10

Data communications

GRAHAM IVERS

This chapter provides the reader with the ability to have a general appreciation of hardware and software, and data communication hardware and software in particular. It will raise an awareness of the need for networks to conform to international standards and for strategies to be developed to allow this transmission to be made. The importance and use of Local Area Networks (LANs) and Wide Area Networks (WANs) in any business environment, but particularly the Health sector should be recognised. Finally the reader should gain an understanding of the importance of network management, especially for the Health sector

There is a vast array of information technology in the market today. Many think of this simply as hardware or software. In most instances, there is a need for the hardware devices to be linked together by a network.

This chapter discusses mainly the technology itself, but does mention applications using the network. It does this by conveniently initially dividing networks into LANs and WANs. Options available within each of these are explored. Technology to allow the interconnection and interoperability of LANs and WANs are also discussed.

It emphasises that it is necessary to utilise information technology to provide solutions for the applications - in this case within the health environment. Attention is also drawn to the need for privacy and security.

Some Definitions

To provide a general framework, some definitions are first provided.

Hardware - "the physical devices that make a computer system. (Reynolds, 1992, p. 478)

Communications Hardware - that special class of hardware associated with transmission of data over a network.

Software - "programs or instructions that tell the computer what to do". (Reynolds, 1992, p. 478)

Information System - "a special class of goods whose components are people, procedures, and equipment that work interdependently under some means of control to process data and provide information to users." (Reynolds, 1992, p. 479)

The above definitions are broad enough to show that they apply in any particular sector of the economy. All sectors are seeking access to information technology, to achieve some specific purpose. As an example, the electricity industry requires the technology to bill electricity accounts (and other functions). The health sector has its own particular requirements. The important thing to note however, is that most sectors use the same base hardware and software to allow information systems to satisfy the business requirements, be they a need or an opportunity. Whilst most of the technology is common, the application being run to satisfy the information requirements is often different. As an example, the health sector would not require access to packages for building power lines. Some of the possible applications used by the Health sector are considered below.

Some basics

Under hardware, items such as Personal Computers, Mini Computers, Mainframes, Printers and other devices are normally considered.

The software can range from Operating Systems to Database Management Software, Application Packages and other specialist software.

The definition of an Information System highlights that it is necessary for the components of the system to work cohesively together to establish a quality system. The best computer hardware in the world is not enough, desirable though good hardware is. If the software is full of errors (bugs), then the system is no good to anyone. Similarly, good software is not sufficient on its own. If the hardware is faulty, then the presence of good software is wasted. The definition also shows that people are an important component in an information system. In recent times, particular attention is being paid to user interfaces such as can be achieved through Windows, menus and other common interfaces. It is also necessary to recognise that without the full support of people, even the best hardware and software will be not used to its full advantage.

One piece of computer hardware does not operate solely on its own. For example, a personal computer usually has a printer attached. The printer is attached using a printer cable. It is controlled by the operating system such as DOS. This principle can be extended to a larger system such as a Mainframe where the disk drives and tape decks are separate devices linked by some type of cabling method. Similarly, these devices are controlled by the operating system. There usually would be a large number of terminals attached to the Mainframe. In some instances, mainframes at various locations might be linked together.

From the above, it can be seen that data communications needs to be considered specifically. Little happens in information technology without data communications. In its simplest form, it consists of special hardware, software and medium. The hardware might be a modem, a multiplexer, a concentrator or other communications hardware. The mix of these will be dependent upon the type of network installed. This is explored later. The data communications software consists of protocols. Formally, these can be defined as "a set of codes to be transmitted and received in the proper sequence to guarantee that the desired

terminals and computers are linked together and can send intelligible messages back and forth." (Reynolds, 1992, p. 489) So it can be seen that it is the protocol that faithfully ensures that what is transmitted is what is received at the other end - even if garbage is transmitted.

Before discussing data communications in more depth, attention is turned to consideration of the direction for selecting the appropriate technology.

A direction for selecting technology

With such an array of information technology available, the question that is often posed is "How does an organisation identify what is required to satisfy its particular requirements?" This question is even more relevant when the pace of changing technology is considered. It is important to recall that:

If you fail to plan, you plan to fail.

No one is going to pretend that the planning process will be easy. But that does not mean that the process should not be attempted. The planning that should take place in organisations when considering information technology is the development of an information technology strategy.

The diagram below from Parker and Case (1993, p. 104) highlights that it is necessary for the Information Technology strategy to be supportive of the functional goals to allow the corporate strategic goals to be realised.

Figure 10.1 Relationship among strategic goals, functional departmental goals and Management Informatin System goals. *Source* Parker and Case (1993, p 104)

Ahituv and Neumann (1990, p. 201) advocate that policies need to be developed (and then implemented) in a number of key areas for the Information Technology strategy.

Details are shown in the list below.

