServe and Internet Mail standards are further discussed later in this document.

If an office already had a local ISP account, it could be used to access the Internet to send and receive email for a number of @omf.net addresses, at little or no additional expense.

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[74] Refer to Chapter 6 (Discussion).

The selection and application process for a local ISP usually required several weeks. However, for the OMF Indonesia office, the selection of a suitable ISP required more than a year from the start of its investigation, to when email could be reliably sent and received using Microsoft Outlook. This was partly due to the Asian economic crisis in 1997 and 1998, when the plight of many local ISP's in Indonesia was uncertain. Selection was a matter of which ISP stayed in business.

Internet Access Limitations

It was found that Internet access during normal working hours in Taiwan, Korea, and Indonesia was not always available, but was available early morning or late evening. Similarly, a small number of telephone lines available within some of the offices, which limited the number calls or dial-up Internet connections that could be made at any one time.

Other @omf.xx domains

For some OMF offices, it was important that the 'omf' domain was represented in their country. For example, the OMF Japan office had registered the **omf.or.jp** domain hosted by a quality service ISP (AT&T), then implemented the FTgate local office email system.

Although the Japan office email mailboxes were not hosted by the OMF IHQ server, since there did not appear to be any problems with sending email attachments, it proved to be successful.

Problems

Some offices had problems downloading their email. This problem was further investigated and was related to the version of Outlook (i.e. workgroup or Internet) discussed later in this document.

6.4   OMF Remote Users

Since the communication system was based on open Internet standards, it was found that older OMF remote systems (i.e. 386 or 486 computers with 8 or 16MB RAM) were able to access the Internet and use the OMF communication system.

Internet Access

For some Individual OMF members working in remote and rural areas of East Asia, Internet access was poor or non-existent due to the lack of availability of both telephone system and local ISPs. This was especially so in the islands of Luzon, Mindoro and Mindanao in the Philippines, as well as some rural areas in Indonesia and Cambodia.

For some of these people wanting to send and receive email, they needed to travel to a major city where there was reliable telephone access and ISP access. Even then, some needed to make a toll call to connect to an ISP service in another part of the country.

@omf.net email forwarding

Many individual OMF members appreciated having a permanent @omf.net email address, however a significant number preferred that their @omf.net email be forwarded to the address of their local ISP or to their CompuServe address.

It was found that by forwarding email to another email system, the overall reliability of delivering email messages with file attachment was reduced. This agreed with earlier findings that showed that one could not ensure the delivery of email with file attachments, when sent from one email system to another. This was particularly noticeable with email forwarded to CompuServe addresses.

6.5   The "Final" Analysis

The OMF email system and IT Infrastructure that has been implemented are all based on open standards[75] and therefore was able to be used by old and new computers. In fact over five hundred @omf.net addresses are used within OMF around the world.

Those that were involved in the development and use of the Candidate Processing System (CPS) project were required to send their email using the global @omf.net email system. Tests from sending (CPS) email messages with complex file attachments between users of the @omf.net email system showed a high rate of reliability (near 100%).

There are four conditions or situations where the @omf.net system fails to deliver email messages correctly:

- When an email message containing Chinese (double-byte character set) is sent[76].

- When an email message with a Microsoft Works files attachment using Netscape version 4.0 email program is sent[77].

- When the Firewall software is configured incorrectly and prevents the sending or receiving of email messages.

- When the IHQ Leased Line connection is unavailable due to maintenance or malfunction.

- When the IHQ server or LAN connections malfunction.

- When the power to the communications system is disconnected, and the (battery) capacity of the backup power supply is depleted.

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[75] The @omf.net Microsoft Exchange Server is only accessed using SMTP/SMTP protocols for sending and receiving email.

[76] Microsoft Exchange Server version 5.5 Service Pack 2 is reported to overcome this problem - refer to http://www.microsoft.com/exchange

[77] Same as footnote 76.

Chapter 7

Discussion of Results

7.1 Discussion

During the implementation phase of the development of a global communication system and global IT infrastructure a number of problems and issues were encountered that required further investigation. These and lessons leant from implementation are discussed in more detail below:

7.2 Microsoft Virtual Private Network (VPN)

Microsoft Exchange Server uses its own proprietary protocols to communicate with an Exchange Client.

There should be no problems using the Microsoft Exchange client and server where computers are connected to in a LAN or WAN, since there are no limitations to the types of network protocol that can be used in such situation.

However, in order to access a Microsoft Exchange Server via the Internet using a Microsoft Exchange Client (i.e. Microsoft Outlook 98

workgroup version), a Microsoft Virtual Private Network (VPN) [78] connection that utilises Point-to-Point Tunneling Protocol (PPTP) is required. A Microsoft Exchange client therefore, uses this 'tunnel' to access the Exchange Server.

Additionally, all other Internet components (i.e. routers, firewalls, and telecommunication systems) involved in a VPN connection from the exchange client to the Exchange server, are required to support PPTP. The Windows 95 computer that is used also requires Dial-Up Networking (DUN) version 1.2 to be installed and enabled[79].

The software that was provided with the Firewall however, did not fully support Microsoft PPTP and Microsoft VPN, but from early 1998 onwards, a newer version of the firewall software was available that was compatible with DUN 1.2. Several months later however, this version (i.e. DUN1.2) of Microsoft VPN was considered insecure.

Bruce Schneier's (June 1998) paper entitled "Cryptanalysis of Microsoft's Point-to-Point Tunneling Protocol (PPTP) [80]", highlighted security vulnerabilities in Microsoft's implementation.

There were also concerns about the performance of Microsoft VPN. According to Data.com Lab Test on VPNs, sending email via the Internet using a VPN connection is considerably slower than a standard TCP/IP connection, and therefore incurs higher Internet charges. (David Newman, July 1998)

In response to these problems, Microsoft released updated versions of its VPN software components including DUN version 1.3[81].

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[78] For more information refer to Windows NT server communication services web site at http://www.microsoft.com/ntserver/commserv/techdetails/

[79] From late 1996 onwards to mid 1998, DUN Version 1.2 was available from Microsoft.

[80] Discussion on Scheier's paper can be found at:
http://www.dejanews.com/=zzz_maf/dnquery.xp?search=thread&svcclass=dnserver&recnum=%3c35d4f455.11420401@news.onramp.net%3e%231/3

Since the firewall software needed also to be updated to cope with changes in Microsoft VPN technology, an updated version of the Firewall software compatible with Microsoft DUN version 1.3 was made available in early 1999.

The delays and changes in software releases as described above, meant that a Microsoft Virtual Private Network environment was not able to be implemented within an acceptable timeframe given the limited resources and delays of software updates.   The IHQ IT infrastructure therefore, was not able to support Microsoft Exchange client/server environment.

7.3   Microsoft Outlook (Workgroup versus Internet Only)

During the earlier evaluation and development stages of this investigation, Microsoft Outlook (i.e. the version that is part of Microsoft Office 97) was used.   However, an updated version (Microsoft Outlook 98) was released at the start of the implementation stage.   Outlook 98 had two versions (or more precisely provided two choices in its installation):

• Microsoft Outlook 98 (workgroup)

• Microsoft Outlook 98 (Internet only)

Since the OMF Candidate Processing System (CPS) Project had intended to use Microsoft Exchange Public Folders for replication functionality between Exchange server and client, the workgroup version was used during the early implementation stages of CPS.

Although there were no problems using Microsoft Outlook 98 (workgroup) within a Local Area Network or when using a faster and more responsive Internet connection within Singapore, the workgroup

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[81] More information on Microsoft PPTP and Dial-up Networking version 1.3 can be found at http://www.microsoft.com/windows95/downloads/contents/wurecommended/s_wunetworking/dun13win95/releasenotes.asp

version proved to be unreliable[82] for some users outside Singapore. An investigation was therefore required, to determine the cause of this problem with an aim to resolve it.

A number of people using Microsoft Outlook 98 (workgroup) had reported this problem from various countries (Australia, Indonesia, Thailand, Philippines and South Africa). However, other people in the same countries who used a different email program (i.e. Microsoft Outlook 98 (Internet), Outlook Express, Eudora, and Pegasus), were able to send and receive email without any apparent problems.

To determine whether the cause was related to Internet access, ISP or the actual email program, a "PING" and "Trace Route" test was carried out by a number of people from various countries. The results of the tests showed that response from the IHQ server to their own computer varied from three hundred milliseconds (300ms) to thirteen hundred and seventy-five milliseconds (1375ms). Such high response times were reported to be acceptable but slow for Web browsing or the transferring of files using File Transfer Protocol (FTP).

It was found however, that some users of the Microsoft Outlook 98 workgroup version were not able to send and receive email, when response times exceeded one thousand milliseconds (1000ms), whilst other email programs worked well even with response times as high as thirteen hundred and seventy-five milliseconds (1375ms). Conclusively, Outlook 98 (workgroup) was found to be unreliable for use in such conditions. Upon recommendation and after appropriate discussions with those working in IT within OMF, a decision was made that OMF should standardise on using Microsoft Outlook 98 Internet version.

This meant that Microsoft Exchange client/server environment was no longer a requirement for OMF's communication system.

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[82] Some symptoms of problems encountered using workgroup version of Outlook 98 were that email could not be downloaded,

7.4   Exchange versus Notes Infrastructure Requirements

As described earlier in this document, it was found that the IT infrastructure requirements to support Microsoft Exchange client/server could not be implemented within OMF and were therefore not used.

It was observed during this investigation that those who used a Lotus Notes (client) to access their OMF US office Notes server which was permanently connected to the Internet, were able to do so from different parts of the world, using a standard an Internet connection.

Further investigation found such Internet connection need only have web (HTTP port 80) access. (i.e. no other special 'port' or protocol was required).

This conclusively shows that by comparison, Lotus Notes's client/server IT infrastructure requirements are considerably less than that of Microsoft Exchange client/server and is therefore better suited for implementation within OMF.

However, it is not known how much volume of data is transferred between a Notes client and Notes server for replication and email services, and therefore charges incurred from Internet providers to do so. This area needs further investigation to determine its financial impact should OMF consider the global implementation of Notes messaging using the Internet as its communication platform.

7.5   Alternative Open Standard Messaging Solutions

A Radicati Group (1999) study estimated that in 1998, seventy percent of all email on the Internet is sent using Sendmail software, which is available free of charge from Sendmail (the company).

This study also revealed that in the enterprise messaging market Lotus Notes had (25%), and Microsoft Exchange (15%) of the total enterprise market, whose combined (40%) market share returned almost all (99%) of the estimated $1.5 billion in revenues for the enterprise messaging in 1998.

This study also revealed that in the Internet Service Providers market messaging solutions were provided by Software.com, with approximately 62% of the total market, Netscape, with 19% of the total market, and Sun Microsystems, 14% of the total ISP market.

Therefore, as an alternatively to using Notes or Exchange messaging, open standard messaging technologies provided by Software.com (Post.Office) or Netscape are lower in cost and complexity, and may therefore be more suitable and affordable to implement within OMF than.

7.6   Rate of Change of Microsoft Technology

As discussed earlier, within two years of the release of Microsoft VPN software components in 1996, its technology had a major security and performance update. Similarly, Exchange Server version 5.5 had two Service Packs within a single year of its (v5.5) release that dealt with security and Year 2000 compliance issues. Other Microsoft products, such as Microsoft Office, Outlook and Internet Explorer have all had updates and Service Packs that dealt either with

security or with functionality issues. The release dates of some of Microsoft's software updates are shown in the diagram below:

Software Updates / Year	1996	1997	1998	1999	2000
i) Microsoft VPN - Dial-Up Networking updates	DUN 1.2		DUN 1.3		? Win2000
ii) Microsoft Exchange Server updates	v5.5	v5.5_SP1	V5.5_SP2	?	
iii) Microsoft Office Updates	O97	O97_SP1	O97_SP2		Off 2000 ?
iv) Microsoft Outlook	OL97	OL98			OL 2000 ?
iv) Microsoft Internet Explorer Updates	v3 v4.0 v4.01		v4.01_SP1		Ie 5.0 ?
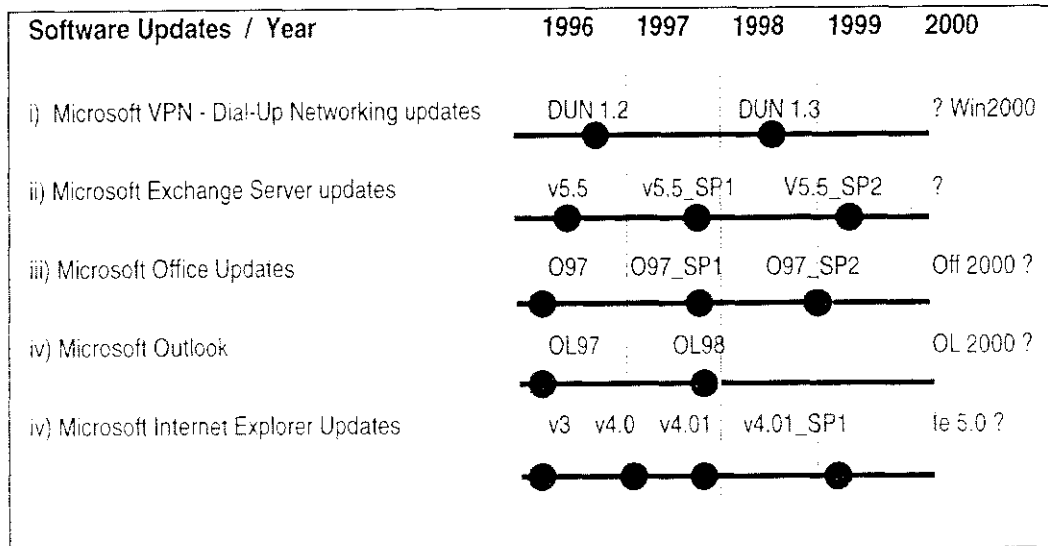
Figure 27:   Changes in Microsoft Software

The rate of change of Microsoft software (i.e. the time between major revisions. updates or Service Packs), is usually less than two years. and some cases less than one year.

These changes have had a significant impact in the development of IT projects within OMF, that is a cause for concern. For example, each revision or change effected the development of the OMF Candidate Processing System (CPS). Initially CPS required Microsoft Office 97 Professional and Outlook 97, which was later updated to Outlook 98 (workgroup). By the end of its two-year project, CPS required Office 97 Professional (SP2), Outlook 98 (Internet installation) including Internet Explorer 4.01 (SP1), and several software "add-ons". The impact of Microsoft software changes meant that during the development and implementation of the CPS project, its software and IT infrastructure requirements changed considerably.

7.7 Updates and Introduction of Open Internet Standards

The diagram below shows both the introduction of new Request For Comment (RFC) standards as well as revisions to existing Internet Mail standards

Changes / Introduction to Open Standards	1996	1997	1998	1999	2000
i) Internet Transport Protocol (TCP/IP)	no change				
ii) Secure Internet Transport Protocol IP v 6.0	RFC 1883,84,85,86				
iii) Post Office Protocol (POP3)	RFC 1939				
iv) Simple Mail Transport Protocol (SMTP)	RFC 1939			RFC 2505	
iv) Multipurpose Internet Mail Extension (MIME)	RFC 2045,46,47		RFC 2398		
vi) Internet protocol for secure email SMIME	v1 RFC 1847		v2 RFC 2311		v3 RFC?

Source: Internet Mail Consortium http://www.imc.org/

Figure 28: Updates and Introduction of Open Standards

Some of these RFCs recommended changes and introduce new technology (such as RFCs 2045,2046,2047 which described new standards for MIME), whilst other RFCs merely provided recommendations on policy issues. (For example, RFC 2505 "Anti-Spam Recommendations for SMTP MTAs").

In comparison, open standard for Internet Mail protocols have fewer changes than Microsoft software. Similarly, the impact on the development of IT infrastructures within OMF International caused by Microsoft software was much greater than that of open standards.

7.8 Actual Implementation Timeline

The actual implementation timeline of IT infrastructures and communication systems within OMF IHQ, OMF Offices and OMF Remote users are shown below:

Actual Implementation Timeline	1996	1997	1998	1999	2000
i) OMF Internal Communications Review					
i) OMF IHQ IT LAN Infrastructure Phase I & II		I	II		
ii) OMF IHQ @omf.net Server					
iii) OMF Offices					
iv) OMF Remote Users					
v) OMF Candidate Processing System (CPS) Project					
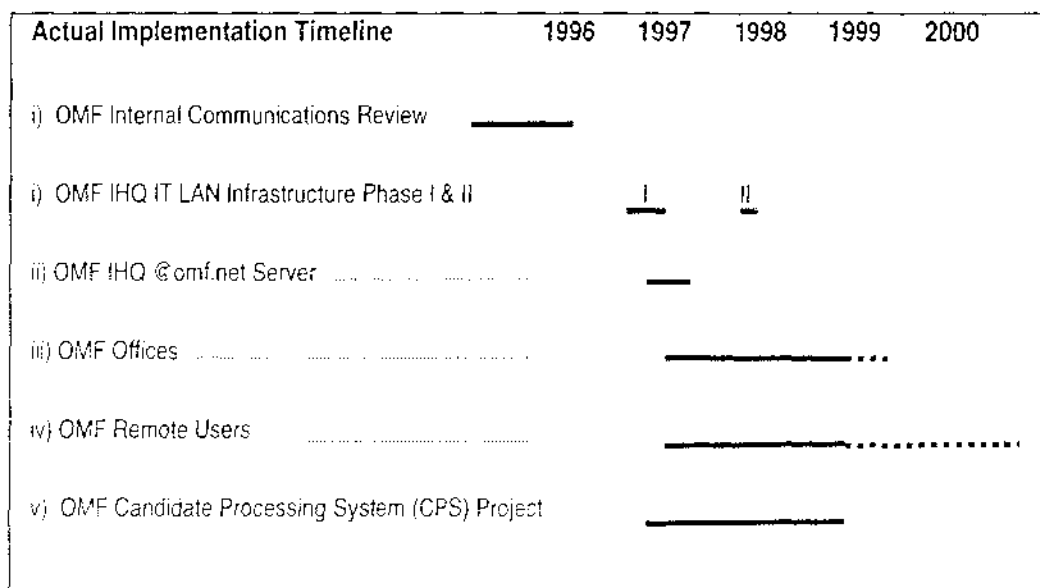
Figure 29: Actual Implementation Timeline of IT Infrastructures

Figure 29 shows that the time taken to implement IT projects or IT Infrastructure within OMF Offices requires two or more years, and within the wider group of OMF remote users possibly more than three years due to fewer financial resources.