- Hardware policies
  - Determination of computer capabilities
  - Computer system selection
  - Financing of equipment (rent, purchase, lease)
  - Use of service bureaus
  - Equipment deployment (integrated or distributed processing)
- Software policies
  - Financing of acquired software (rent, purchase)
  - Software standards and languages
  - Employment of external contractors
  - Centralisation or decentralisation of software development
- Personnel policies
  - Training and education
  - Recruitment and displacement of employees
  - Career development practices
  - Centralisation or decentralisation of human resources
- Organisational policies
  - Committees (information system, steering, audit)
  - Location of the information system unit in the organization
  - Organisational structure of the information system unit
  - Security practices
  - Information system unit responsibilities
  - Interface between information system unit and users
  - Auditing the information system function
- Application development policies
  - Employment of external assistance (consultants, software houses, computer manufacturers)
  - Development approach (top-down, bottom-up, etc.)
  - Initiation, approval, and release of applications
  - Documentation standards
- Planning policies
  - Information system planning responsibilities
  - The planning process.

In developing the policies, it is not only necessary to consider present requirements, but to have some regard to possible future requirements. The policies might result in a staged implementation. As an example, a medical practice might purchase a personal computer initially, but ensure that the one purchased can support Windows later. It might also allow connection to a Local Area Network.

In recognition that models of hardware are continually changing and new releases of software are becoming available, any prospective purchaser needs to give strong

consideration to what is known as Open Systems Architecture. Reynolds (1992, p. 486) defines this as "one in which software can easily run on hardware from different vendors, and hardware from different vendors can be linked together in a multi vendor telecommunications network."

Of particular importance is the choice of Operating Systems such as DOS or Unix, the choice of application software that can run on several platforms and also the choice of communications protocols such as those that fall under the umbrella of OSI. The Open Systems are important as they are compliant with international standards and allow different vendors' hardware and software to work in harmony with one another. Strange as it might seem, this has only been a fairly recent development in information technology. Until recently, vendors simply developed to their own standards, and did not pay major attention to interconnection and interworking with other vendors hardware or software. The pressure from users has brought about this change in attitude by vendors.

Data communications

In recent times, it has become convenient to ignore some older technology used for connecting terminals and printers. Thus, as mentioned in the introduction, networks can conveniently be broken into LANs (Local Area Networks) and WANs (Wide Area Networks).

The choice of a LAN or a WAN is very much application oriented. For example, it would be very unusual to run word processing on a WAN, but is very common to run it on a LAN. On the other hand, a bank would not consider running its main banking system for customers on a LAN, but would run it on a WAN. The main determining factor is the nature of the application. In the above examples, customers want to be able to make bank transactions from any branch, so a WAN is necessary to support the application. On the other hand, where the bank simply wants to write to its customers and uses word processing, a LAN is suitable for this purpose. However, in many instances, businesses (including the Health sector) have applications that need to be supported by a LAN and a WAN. Methods of doing this are discussed later.

Local area networks

There are now few businesses of any size that simply operate a stand-alone computer to satisfy their information requirements. At a minimum, there are several personal computers. Rather than operating each on a stand-alone basis, consideration can be given to having these linked to form a Local Area Network (a LAN).

A formal definition provided by Stamper (1992, p. 599) states that a Local Area Network is "a communications network in which all of the components are located within several kilometres of each other and that uses high transmission speeds, generally one million bits per second or higher".

In any Local Area Network, there is a need for specialised hardware. The definitions below provide a base introduction to hardware associated with Local Area Networks.

Server - "the routine, process, or node that provides a common service for one or more other entities. (Stamper, 1991, p. 603)

Multi station Access units - a device "used to interconnect workstations". (Stamper, 1991, p. 594)

Bridge - "an interconnection between like networks, for example Ethernet to Ethernet. (Stamper, 1991, p. 594)

Gateway - "the interface between two different networks" (Stamper, 1991, p. 598)

The particular hardware required in any particular Local Area Network will depend upon factors such as the facilities required, the size of the LAN and the type of LAN (see below).

To operate a LAN, it is necessary to have LAN management software. Some of the more common packages in use are Novell, Lantastic and Pathworks. This software performs additional functions to the Operating System as discussed below.

The terminals on a LAN are usually connected by a wire of some type. This is known as the "medium". The choice of medium can range from coaxial cable to twisted pair to fibre optic. The particular medium type chosen for the implementation depends upon a number of factors such as level of security required, flexibility for alteration of the route later, the particular LAN implementation type and response time required. Although the distance that can technically be supported by a LAN is "several kilometres", there are restrictions on this. As an example, a LAN cannot cross a public road.