Since development and implementation of IT projects and IT infrastructures within OMF require more than two years, it needs to be able to cope with changes in software and technology whilst continuing to support existing infrastructures.

7.9 Open Standards versus Proprietary Solutions

There are issues relating to the selection technology and systems that are based on proprietary protocols, such as the rapid rate of change in proprietary software, and the lack of compatibility and interoperability, that was discussed earlier.

It has been shown earlier in this document that the rapid rate of change in proprietary software has a much greater impact on the development and implementation of IT projects within OMF than that of open standards.

As a result of discussions[83] regarding the use of open standards versus proprietary solutions on the above issues with those involved in implementation of IT within OMF, the following (abridged) statement was made:

OMF values solutions that conform to open standards ahead of proprietary solutions

This statement covers all aspects of information systems, from omf-wide decisions to local implementation to components of larger solutions. This is especially important in areas that effect the entire organisation.

	Open Industry	De Facto Industry	Tailoring	In-house Development	Outsourced Customised	
Open Standards						Proprietary Solutions
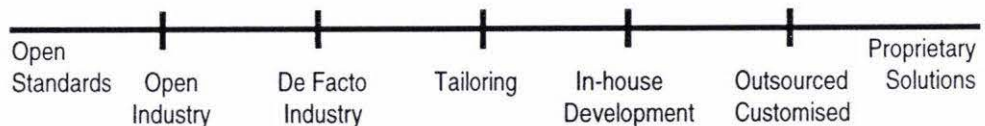
There is a continuum from the purest open standard to de facto industry standards to tailoring to in-house development to outsourced customised solutions.

The more specialised the solutions becomes, and the more dependent it is on one organisation, person or group, the less desirable it becomes for OMF.

In developing solutions, OMF will strongly favour open standards over proprietary solutions.

OMF International, (Sept 1998) .

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[83] Discussion of the OMF IT Standards Workgroup - August 28-29, 1998

7.10   CompuServe and Internet Standards

During 1997 and early 1998, CompuServe versions 2 and 3 were available which used proprietary protocols to communicate with CompuServe systems. It was found that these systems were not compliant with Internet standards.

From mid 1998 onward CompuServe version 4 and a "POP" mailbox were available, which provided Internet compliant Post Office Protocol (POP) and Simple Mail Transport Protocol (SMTP) services.

Although it was now possible to send email attachment between CompuServe version 4 (with POP mailbox subscription), previous versions of CompuServe remain incompatible with Internet standards.

This is perhaps an example of how this early pioneer in global communication has had to reengineer its systems to comply with open standards. Had there been system standard at the onset of implementation, no reengineering would be needed.

7.11   Discussion of Development Model

The methods and processes used in the development of a global IT Infrastructure for OMF has helped realise its development to actual implementation.

It was found that an important aspect of the IT Infrastructure Development Model, is the reiterative processes between various stages of the development model. Non-acceptance, and analysis of implementation problems provide such feedback as shown in the diagram below.

For example, the decision to change from MS Outlook workgroup version to the Internet version was made due to a recommendation[84] aimed at resolving implementation problems.
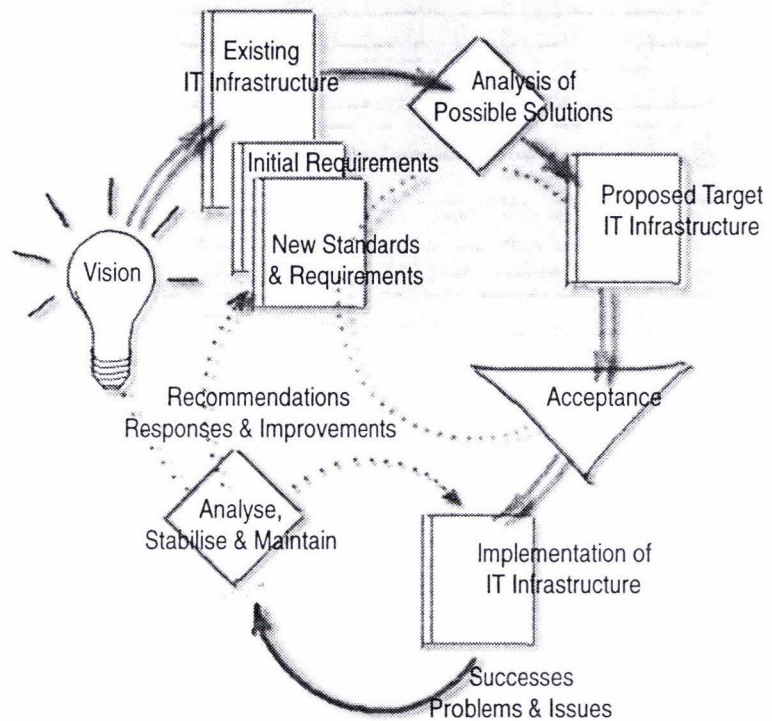
Figure 26:   OMF IT Development Model

Figure 26 shows how these reiterative processes provide feedback for OMF standards and guidelines that aims to improve the development and subsequent realisation of IT projects.

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[84] OMF International recommends the use of MS Outlook'98 ('Internet' install) as a current email client for OMF Centres and MS Outlook'98 or Outlook Express as a current email client for OMF members. (OMF, Sept 1998)

7.12   Problems with Concurrent Projects

According to Beauchamp (1996), an IT infrastructure provides the technological capacity to communicate and share information.

One could suppose that by using needs analysis methods, the IT requirements of various IT projects can be determined and subsequently proposed for implementation, as was done in this investigation.   It was found however, not all IT infrastructure requirements could be met either due to financial and human constraints within OMF, or due to inability of certain technologies to function within a global IT infrastructure.

This investigation showed that technologies required by other IT projects were not fully tested, and were later found to be unsuitable, (i.e. Microsoft Outlook workgroup version was unsuitable for use in a global Internet environment).

It was found that recommendations resulting from investigation and research of suitable technologies made by those developing IT infrastructures were ignored or not accepted by other project teams within OMF.   The consequence of such decisions resulted in the inability to implement fully IT projects.   (For example, the CPS project's requirement for replication of information using Microsoft Exchange client/server could not be implemented due to both limitations in technology and OMF resources constraints).

These problems would have been overcome had there been an IT architecture describing the IT systems (i.e. all information systems and IT infrastructures), and acted as a plan from which systems (or IT projects) can be developed.   Such an architecture should support reasoning about its structural properties and limitations of the system. There is a need therefore to select and build an appropriate IT architecture for OMF International.

Chapter 8

Conclusions

& Recommendations

For OMF International, a global non-profit organisation, the low-cost use of the Internet has made it possible to communicate with others within the organisation using email. The increase in use of email within OMF[85] is a realisation of this fact.

Delivery of Email Unreliable Between Different Email Systems

Results of tests[86] have shown that one cannot be assured of the delivery of email messages when sent between different email systems. These results reveal a significant failure rate in the sending email messages with file attachments between different email systems. There are a number of reasons for this failure, which are discussed in this document[87].

Conclusion: Global Email System Required

The investigation concluded that, within an International organisation using the Internet as its communications platform, a globally

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[85] Refer to Appendix E
[86] Refer to Chapter 3 and Appendix C.
[87] Refer to Chapter 3.

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accessible email system[88] compliant with Internet Mail[89] standards was required to ensure the delivery of email messages with file attachments.

Limitations of the Internet

Many people view the Internet as a universal communications medium that could replace telephone, television and radio, but may not have considered the Internet's limitations. This study has highlighted the following limitations related to the use of the Internet for global communications:

- There are costs involved in connecting to the Internet, which restricts its usage according to the financial resources of its users.

- There is a limit to the maximum size of email message that can be reliably transferred between global Internet mail systems[90].

- In some places in East Asia the availability of Internet access is only outside normal working hours or other busy times.

- Internet communication is based on Internet Transport Protocols (TCP/IP), and does not route proprietary protocols without additional requirements[91].

- In some instances[92] applications such as Microsoft Outlook 98 workgroup version and real-time (audio or video) conferencing software are unsuitable for use within a global Internet environment.

For those that can afford to do so, these limitations can overcome or avoided by the use of expensive private leased lines or Wide Area

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[88] Compliant email system: i.e. both mail server and email programs to comply with Internet Mail standards.

[89] Internet Mail standards: as specified and defined in RFCs related to Internet standards for POP3, SMTP and MIME.

[90] From experience, this is estimated to be between 1000kb and 1800kb for the OMF @omf.net email system.

[91] For example, a Point-to-Point Tunneling Protocol (PPTP) connection in additional to a standard Internet connection will allow proprietary network protocols, such as Microsoft NetBEUI, to communicate to other computers connected to the Internet via a "tunnel"

Network (WAN) technology, however for OMF International this was not feasible.

Therefore, the value (in cost saving) and benefits (i.e. faster communication) from the use of a reliable and dependable global "Internet" email system to communicate with others within a global organisation is significant, compared to lower or more expensive alternatives[93].

Limitations of IT Development within OMF International

In addition to coping with the limitations of the Internet, the following limitations within OMF International also needed to be considered in the development and implementation of IT projects and global IT infrastructures:

- Lack of financial resources in most areas within OMF, but particularly in smaller offices and with individuals.

- A disparity of financial and human resources and IT equipment and infrastructures within OMF.

- Acceptance and subsequent installation of IT systems dependent on affordability, perceived need, and urgency of each OMF office or individual (OMF remote user).

- Lack, or non-existence of IT support staff within areas of OMF, especially people with in-depth knowledge of IT and project management.

- Lack of IT training and understanding by many of those who were required to implement and use the IT solutions.

- Non-acceptance of advice and recommendations given.

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[92] Instances, when slow (1375ms) response rates and poor transfer rates (300bytes/sec) occur
[93] Examples of alternative communication methods to email are postal mail, telephone, facsimile, or Wide Area Networks.

Consequences of Limitations ... Implications

As a consequence of the lack of (financial and human) resources, the time taken to implement IT projects and IT infrastructures within OMF Offices exceeded the time between Microsoft software changes. This in turn has an impact on the effectiveness of IT development within OMF.

This agrees with Microsoft's (2, 1998), statement that a project that takes more than one year to complete may lose its value due to the rapid rate at which technology is evolving. Microsoft points out that on large projects the deployment of any single version of [Microsoft] technology may never be complete; as soon as one wave of deployment is nearing completion, another wave will be in the planning stages.

Open Standard IT Solutions better Suited

This study showed that the faster rate of change of proprietary (i.e. Microsoft) IT solutions[94] had greater adverse impact on IT development in OMF, than that of the slower rate of change of open standard IT solutions, concluding that open standard IT solutions were better suited than proprietary solutions.

Upon recommendation, OMF has adopted an IT strategy statement that "in developing [information technology] solutions, it will strongly favour open standards over proprietary solutions" (OMF International, Sept 1998).

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[94] Refer to Chapter 6.

Technology Choices ... Implications for IT Infrastructure

Microsoft Exchange Client/Server messaging had been chosen for the Candidate Processing System (CPS) project without fully considering its IT Infrastructure requirements.

It was found however, that within OMF International using the Internet as it communications platform, it was not practical to implement or use Microsoft Exchange Client/Server environment. The reasons for this are discussed in chapter 7.

Therefore, without a clear understanding of the limitations of the technologies in question, and the because of the financial and human constraints of the recipient organisation, the implementation of IT projects are likely to be flawed or fail. This statement agrees with other studies on this subject. (Standish Group, 1995)

Alternative Choice of Messaging Solutions

By comparison[95], Lotus Notes' client/server IT infrastructure requirements are considerably less than that of Microsoft Exchange client/server, and are perhaps better suited for implementation within OMF. Alternatively, low-cost open standard global messaging options[96] may be more affordable and therefore more suitable for OMF.

Making the "Right" Choice

A recommendation for future IT development within OMF would be that:

The choice of technologies for use in OMF should not be based on a comparison of functionality, but instead on a feasibility study which aims to investigate the limitations of the technology in question, and to determine whether it can be implemented within financial and resource constraints.

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[95] Refer to Chapter 6.
[96] For example: Sendmail, Post.Office (Software.com) or Netscape.

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IT Architecture: a Plan and a Context for Future IT Development

It was found that problems encountered during the development of a global IT infrastructure concurrent with other IT projects and developments, has highlighted the need for an IT architecture[97] that provides a plan and strategic context for future IT development within OMF.

As methods similar to those used in for-profit organisation (i.e. TOGAF[98] and MSF[99]) were used to development and implement a global communications system and IT infrastructure, the study found that such frameworks were applicable[100] for use in a non-profit organisation.

This study therefore recommends that such methods be used for the selection and building of an appropriate IT architecture for OMF International, and strongly recommends that it investigates technologies and standards compliant with IT DialTone Architecture.

The application of an IT DialTone Architecture within OMF International will allow OMF to:

- plan and implement systems that will rely on the Internet as its communications platform

- identify technology gaps, and avoid IT project failure in early development stages

- select products and technologies that are compliant with open standards and compatible with other systems

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[97] That is, a formal description of a system, that acts as a detailed plan from which a system can be implemented, and is organised in such a way that it supports reasoning about the structural properties of the system.

[98] TOGAF - The Open Group Architecture Framework, refer to http://www.opengroup.org

[99] MSF - Microsoft Solutions Framework, refer to http://www.microsoft.com/msf

[100] Refer to Chapter 6.

Broader Implication of Findings

This study has primarily focussed on the development and implementation of a global communication system and a global IT infrastructure for a non-profit organisation, which uses the Internet as its communications platform.

The study found that financial and resource constraints limit IT development within the non-profit organisation in question. This may be overcome or avoid in a for-profit organisation or enterprise.

The study also found limitations in the use of the Internet as a global communications platform. Although many people consider the Internet as a universal communications medium that can replace telephone, television, and radio, conclusive findings from this study has disproved this belief.

The following limitations must be considered when developing systems in any (for-profit or non-profit) organisation, where users of the system are expected to use local ISPs to access global communication systems via the Internet:

- limitation or non-existence of Internet access in many parts of the world
- availability of Internet access during working hours
- possible restrictions on the email message size
- sufficiency of response and throughput for Internet applications such as real-time (video) conferencing

These findings agree with other studies on this area. (Berge, 1995, Konsynski, 1993, Poling, 1994, Thach, 1995, Weinschenk, 1997, Waggoner, 1992).

With such constraints and limitations, it is uncertain whether any Virtual Private Network (VPN) would function successfully. An in-depth investigation would be needed for any organisation contemplating a global VPN implementation.

Appendix A

OMF Questionnaire

April 1997

The OMF email questionnaire was intended to provide information about the existing IT infrastructure and in particular, determine the range of email programs in use.

It was intended that answers given to the wide range of questions in the questionnaire would influence decisions in determining suitable communications and information technology infrastructures.

A.1 Cover letter

Dear OMF member and IT coordinator

I have prepared a questionnaire to better assess OMF's needs of a communications infrastructure. Most questions are related to the use of email, whilst others are associated with electronic communication.

1.
Please make a list of all people in your office, and with whom you communicate. (e.g. OMF reps, missionaries on field, local assistants (voluntary or otherwise), anyone else willing to complete the questionnaire.- the more people who respond the better the assessment).

2.
Please redirect the next email message (questionnaire) to people on your list.

To complete the questionnaire:
1. Reply to the (questionnaire) email message
2. Make sure the reply is addressed
   To: R.vanLaar@massey.ac.nz
3. Answer questions and send.

If you have people on your list who do not use email please print the form and ask them to fill it in and return it to you.
For convenience this email has two documents attached - email.rtf and email.doc
If you are able to receive and open these documents they can be printed and completed. Let me know if you have any problems with the attachments.

Completed printed forms can be posted to:

Richard van Laar-Veth
<address removed>

Thank you for your co-operation.
Please contact me if you have any questions or problems.
I look forward to your responses.

B.2 Questionnaire

Email - Electronic Messaging Survey

This survey has been designed to better understand an email user's needs, and to analyse existing email infrastructures.

Your participation is greatly appreciated.

To complete the questionnaire:
1. Reply to this message
2. Make sure the reply is addressed
   To: R.vanLaar@massey.ac.nz
3. Answer questions and send.

e.g. Suggested is to enter a line below question or mark next to answer
>Q3
> Which word-processing application(s) do you use?
> (cross(*) one or more and specify version)
>   WordPerfect   version:
*   Microsoft Word/Office   version: 6.0
>
>Q4 Have you ever:
>   Added graphics, graphs or drawings to your typed documents? Y/N
N
>

Name:
Email address:
Country:

Q1 What type(s) of computer do you use?
   Macintosh
   PC - DOS only
   PC - Windows 3.1 or 3.11
   PC - Windows 95
   PC - Windows NT
   UNIX workstation

Q2 For what function(s) do you use a computer? (cross(*) one or more)
   Typing up documents in a word-processing application
   Enter finances or other information in a spreadsheet or database
   Send and receive electronic messages (email)

Keep an electronic calendar or diary
Keep track or manage shared projects using project, database or workflow software
Other.............................

Q3 Which word-processing application(s) do you use? (cross(*) one or more and specify version)

WordPerfect	version:
Microsoft Word/Office	version:
Microsoft Works	version:
Claris Works/Office	version:
Lotus Ami Pro	version:
Other..........	version:

Q4 Have you ever:

Added graphics, graphs or drawings to your typed documents?	Y/N
Printed a form letter using the "mail-merge" feature?	Y/N
Printed name and address labels?	Y/N
Sent a document from within (mail enabled) wordprocessor?	Y/N

Q5
Which email application(s) do you use to send and receive email (cross(*) one or more and specify version of software)

Eudora Light (free)	version:
Eudora Pro (licensed)	version:
Netscape Mail	version:
Claris Mail	version:
Pegasus	version:
Lotus Notes	version:
Lotus Mail	version:
Microsoft Mail (MS Exchange)	version:
Microsoft Outlook	version:
Other	version:

Q6 By what connection are you able to send and receive email at work?
(cross(*) one or more)
Connected to local network
Use modem to connect to ISP
Other ....