LANs are required for purposes such as the need of several users to share data and the need to share resources such as a printer. Thus, two receptionists in a practice could have access to accounts, to word processing and other office environment software. Unlike on standalone personal computers where for example there is a for word processing software to be installed on every personal computer, one copy of the software is installed on a server. It can be made available for use by all personal computers on the LAN. The site is required to attend to copyright matters by purchasing a licence for the number of copies that are to be made available concurrently. Under this arrangement, the number can be less than the number of terminals, but all terminals can be provided with access. As an alternative to negotiating a licence for a number of copies, a site such as a hospital can negotiate a site licence so that the software can be used on as many terminals as there are on the site.

The facilities required for LAN management are more comprehensive than those that exist under plain MSDOS. (LANs also are available for personal computers and workstations that do not use MSDOS; an example is Appletalk for Macintosh microcomputers.) This is because MSDOS was designed for a single user, whereas LANs are about multi users sharing data and resources. Some of the extra requirements include, control over who can access what applications, if access is given and whether this is simply retrieval only or if update is allowed and the need to control the resources such as sharing printers. As an example, a receptionist might not be given access to medical details, whereas that person would be given access to accounts.

There are three common types of LAN implementations. These are Ethernet, Token Bus and Token Ring. Under Ethernet, any user has the right to transmit data at any time. The

protocol overcomes the possibility of two or more users transmitting at exactly the same instance by means of "carrier sense multiple access with collision detection". Users would only be aware of the collision through slightly slower than normal response times. On the other hand, under the Token implementation, each user receives a turn at transmitting. Again, the user is not aware of this. The protocol passes a token to each user to allow the message to be sent.

It is important to note that these architectures are supported by international standards. The international standard varies according to whether the network is implemented using a bus or a ring architecture. The Ethernet standard for a bus implementation is ISO 802.3. International standard ISO 802.4 applies to a Token Bus implementation. Where the LAN architecture is a Token Ring, international standard ISO 802.5 applies. The diagrams below show an example of a bus and a ring implementation.

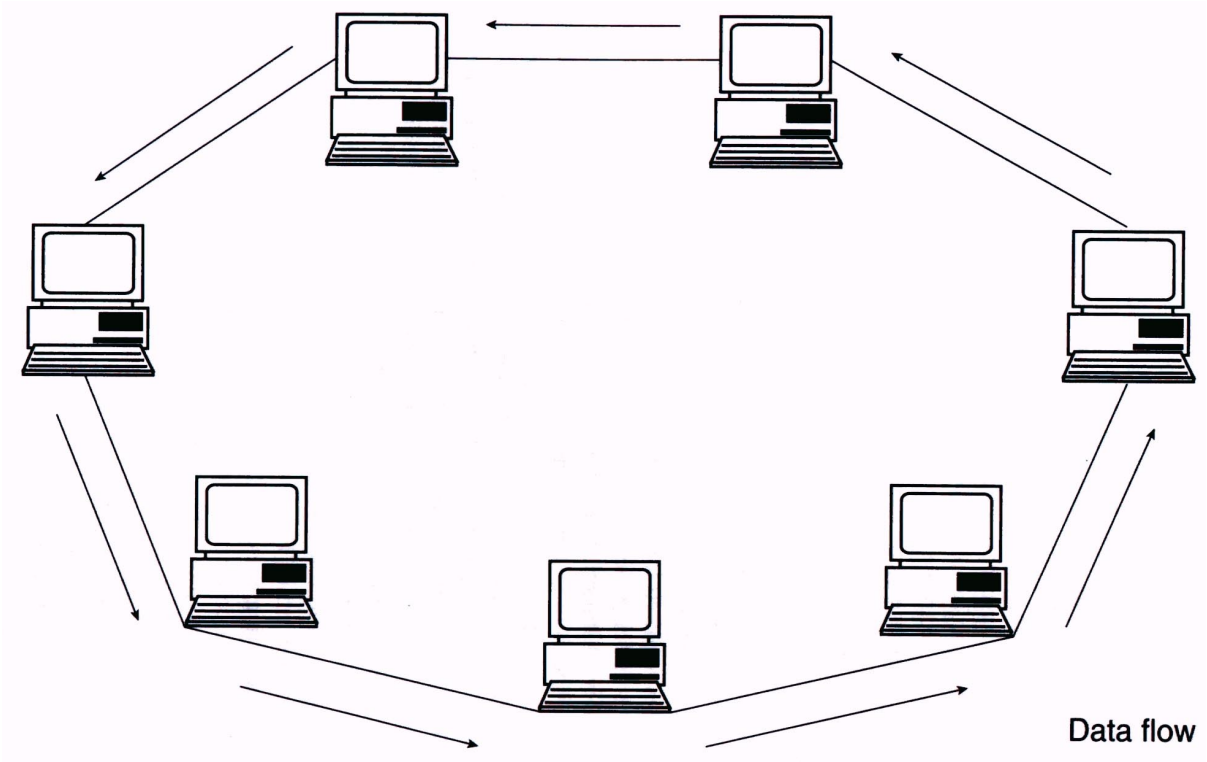

Figure 10.2 A ring configuration. *Source:* Stamper (1991, p. 252-253)