Q7 How often would you say that you use email ? (cross(*)below)
Several times each day
Daily
Weekly
Occasionally
Never

Q8 Do you send and receive email at home or when travelling overseas?   Y/N
If yes, do you have a separate email address for home or when travelling?   Y/N
If yes, which Internet Service Provider (ISP) do you connect to? (cross(*) one or more)
CompuServe
AOL
Xtra (Telecom NZ)
ClearNet (Clear NZ)
Other ....
If yes, what are your average monthly costs? $ ....
Are these more than expected?   Y/N

Q9
On average, how many email messages in total would you receive each week?
....

Q10 How many of these messages come from mailing lists?

············

Q11 How many mailing lists are you subscribed to?
············

Q12 Out of every 10 messages you receive, how many would you delete?
············

Q13 Do you print and file important email messages?   Y/N
If yes, do you have a filing system for email messages?   Y/N
Please explain
·······································

Q14 If you save email messages, do you set up mailboxes/directories for files?   Y/N

Q15 Do you have a backup of these files?   Y/N

Q16 Have you ever:
   created and sent new messages?   Y/N
   replied to an email message?   Y/N
   incorporated small portions of messages received into the message you send?
         Y/N
   forwarded an email message?   Y/N
   redirected an email message?   Y/N
   sent email to more than one individual at a time?   Y/N

Q17 Have you ever constructed a group list?   Y/N
i.e. An entry in your electronic address book with more than one email address

---

Q18 Have you ever sent email to an email mailing list?   Y/N

Q19 Have you ever setup an email mailing list?   Y/N
i.e. An email mailing list is one to which people can subscribe automatically.

Q20 Have you ever prepared a document, in e.g. a word-processing application, in
advance and attached it to an email document?   Y/N
If not, why not?
·····························

Q21 Have you ever received an attached document which looked like a long list of
strange characters in the message?   Y/N
If yes, did you know what to do with it?   Y/N

Q22 Have you ever received an attached document   and been able to open it
successfully in another application?   Y/N

Q23 What provision do you make for your email when you are away for extended
periods of time? (cross(*) one or more)
   None
   Have someone else check email
   Automatically forward email to home or other email address
   Other·······················

Q24 Do you use advanced features in your email application that filter, prioritise or
forward email message based on the content of the message?   Y/N

Q25 Do you save email messages for the purpose of keeping someone's   email
address?   Y/N

Q26 Do you use a local address list / book feature of your email application to keep
email addresses?   Y/N

Q26   What other sources have provided you with the email addresses of people you have sent messages to?

....

Q27 What are the main advantages of email to you? (cross(*) one or more)
   Speed
   Accessibility of people
   International contact
   Can check at ones own convenience (asynchronous nature)
   Ease of use
   Relatively cheap
   Informal use of communication
   Other.................

Q28 What forms of personal training have you received for using email?
   None
   Read instruction manual
   Attended training course
   Other.................

Q29 Comment on the adequacy of this training.

....

Q30 What are the most common problems you have encountered when using email?

....

Q31 How do you think these problems could be overcome?

....

Q32 Have you ever sent confidential information in an email message?	Y/N
If yes, did you use any security or encryption mechanism?	Y/N

Q33 Do you consider the transmission of email messages on the Internet to be secure?
                                                                                   Y/N

Q34 Do you use a paper diary or calendar?   Y/N

Q35 Do you use an electronic calendar?   Y/N
If yes, please specify what software and version ....
If yes, do other people share or have access to your electronic calendar?   Y/N

Q36 How do you prefer to arrange meetings with people locally?
   Electronic Calendar/Scheduling software
   Email messages
   Telephone
   Other........................

Q37 How do you prefer to arrange meetings with people internationally, or remote from you?
   Electronic Calendar/Scheduling software
   Email messages
   Telephone
   Other........................

Q38 Do you use an electronic scheduling software to book rooms or other facilities?
                                                                                   Y/N
If yes, please specify what software and version ....

Q39 Do you use a database or workflow software to manage projects?   Y/N
If yes, please specify what software and version ....
If, yes, can other people view or update these projects/database?   Y/N

Q40 Have you ever used a computer for audio (voice) conferencing between two people via the Internet?   Y/N

Q41 How important are the following for you:
(please type number which best represents your choice)
    1=Not important , 5=Very important)
i) Word-processing and printing documents
1--------------2-------------3-------------4--------------5
Not Important   Very Important

ii) Sending and receiving email messages
1--------------2-------------3-------------4--------------5
Not Important   Very Important

iii) Sending and receiving email messages with "attached" documents
1--------------2-------------3-------------4--------------5
Not Important   Very Important

iv) Looking up email addresses of people within your organisation
1--------------2-------------3-------------4--------------5
Not Important   Very Important
v) Within your email application; having an automatically updated email address list of people within your organisation
1--------------2-------------3-------------4--------------5
Not Important   Very Important

vi) Have adequate training material on email available
1--------------2-------------3-------------4--------------5
Not Important   Very Important

vii) Able to share an electronic calendar with other people in same organisation
1--------------2-------------3-------------4--------------5
Not Important   Very Important

viii) Able to schedule meetings or book facilities using scheduling software
1--------------2-------------3-------------4--------------5
Not Important   Very Important

ix) Share and work collaboratively on projects using project, database or workflow software
1--------------2-------------3-------------4--------------5
Not Important   Very Important

x) Use Internet and computers for audio (voice) conference
1--------------2-------------3-------------4--------------5
Not Important   Very Important

Thank you for completing the above survey. Your comments are greatly appreciated.

B.3   Results

Only relevant data is shown in the tables below:

Q1	What computer platform do you use?					
	Q1-1	Q1-2	Q1-3	Q1-4	Q1-5	Q1-6
	Apple	Microsoft	Microsoft	Miocrosoft	Microsoft	UNIX
	Macintosh	DOS	Windows	Windows	Windows	

			3.x	95	NT	
%	25%	2%	23%	47%	0%	3%
Total	8	0.5	7.5	15	0	1

Q2	What function do you use your computer?				
	Q2-1 Word Processing	Q2-2 Spreadsheet or Database	Q2-3 Email	Q2-4 Electronic Calendar or Diary	Q2-5 Project Management
%	100%	64%	97%	27%	9%
Total	33	21	32	9	3

Q5	What email program do you use?	Total	%
Q5-1	Eudora Light	6	19%
Q5-2	Eudora Pro	0	0%
Q5-3	Netscape	4	13%
Q5-4	Claris	1	3%
Q5-5	Pegasus	0	0%
Q5-6	Lotus Notes	0	0%
Q5-7	CC:mail	1	3%
Q5-8	MS Exchange	0	0%
Q5-9	MS Outlook	0	0%
Q5-10	Compuserve	3	9%
Q5-10	FirstClass	2	6%
Q5-10	AOL	13	41%
Q5-10	Other	2	6%

Q21,22	Email Attachment problems?		
	Q21a Receive undecoded email attachments	Q21b Can manually decode encoded attachments	Q22 Can open?
%	93%	40%	73%
Total	28	11	21

Q41	How Important are the following?									
	Q41-I Word process-ing	Q41-ii Email	Q41-iii Email w Attach-ments	Q41-iv Lookup Address es	Q41-v Auto-Address Updates	Q41-vi Email Training	Q41-vii Calen-dering	Q41-viii Sche-duling	Q41-ix Work-flow	Q41-x Audio & Video Confere n-cing
Average	4.91	4.77	3.1	3.13	2.85	2.88	1.5	1.25	1.75	1.8

1 = Not Important   5 = Important

Appendix B

Communication Requirements

The OMF Communications System will be an International communications hub, providing functionality to all OMF personnel. It will provide email, mailing lists (conferences), on-line information and directory service for all OMF personnel.

In order to determine appropriate products and solutions, a list of requirements was compiled from various sections and projects.

The list is categorised into four sections: email, directory, discussion, and information. Each section has the subcategories security, usability (ease of use), compliancy (with open industry standards), functionality, and management (expectation, regulation, or code of practice).

Items are labelled as being essential (**E**) or desirable (**D**), having a value of importance according to a priority rating between 1 to 5. (1-critical, 2-very-important, 3-important, 4-desirable, 5-would-like)

B.1 Email

E	1	Compliancy	Compliant with POP/SMTP and MIME standards.
E	1	Compliancy	Supports SMIME - Secure MIME
E	1	Security	POP and SMTP Authentication by Usercode / Password
D	3	Security	Password encryption via Internet
D	4	Security	Anti-virus detection and removal of email attachments by SMTP servers and email clients.
E	2	Security	SMTP server to prevent "junk mail" (e.g. from unsolicited advertising)
E	1	Security / Usability	Easy to use encryption of messages without the need of manual steps to encode and decode.
D	3	Compliancy	Supports HTML formatting.
E	1	Functionality	Sends messages to (To), Carbon Copy (CC) or Blind Carbon Copy (BCC) to any number of recipients.
E	1	Functionality	Ability to send documents programs and forms without manual decoding steps.
E	1	Functionality	Data, filename and type transferred unaltered.
E	1	Functionality	Send attachments of 5Mbyte or smaller
E	2	Functionality	Send message with 3 or more attachments
E	1	Functionality	Transfer Microsoft Outlook forms in both "with form information" and "without form information" formats.
E	2	Functionality	Sends, replies, forward, and redirects email messages by use of filters acting on message content.
E	2	Functionality	Full Internet header information sent on forwarded, redirected or replied messages.
E	2	Functionality	Search capability for content of email messages in all email folders and subfolders.
E	2	Functionality	Collects email from multiple email accounts and providers into the same email client.
D	3	Functionality	Ability to send email from within MS Office applications.
D	3	Functionality	Drop-and-drag capability - e.g. drop-and-drag filing capability with sub-folders.
D	3	Functionality	Auto "read message" capability. (i.e. the email client (program) will automatically send a reply to an email message that has the "let me know when message is read" flag set, after it has been received and read).
D	3	Functionality	Import and export email and address book to/from other email clients (e.g. Import Eudora address book to MS Outlook).
D	4	Functionality	Behaves in a similar fashion as other Windows applications.
D	5	Functionality	Receives facsimile documents directly from personal fax/modem.
D	3	Management	Can use OMF standardised email template for composing new email messages

B.2 Directory

E	2	Management	IHQ to maintain OMF directory containing names, email addresses, postal addresses, telephone and facsimile numbers of all OMF personnel.
E	2	Management	Establish OMF International email addressing schema
E	1	Functionality	Searchable for name, email address and office function.
E	2	Functionality	Separate OMF address and personal address list in the Email client (i.e. multiple address books).
E	2	Functionality	Automatic distribution/update of OMF directory with email clients.
D	3	Functionality	Automatic synchronisation of OMF directory on major OMF office mail-systems.
E	2	Functionality	OMF directory updates to import directly into Email clients without modifying personal address lists.
E	1	Security	OMF International email address to be available to OMF members only
E	2	Compliance	LDAP support for on-line Directory
E	1	Functionality	Ability to transfer address list from one computer to another - Desirable to merge with other address list - Essential to be able to copy.
D	3	Functionality	Email client automatically adds new addresses from any incoming mail to the personal address list.

B.3 Discussion / Mailing Lists

E	1	Security	Appropriate security applied to conferences (e.g. open/closed, moderated/unmoderated, post only from OMF addresses, etc).
E	1	Security	Postmaster (not individuals) to create OMF conferences.
E	1	Usability	Easy to create and maintain mailing lists.
E	1	Usability	Able for users to determine available mailing lists and who is subscribed.
E	1	Functionality	Users remotely subscribe and unsubscribe to conferences using either email or web using their OMF International email address.
E	1	Functionality	Ability to send email attachments to conferences.
E	2	Functionality	Headers and footers automatically applied (e.g. "this message comes to you from the omf-news conference" and "to unsubscribe from this conference send an email message to...").
D	2	Management	List all OMF conferences used within OMF Internationally, with statement about their purpose, owner and membership requirements.
E	1	Functionality	Users to be able to determine which mailing lists they are subscribed to via email message or web browser.

B.4   Information

E	1	Security	Firewall security for International communications hub and IHQ LAN. (Prevent attack or break-in).
E	1	Security	Authentication using username password
E	2	Security	Authentication using digital certificates (e.g. Secure ID, Digital ID or Smarcard).
E	2	Security / Functionality	Synchronisation and replication between major OMF offices of Database and other information via Internet to use encryption (e.g. VPN plus encryption).
E	1	Usability	Easy to use interface on client
E	1	Compliancy	Supports HTTP, SHTTP, SSL and FTP

Appendix C

OMF Email Analysis

April 1997

If all email programs and mail servers involved were compliant with the RFCs[101] for POP3[102], SMTP[103] and MIME[104] one would expect no problems in sending and receiving email with file attachments, but this is not so.

It could be shown from various Provider lab tests[105] that availability and performance from some ISPs could provide reliable Internet Access and reasonable speed. However, no published works could be found that tested the reliability in terms of being able to send email attachments between various people using different ISPs.

A series of tests were designed to provide a better understanding of the reliability of different email systems to deliver email messages containing two different types of email attachments.

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[101] Request For Comments (RFCs)
[102] Post Office Protocol (POP) is described in RFCs 1957, 1939 and 1725
[103] Simple Mail Transfer Protocol (SMTP) is described in RFCs 821, 2197, 1830, 1845, 1869, 1870, 1891, 1985, and 2034
[104] Multipurpose Internet Mail Extension (MIME) is described in RFCs 2231, 2184, 2112, 2049, 2048, 2047, 2046, 2045, 1927, 1896, 1741, 1740, 1641, 1556, 1437, 1428 and 1344.
[105] Internet Magazine, December 1998, *The Best ISPs in Britain*

C.1   Participants

Participants were selected people within OMF, working in different countries, most of whom used different Internet Service Providers for sending and receiving email. As many people as possible intending to use the Candidate Processing System (CPS) were included, to ensure that the OMF's communication system could cope with specific requirements of CPS.

	OMF Office	OMF Remote	CPS Users
Participant included:	✓	✓	✓

C.2   Number of respondents, Countries and ISPs

Country 12 Countries	ISP 27 ISPs	Nunber 88 Respondents
Global	aol.com	18
Global	CompuServe.com	18
AU	aone.net.au	1
CA	omf.ca	2
ID	indo.net.id	2
KR	chollian.dacom.co.kr	1
MY	jaring.my	1
PH	weblinq.com	1
PH	jmf.org.ph	4
PH	mozcom.com	1
SG	omf.org.sg	5
SG	post1.com	3
TH	ksc15.th.com	2
TH	a-net.net.th	1
TH	loxinfo.co.th	2
TW	cef.org.tw	1
TW	gcn.net.tw	1
TW	kscgeb.edu.tw	1
TW	hinet.net	1
TW	thu.edu.tw	1
TW	seed.net.tw	1
UK	cam.ac.uk	1
UK	omf.org.uk	8
US	cproject.com	8
US	omf.org	2
ZA	pixie.co.za	1

C.3   Methodology

Email messages were sent to people within OMF requesting them to respond accordingly. Subsequent messages would then be sent to them containing two different file attachments: the first a Microsoft Word document (.doc) file attachment, the second a Program (.exe) file attachment that could run on a Microsoft Windows 3.1 or 95 computer.

There were three tests:

- Test 1 (plain text message)
- Test 2 (MS Word.doc file attachment)
- Test 3 (Program.exe file attachment.

Test 2 and 3 were compromised of two parts:

- part a - response: Could they open the file attachment?'
- part b - response: reply with file attachment

Expected outcome from tests:

- pass - response OK
- fail - response NO or message delivery failure
- no response

Expected response:

Pass - reply OK	✓
Fail - reply NO or delivery failure	✗
No response	?

No response meant that no delivery failure notification was received from any email system, and no message was received from participant in response to the message sent. In such circumstances, one could not be certain that the message was actually received by the recipient.

Success meant an email response had been received.

C.4   Results

Test 1 - Text message

Sent text message	88	
Replied to text message	59	67%
Message bounced	2	2%
No reply	27	31%
Total		100%

Test 2 (a) - Sent MS Word document file attachment

Sent MS Word document	57	
Pass - Reply - OK - could open document and read document	36	63%
Fail - Reply - NO - could not open and read document	4	7%
Fail - Message bounced	5	9%
No response	12	21%
Total		100%

Test 2 (b) - Recipient replies by sending Word document file attachment

Pass reply-OK - received document intact	28	49%
Fail - NO - received corrupted document	8	14%
Fail - reply-NO - Said they could not send attachment	4	7%
No response	17	30%
Total		100%

Test 3 (a) - Sent and received a Windows Program file

Sent Windows program file	35	
Pass - reply-OK - recipient could run program	18	51%
Fail - reply-NO - recipient could not run program	5	14%
Fail - Message bounced	0	0%
No response	12	34%
Total		99%[106]

Test 3 (b) - Recipient replies by sending back a Windows Program file

Pass - OK - could run program	15	43%
Fail - NO - could not run program	3	9%
No response	17	49%
Total		101%[107]

---

[106] 1% rounding error
[107] 1% rounding error

Test 1) - Sent Plain Text Email Message

A plain text message was sent to eighty-eight people within OMF requesting them to participate in the testing programme by replying to the email message. Fifty-nine people responded, and all but two were willing to participate.

Test 1 - Plain Text Message	Pass reply-OK	Fail	No Response	Total
Number responded	59	2	27	88
Percentage	67%	2%	31%	100%

Test 2 part (a) - Sent MS Word Document File Attachment

An email message with a Microsoft Word document file attachment was sent to the fifty-seven people who indicated they were willing to participate in Test 1.

Thirty-six of the fifty-seven (or sixty-three percent) participants responded saying they could open the Microsoft Word document file attachment, that was sent to them. Four responded saying that they could not open the file attachment, and five delivery notification messages were received. The remaining twelve participants did not respond.

Test 2 part (a) Send and receive message with MS Word document	Pass reply- open attachment OK	Fail reply-can not open attachment	Fail delivery failure message	No Response	Total
Number responded	36	4	5	12	57
Percentage	63%	7%	9%	21%	100%

Test 2 part (b) - Reply with MS Word file Attachment

In Test 2b participants were requested to respond by sending an email message containing a Word document file attachment. Success meant that the reply email message with file attachment could be opened.