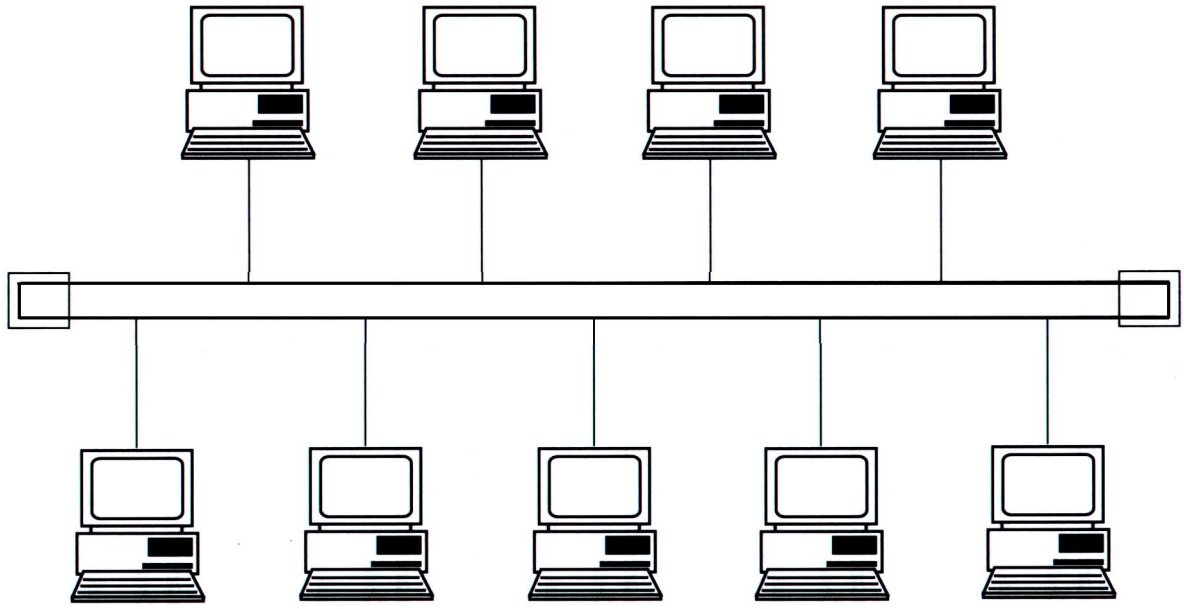

Figure 10.3 A bus configuration. *Source*: Stamper (1991)

Now as there are several suppliers of LAN management software, it is necessary for the network manager to determine which management software is appropriate for the site. This

can be done by setting up criteria and evaluating each supplier's software against the criteria. The criteria can be weighted to give recognition to those criteria deemed to be more important. The importance of the weights is vital, particularly where imaging data is to be transmitted over the LAN. For example, a LAN may be used to transmit images from the source to where the medical practitioner is located.

Criteria that is often used to evaluate LAN network management software includes the following:

Network architecture
The applications required to be run
Number of users
Distances
Expandability
Vendor support
Number of workstations
Speed
Device connectivity
Cost
Interconnectivity with other networks

The network manager needs to consider these criteria carefully and choose one that supports international standard protocols. As an example, the network manager might conclude that Novell is appropriate as it conforms with IEEE 802.3 or ethernet standard.

Alternatives to a LAN

With the vast array of technology that is available, it is possible to satisfy a particular requirement by more than one means. Two examples are provided below.

Suppose a hospital has an inventory system or a patient system. It might implement these systems on a central host computer as shown in the diagram below (Stamper, 1992, p. 313).

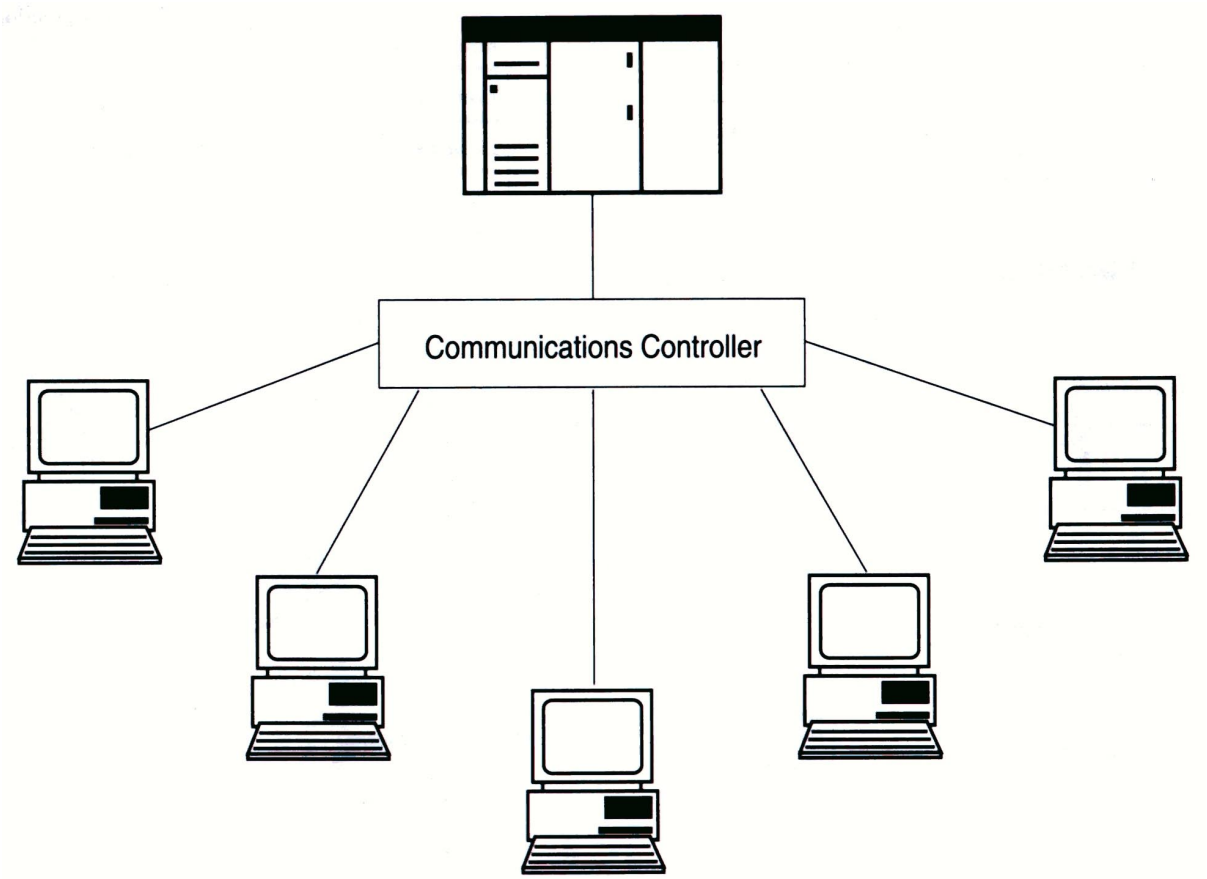

Figure 10.4 A central host computer. *Source:* Stamper 1992 p.313

Here the terminals are not connected via a LAN. Rather, they are connected via a communications controller. This implementation method is often used when dumb ASCII terminals are used. With the reducing price of technology, this implementation method is fast giving way to the LANs. Terminals on a LAN can be used to perform all processing under this method, but in addition offer extra processing options. Nevertheless, dumb ASCII terminals are appropriate when used for central processing such as creditors payment systems for a hospital.

In a small practice, initially, it might be decided to have only a couple of personal computers. Rather than purchase a printer for each or install a LAN, the option exists to simply use a switch. The switch can be manually operated or be a coded data switch allowing the program to select automatically the appropriate printer. The printers might be set up with different types of stationery. For example, ordinary stationery, account stationery, letterhead or Medicare forms. Each personal computer has access to whatever printer it requires. The example shown below is taken from Stamper (1992, p. 317).