Thirty-six had sent a reply with Microsoft Word document file attachment, of which twenty-eight were able to be opened automatically and eight were encoded and could not be opened automatically (fail). Four people indicated they did not know how to send an attachment (fail). The remaining seventeen participants did not respond.

Test 2 part (b) Participant replies by sending an email message with MS Word document	Pass open reply attachment OK	Fail can not open reply attachment	Fail delivery failure message	No Response	Total
Number responded	28	8	4	17	57
Percentage	49%	14%	7%	30%	100%

Test 3 part (a) - Sent Windows Program File Attachment

In Test 3a, twenty-three of the thirty-five participants who were sent a message with a program file that could be run on a Windows computer responded. Eighteen participants were able to run it on their computer, five replied saying they could not run the program, and no response was received from the remaining twelve participants.

Test 3 part (a) Sent Windows program file attachment	Pass reply- open attachment OK	Fail reply-can not open attachment	Fail delivery failure message	No Response	Total
Number responded	18	5	0	12	35
Percentage	51%	14%	0%	34%	99%[108]

---

[108] 1% rounding error

Test 3 part (b) - Reply with Windows Program File Attachment

In Test 3b, eighteen out of the thirty-five participants responded by sending a program file, ten (or thirty-two percent) of which could be run when received, and one could not be opened. No response was received from remaining twenty participants.

Number Responded	15	3	17	35
Percentage	43%	9%	49%	101%[109]

C.5   Summary of Results

Test 1 - Text message	67%	2%	31%
Test 2 (a) - Receive MS Word document OK	63%	16%	21%
Test 2 (b) - Reply with MS Word document	49%	21%	30%
Test 3 (a) - Receive Windows Program OK	51%	14%	34%
Test 3 (b) - Reply with Windows Program	43%	9%	49%

As shown in the above summary, there are a significant proportion of email messages with file attachment that failed to be delivered correctly.

---

[109] 1% rounding error

Richard van Laar-Veth

C.6 Reasons for Delivery Failure

Delivery failure occurred for the following reasons:

- Computers store information in 8-bit bytes, but the email gateways (or mail servers) through which email often passes transmit information in 7-bit bytes. The various standards give different ways to convert back and forth between 8-bit and 7-bit streams of information.

- Email programs and systems use different encoding methods to transfer email, Uuencode, Binhex or MIME. Incompatibility means attachments are received as encoded text within the body of message.

- Mail transfer between SMTP servers was not reliable or had too many hops, causing message to bounce.

- Domain Name was not found of recipient's SMTP mail server, causing message to bounce.

- CompuServe email system proved incompatible, often attachments were lost or corrupted.

- Participants did not understand instructions.

Background information and explanations of how email works can be found in Appendix D.

Appendix D

Email Explained

The following explanation provides a better understanding of how email is sent and received using Internet Mail Protocols (SMTP, POP)
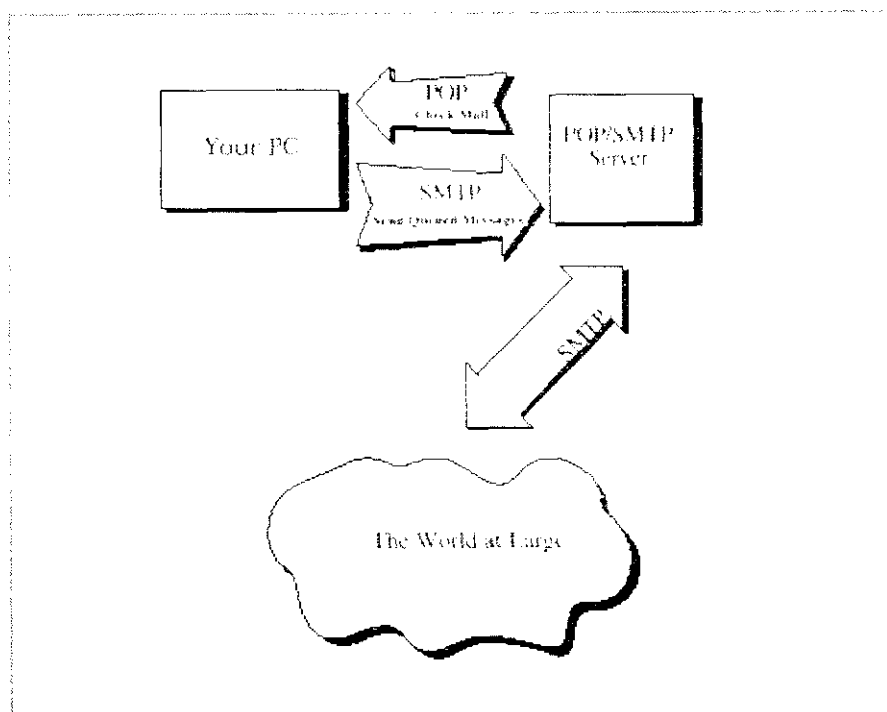

Figure 30:   How Email Works - SMTP/POP3

D.1   Mail Transport

Email Attachment tests showed that one cause for delivery failure of email messages was due to unreliable mail transfer between SMTP servers.

An email program such as Eudora or Outlook uses Simple Mail Transfer Protocol (SMTP) to transfer your outgoing mail to an SMTP mail server, which in turn uses SMTP to send your email message to the world at large. Mail from the world at large arrives on your Post Office Protocol (POP) server, where it waits for your email program to pick it up with POP version 3. The mail your email program sends and receives is constructed in accordance with RFC 822 and RFC 1521 (MIME).

Outgoing Mail (SMTP)

When you send an e-mail message to someone, your email program uses SMTP to send the mail to your local SMTP server computer. That computer then sends the email message to the address of the person to whom you are sending the email message, also (usually) by means of the SMTP protocol.

An email program does not normally communicate directly to the computer you are sending email. This is because it would take a lot longer for your email to leave your personal computer (PC), since your PC would have to call up each of the computers you are sending email and deliver your messages. Another reason is that some computers are "hard to find;" it's much better to let another computer "hunt" for the computer you are sending email to than to make your PC do it. In addition, sometimes computers are not always available when mail is to be sent, particularly if the PC's are on a dial up connection.

The SMTP mail server handles this by holding your mail until the other computer is ready to accept it, eliminating the inconvenience of having messages waiting to be sent stored on PC.

Incoming Mail (POP)

When somebody sends you email, other computers use the SMTP protocol to deliver the mail to your POP mail server. Your POP mail server puts email messages in your server mailbox where it remains

until your email program downloads your email messages. When you
check your mailbox for new messages, your email program uses POP
version 3 to download your email messages onto your PC.

D.2   Email Client Compatibility

Within OMF a variety of email programs and systems are used. The
email attachment tests showed that one of the causes for delivery
failure of email messages was due to the incompatibility of email
programs and systems using different encoding methods to transfer
email, Uuencode, Binhex or MIME.

The basic technology issue is that desktop workstations maintain
information in 8-bit bytes, but the email gateways through which
email often passes transmit information in 7-bit bytes. The various
standards give different ways to convert back and forth between 8-bit
and 7-bit streams of information.

The following tables indicate which encoding methods are used by
various email programs:

Sending System Attachment Decoding Protocols

Email System	MIME	Uuencode	BinHex
Eudora 1.n.n	MIME		Binhex
Eudora 2.x	MIME	Uuencode	Binhex
Eudora Lite 3.x (Mac use AppleSingle setting)	MIME		Binhex
Eudora Pro 3.x (Mac use AppleSingle setting)	MIME	Uuencode	Binhex
NUPop 1.n	none	none	none
NUPop 2.n		Uuencode	Binhex
Netscape 1.n	none	none	none
Netscape 2.n	MIME		
Netscape 3.0	MIME		
Netscape 4.0	MIME	Uuencode	
Explorer 3.0	MIME	Uuencode	
CC:Mail	MIME		
Groupwise (Novell NLM gateway)	MIME		
MS Mail		Uuencode	

Microsoft Exchange	MIME	Uuencode	
Microsoft Outlook 97	MIME	Uuencode	
Microsoft Outlook 98	MIME	Uuencode	
Pegasus DOS 3.0R1		Uuencode	Binhex
Pegasus DOS 3.2 or greater	MIME	Uuencode	Binhex
Pegasus Windows	MIME	Uuencode	Binhex
Pegasus Macintosh 2.1.2	MIME	Uuencode	Binhex
Pegasus Macintosh older	unknown	unknown	unknown
VMS Email	None*	None*	None*
VMS Email with PMDF	MIME	Uuencode	
Pine	MIME	Uuencode*	
Elm		Uuencode*	

*Must use separate decoding software.