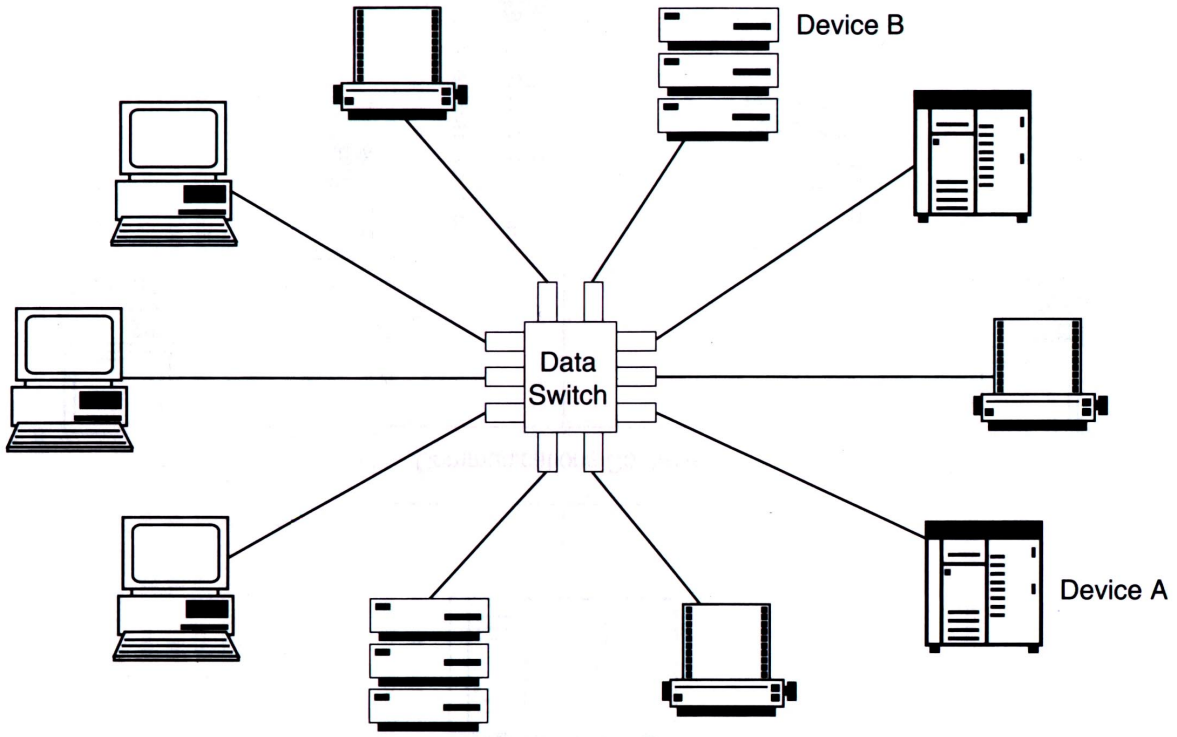

Figure 10.5 A sub-LAN configuration. *Source:* Stamper 1992, p.317

In general terms, the above has considered the use of conducted media. However, radiated media is now emerging. The use of wireless LANs, microwave and satellite are becoming more prevalent in the Health sector. Whilst radiated media does have the advantage of not requiring the installation of cables, the use of radiated media needs to be carefully considered. This is because unless special measures are put in place, it is possible for the message to be intercepted. With privacy being such a major issue in the Health sector, the network manager needs to give strong consideration to the use of encryption techniques when radiated media is used.

Wide Area Networks

Whereas a LAN provides communication over a relatively short distance, a Wide Area Network (a WAN) provides communication over vast distances. This might be between suburbs, between cities, between States or countries. If the sites to be connected are different organisations, in most cases, it is necessary to use a WAN. Even if the communication is between different parts of the same organisation, then it is determined by distance.

For use of a WAN, it is only necessary to consider an Electronic Mail system. In the Health sector, it could be used to send messages between doctors in different cities. Another example is the transmission of diagnostic imaging where a doctor seeks the opinion of a specialist in another location.

Another distinguishing feature between a LAN and a WAN is that whereas the LAN is privately owned, it is necessary to use a common carrier for a WAN. In Australia, Telecom is an example.

Both LANs and WANs require specific technology. The definitions below provide an introduction.

Analog - "measurable physical quantities, which in data communications take the form of voltages and variations in the properties of waves. Data is represented in analog form by varying the amplitude (voltage), frequency (hertz) and / or phase of a wave. (Stamper, 1991, p. 64)

Digital- where "data is (are) represented by a series of distinct entities. In data communications equipment this series is almost always a binary digit, or bit - either 0 or 1." (Stamper, 1991, p. 64)

Packet Distribution Network - "a network that divides messages into packets for transmission at their source and reassembles the packets into messages at the destination." (Stamper, 1991, p. 601)

Asynchronous transmission - the method of transmission where "each character is transmitted individually with its own error detection scheme, usually a parity bit. The sender and receiver are not synchronous with each other." (Stamper, 1991, p. 593)

Synchronous transmission - the method of transmission where "the sender and receiver are synchronised. Data is generally transmitted in blocks, rather than a character at a time as in asynchronous transmission." (Stamper, 1991, p. 601)

Half duplex transmission - the method of transmission where "the data travels in both directions over a link, but in only one direction at a time." (Stamper, 1991, p. 598)

Full duplex - the method of transmission where "data can be transmitted over a link in both directions simultaneously." (Stamper, 1991, p. 598)

Bandwidth - "a measure of the amount of data that can be transmitted per unit of time. The greater the bandwidth, the higher the possible data transmission rate." (Stamper, 1991, p. 594)

Data Compression - the method "used to reduce the number of characters or bits in a message." (Stamper, 1991, p. 596)

Not all users of a WAN have the same requirements. Traditionally, most sites only required connection to allow voice transmission. However, in recent times, this has been extended to text data and image.

Some users require dedicated access because of the large volume of communication required to be done. Others require access to numerous different sites on an occasional basis. Telecom offers a wide range of choices for sites requiring access to a WAN. Thus, Telecom provides offerings that allow analogue, digital and packet switching communication. Within these, there is a choice of asynchronous and synchronous. Further, Telecom provides a choice of speeds in half duplex or full duplex modes. The selection of the particular offering is entirely up to the site.

As the Health sector moves to take advantage of communication technology (be it through the Health Communication Network (HCN) or simply privately between medical practitioners), it will utilize WANs.

Suppose for example that a rural hospital requires permanent access to an application installed on a computer in its base hospital, it could choose between offerings such as Telecom's ISDN, Digital Data Service, Austpac or Datel. If a practice wanted occasional access to a Pathology practice, it might select Austpac. Clearly, if patient information is to be available between practices, then WANs will become an important feature. Consideration might be given to optional facilities available within offerings. As an example, a closed user group might be established under Austpac for practices sharing the patient information. A further example involves a large hospital that might desire to have its voice, facsimile and data communications controlled in one system. Alternatively, a general practitioner might want an opinion from a specialist. To do this, it might be necessary to transmit diagnostic imaging. Here, the choice would be Telecom's ISDN. Even with the bandwidth available under ISDN, as Hovenga (1994, p61) points out, to reduce the amount of data to be transmitted, it is desirable to employ some type of data compression.

So it can be seen that the offerings by Telecom differ in a number of respects. Different offerings support the use of different protocols. Others provide dedicated services whilst others provide non dedicated to numerous sites. Speed of transmission is another factor that differs between the services. Some offerings provide optional facilities. The different offerings also have different pricing structures ranging from fixed irrespective of volume to others that are variable including according to the time of transmission. Thus it will be recognised that it is necessary to have a detailed knowledge of Telecom's offerings and the applications that will operate on the WANs to select the most appropriate offering.

Just as it is necessary to manage every function in business, so it is necessary to manage a network. The network manager is responsible for the design of the network and its day to day running.

Expansion of the network or planned changes to the network can be performed in a controlled environment. The new equipment can be ordered and changes to the network management software and / or applications software can be planned in advance. By being able to plan in advance, the network manager can also plan the upgrade so that in the event of major unexpected problems, the network can be restored to its original condition.

On the other hand, some day-to-day matters require the immediate attention of the network manager. Often the network manager is contacted with the message "the network is down". On investigation, it might be found that only part of the network is down, that the network is alright but the users application is not working or that only a certain terminal is not working. So the first step in the faultfinding is to establish the nature of the fault and working from there to establish the cause of the fault. With the cause of the fault established, the network manager can then carry out the changes to overcome the problem. Ideally, this should be an immediate permanent fix. However, on some occasions it might be necessary for the network manager to provide a temporary circumvention of the problem and then to provide the permanent solution at a later stage.

LANs have become reliable, so that it is the exception rather than the rule for them to be non operational. On occasions when a LAN does go down, it can be due to a hardware fault

such as occurs on a personal computer. If the LAN is absolutely critical, it is possible to incorporate design features into the LAN to provide redundancy and to minimize the extent of the problem. One simple example is where the LAN extends over several floors such as in a hospital to split the LAN into sections and use bridges. If the cable is faulty in the top floors, the lower floors of the LAN can continue to operate. In this situation, staff can temporarily use the terminal on the other floors to gain access to the information in the emergency situation. It is possible to have terminals connected to a LAN so that even if the network does go down, the terminals can operate in a stand alone mode, thus allowing a reduced service.

It needs to be recognised that a LAN does not remain static. There are always new users, new applications, new hardware and changes of requirements that require the attention of the LAN Manager. One person should be responsible for the LAN management. The details of the LAN should be documented. Just as in any other position, there should also be a back up. Many sites contract out the management of their LAN, in recognition that their staff do not have the necessary expertise nor is there the volume of work sufficient to warrant their development of the expertise.

The management of a WAN depends upon the Telecom option that is being used on the WAN. Where the service is a Digital service, the network manager has more capacity to perform diagnostics before contacting Telecom. Similarly, Telecom has better fault diagnostic equipment. The network manager requires access to tools for performing the diagnosis. These tools can be hardware or software.

The network manager requires access to at least a network line monitor and a break out box. The network line monitor can be “attached to a communications circuit so that bit patterns being transmitted over the link can be captured and displayed to detect transmission or protocol violations.” (Stamper, 1991, p. 599) On the other hand a break out box is a diagnostic tool that “checks that signals being transmitted and to change the leads on which the signal is transmitted. A breakout box may also have features allowing cable testing and generation of bit test patterns.” (Stamper, 1991, p. 594) Other hardware tools are also available.

The network manager also can make use of the trace facility often available under the operating system. Other specialised software to assist in fault diagnosis is also becoming more prevalent.

Security and privacy are also important matters, particularly in the Health sector. These need to be considered in the design of the LAN. The LAN implementation can be made so that a particular terminal can be used by any user. On the other hand, it can be made restricted. The security and privacy measures available within the LAN should be only one part of the full security and privacy measures. It is highly desirable that several layers of security and privacy be incorporated. Examples of further layers are the use of passwords, restriction on users having access to applications and database access restrictions.