Receiving System Attachment Decoding Protocols

Email System	MIME	Uuencode	BinHex
Eudora 1.n.n	MIME		Binhex
Eudora 2.x	MIME	Uuencode	Binhex
Eudora Lite 3.x	MIME		Binhex
Eudora Pro 3.x	MIME	UUencode	Binhex
NUPop 1.n	None.*		
NUPop 2.n		Uuencode	Binhex
Netscape 1.n	none		
Netscape 2.n	MIME		
Netscape 3.x	MIME	Uuencode	Binhex
Netscape 4.x	MIME	UUencode	Binhex
Explorer 3.0	MIME	Uuencode	
CC:Mail	MIME	Uuencode	
Groupwise (Novell NLM Gateway)	MIME	Uuencode	Binhex
MS Mail		Uuencode	
Microsoft Exchange	MIME	Uuencode	
Microsoft Outlook 97	MIME	Uuencode	
Microsoft Outlook 98	MIME	Uuencode	
Pegasus DOS 3.0R1		Uuencode	Binhex
Pegasus DOS 3.2 or greater	MIME	Uuencode	Binhex
Pegasus Windows	MIME	Uuencode	Binhex
Pegasus Macintosh 2.1.2	MIME	Uuencode	Binhex
Pegasus Macintosh older	unknown		
VMS Email	None*		
VMS Email with PMDF	MIME	Uuencode	Binhex
Pine	MIME	Uuencode*	
Elm		Uuencode*	

*Must use separate decoding software.

Appendix E

General Information

E.1 Information Technology in OMF

The following general observations were made about the use of information technology and IT infrastructures within OMF.

Word-processing and Administration

The wordprocessor cum typewriter has become a tool for printing letters and envelopes that have address labels automatically printed from databases onto continuous sheets of peel-off / stick-on labels. Word-processing is perhaps the most used computer application within OMF, though no survey has been conducted to prove this, observation provides enough evidence to indicate this.

Finance

Donations to OMF are processed and entered on accounting and ledger software, and are further processed through an International Finance System (IFS) developed by OMF, so that monies can be allocated and distributed accordingly. The IFS system uses both Timeline and Microsoft Access version 2 software.

As there is no OMF standard for the accounting software used to record donations, a number of different software / systems are used within OMF. However, one system called OASIS has been developed and used within a number of OMF Offices.

Desktop Publishing

The use of desktop publishing software allows each OMF office to develop their own brochures, newsletters, and booklets in the language and context of their own country. These are usually printed on a quality laser printer, or files are sent to a commercial printer for high-quality printing. The OMF standard for Desktop Publishing is either Microsoft Word or Adobe PageMaker.

Printing

For colour brochures and other information, a colour printer is used for creating samples or proofs of materials, before electronic versions are sent to commercial printers for offset printing.

For most other printing requirements, a good quality laser printer and photocopier are necessary, thus avoiding the more expensive commercial printing charges.

Mailing Lists

Electronic mailing lists, otherwise known as electronic conferences were setup using Mission Aviation Fellowship CrossConnect (MAFxc) servers. This was free for those who had an account on the MAFxc system.

Groupware

The three major OMF offices' email systems each have capabilities for some form of Groupware or group computing. There are examples of workflow using Lotus Notes in the US office, and in the UK office, the Microsoft Exchange Server provides forms processing and shared (or public) folders.

Email Directory

Although each email system had its own directory of email and postal addresses, automatic updates between systems were not possible.

OMF's International Headquarters (IHQ) maintained the most reliable list of email addresses and made available a text version of this list.

Facsimile

Communication via facsimile was available in each OMF office, and was used extensively for messaging between offices and other people to send information such as tables or graphics. As OMF was limited to sending text only messages, facsimile and post were the only means of sending such information. The cost of sending facsimiles to other countries is much more expensive than postage, due to international telephone charges incurred in sending overseas facsimile messages.

OMF World Wide Web Home Page

Like most other organisations, OMF has a World Wide Web page available to the public, containing information about itself.

OMF International's home page (www.omf.org) has hyperlinks to the web pages of each OMF country and to its International Headquarters.

Each OMF office is responsible for the design and content of web pages related to its own country.

As shown in the diagram below, OMF Information is available on web pages in different languages.

Figure 31:   OMF Home Web Page

E.2   OMF Notation: Country & In House Codes

OMF uses the International Standard Organisation (ISO 3166) two-letter (A2) and three-letter (A3) notation for country codes, such as *US* or *USA* for United States of America.

As OMF acts to place people from their own (Home) country to work an overseas (Field) country, in-house terms such as *IHQ*, *Home* or *Field* are commonly used within OMF communication.

Therefore, combinations of ISO 3166[110] as well as OMF in-house notations are used within OMF to represent specific countries or areas of work.

E.3   Definitions of Global IT Infrastructure and IT Architecture

The following definitions provide some insight into global information technology infrastructure and architecture:

Infrastructure: a substructure or underlying foundation.

Global: involving the earth as a whole, worldwide.

Communications system: a set of assets (transmission media, switching nodes, interfaces, and control devices), that will establish linkage between users and devices.

Information system: Information pertaining to computer systems.

Wide-Area Network (WAN): a network spanning a large geographic area. (UniForum, 1997)

Information Technology (IT): the technology included in hardware and software used for information, regardless of the technology involved, whether computers, communications, micro graphics, or others. (The Open Group, 1997)

An *architecture* is a formal description of a system. It acts as a detailed plan from which a system can be implemented, and it is organised in such a way that it supports reasoning about the structural properties of the system. (The Open Group, 1997)

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[110] More information on ISO 3166 codes can be found at http://iso3166.styx.net/

E.4   Glossary of Terms used in Email Systems

The following terms are often used concerning email, in particular with respect to files attached to an email message:

Attached File

An addition to the body of an email message which is designated by the sender to be processed as a separate file by the receiving email system.

Base64

One of the encoding methods used in the MIME protocol. It converts each 3 bytes into 4 printable ASCII characters by indexing into a table.

Binary file

A file which may have significant information in all 8 bits of its bytes. Therefore it cannot be part of the normal body of an SMTP message which accepts only 7-bit ASCII characters.

Binhex

A protocol for attached files made popular in the Macintosh environment. The basic encoding method is to make each byte into 2 hexadecimal characters. The structure consists of defined begin and end lines.

Encoding

That part of a attachment protocol which specifies how the 8-bit binary bytes are translated into 7-bit bytes acceptable to SMTP.

Email Client or Program

The program on the user's workstation that accesses, displays, organizes, and sends her email. Sometimes protocol processing is performed here.

Email gateway (mail server)

A computer system which transmits email messages from one email system to another, usually between different types of email systems. Sometimes protocol processing is performed here.

Email router

A computer system that transmits email messages from one email system to another, usually within the same type of email system.

Email system

The combination of email clients and host computers or LAN's necessary to exchange email messages. For example, user workstations with CC:Mail clients plus a PC acting as a post office.

IETF

Internet Engineering Task Force. A collection of mostly volunteers who administer the Internet, broken down into working groups.

Included file

A file that is placed into the body of an email message without any encoding on the assumption that the file consists solely of printable characters (See definition of Text as Binary). Receiving email systems will not treat such files as attached files.

LAN email system

A type of email system in which the messages are stored in a file server for the LAN. Sending is accomplished by writing into the storage area belonging to the recipient.

Mainframe email system

A type of email system in which the messages are stored in files on a medium-to-large host computer. Sending is accomplished by writing into a mail file belonging to the recipient.

MIME

A protocol for attached files, which is a standard on the Internet defined by RFC 1521. It has 2 encoding methods; base64 and quoted-printable. Its structure is a system of boundary markers and content definition statements.

MIME type/subtype

One of the content definition statements in a MIME structure that provides information about the intended use of a binary file after it has been decoded. It often indicates the application that generated the file.

Microsoft Virtual Private Network

Windows VPN technology is built on the Point to Point Tunnelling Protocol (PPTP). Multi-protocol VPN protocols, like PPTP, allow organisations that are currently not IP based to still use the Internet as a secure private network. PPTP was defined by the PPTP forum made up of US Robotics, 3Com, Ascend, Telematics, and Microsoft. PPTP uses the existing Windows encryption, authentication, and configuration infrastructure of the Point to Point Protocol (PPP) and the Windows NT Server Remote Access Services.

MTA

Mail Transfer Agent. An email router or mail server (See defn). This term is defined within the X.400 specification.

POP email

An email system consisting of a server which transmits incoming email messages to user email client programs using the POP3 protocol described in RFC 1725. The server receives email normally from the Internet.

Point to Point Tunnelling Protocol

Multi-protocol VPN protocols, like PPTP, allow organisations that are currently not IP based to still use the Internet as a secure private network.

Protocol

A well-defined method for converting binary files into a portion of an SMTP message's body so that the recipient can reconstruct an exact copy of the file as it existed on the senders workstation. It consists of a structure to mark off the file from the rest of the message body, and an encoding method for the contents of the file.

Quoted-printable

One of the encoding methods used by the MIME protocol. Non-printable characters are represented by the equal sign plus 2 hexadecimal digits. Printable characters are kept as is.

RFC

Request For Comments. The definitions of Internet standards Server email system - an email system consisting of a server which transmits email messages between user email client programs using proprietary methods.

SMTP

Simple Mail Transfer Protocol. The standard for the structure and handling of email messages on the Internet as defined in RFC's 821 and 822. It allows only characters from the 7-bit ASCII character set in the body of a message. There is no provision for attached files in this protocol by itself. Hence, attached files must be placed in the body in a manner transparent to SMTP-compliant gateways.

UUencoding

A protocol for attached files made popular in the Unix environment. The basic encoding method is to make each group of 3 bytes into 4 printable characters by offsetting each 6-bit group from the space character. The structure consists of defined begin and end lines.

X.400

A comprehensive email standard issued by the International Systems Organisation.

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