In general terms, a network carrier such as Telecom does not provide security and privacy features. However, new initiatives such as closed user groups under Austpac are beginning to emerge.

Communications in general

LANs and WANs are not mutually exclusive. A LAN can connect to another LAN. The particular additional hardware and software depends upon whether it is of the same type of LAN or not. Where the LANs are of a similar type a bridge is used, whereas when the LANs are of a different type a gateway is used. Thus, a bridge would connect two Ethernet LANs together, whereas a bridge would be used to connect a Token Ring and an Ethernet together.

A LAN can also communicate with a WAN. It does this through the server to which it is attached. Similarly, a WAN can communicate with another WAN. This simply recognises that two serves can communicate with one another when connected through a WAN. Again, with different requirements, different technology is required.

It is not uncommon for a user to require access to several servers, be they on the same LAN or not. Users are becoming accustomed to open architecture, whereby connection can be made to wherever is necessary.

Irrespective of where the connection is being made to, the technology is now available to allow a user to use the same procedure to gain access. As an example, the user simply clicks on the appropriate icon under Windows and the connection is automatically established. This preferred method of connection is often referred to as “transparent connection” or “seamless connection”.

To satisfy the user requirements, the network manager needs to prepare script files in conjunction with the user. Obviously, this script file will only work while the parameters applicable to the network do not vary, so that for example if an application is shifted from one server to another, a corresponding change needs to be made to allow the connection to work.

With many applications changing from the traditional centralised approach to one involving the use of LANs and WANs, there is a need for security and privacy to be reviewed.

Very few sites now do not require some type of communications. The technology available can meet the most simple or most complex requirements. The pace of change in communications will not slacken. It is fast becoming a very important part (if not the most important part) of an information site.

Summary

With the vast array of technology available, it is necessary to ensure that a strategic approach is adopted. This is to ensure the information requirements are met, that compatibility is obtained and that investment in hardware and software is protected.

The Health sector is moving very quickly to take advantage of the technology that is available. It will use LANs and WANs according to the different requirements. It is imperative that a strategic approach is used to identify the most appropriate information and communication needs.

Network management is required to ensure that the network continues to serve the present and future requirements of the organisation.

References

Ahituv, N. and Neumann S. 1990, *Principles of Information Systems for Management*, 3rd edn, Wm. C. Brown Publishers, Dubuque.

Brown, N. 1990, "Internal controls and systems integrity", *EDPACS*, September, pp 9-14.

Cooper, J.A. 1989, *Computer and Communications Security*, McGraw-Hill Book Company, New York.

Currid, C.C. 1992, Planning, designing and staffing LANs, *Network Management*, March, pp 61-64.

Denning, P.J. 1990, *Computers under Attack: Intruders, Worms and Viruses*, Addison Wesley Publishing Company, Reading, Massachusetts.

Forgione, D. and Blankley, A. 1990, "Micro security and control", *Tutorial of Accountancy*, June, pp 83-90.

Highland, Dr H.J. 1990, "Communications Checklist", *Computers and Society*, vol. 9, no. 6, October, pp 5-8.

Highland, H. 1989, "What if a computer virus strikes?', *EDPACS*, July, pp 11-17.

Hovenga, E.J.S. 1994, "Information Systems and Diagnostic Imaging", Informatics in Healthcare Australia, vol. 3, no. 2, pp 61 - 64.

Kauffels, F. 1992, *Network Management; Problems, Standards and Strategies*, Addison-Wesley Publishing Company, Reading, Massachusetts.

Mair, A. and Scott, J. 1994, "High hopes for productivity and health gains from Health Communication Network, *Healthcover*, April - May, 1994, pp 42 - 47.

Marcella, A. 1989, "Telecommunications; A control strategy", *EDPACS*, May, pp 1-5.

Parker, C, and Case T 1993, *Management Information Systems*, 2nd edn, Mitchell McGraw-Hill, New York.

Reynolds, G.W. 1992, *Information Systems for Managers*, 2nd edn, West Publishing Company, St Paul.

Schweitzer, J.A. 1987, "Securing information on a network of computers", *EDPACS*, July, pp 1-8.

Scott, J. 1993, "Health Communication Network : Current status and future developments, *Informatics in Healthcare Australia*, September, 1993, vol. 2 no. 4, pp 9 - 12.

Stallings, W. 1993, *Local and Metropolitan Area Networks*, 4th edn, Macmillan Publishing Company, New York.

Stamper, D.A. 1991, *Business Data Communications*, 3rd edn, The Benjamin/Cummings Publishing Inc, Redwood City, California.

Utter, A. 1989, “The four essentials of computer and information security”, *Internal Auditor*, December, pp 44-50.

Waters, S. 1989, “15 questions to ask before you buy a LAN”, *PC World*, 4 October, pp 96-99.