Chapter 10: Network Management

Current IT project systems have requirements for networking so that the data can be accessed electronically from a distance. The IT project manager should understand the basics of network management for effective IT project planning.

Telecommunications Basics

Telecommunications is defined as the electronic transmission of information. An example of telecommunications is the combination of a computer with a link for two−way communications with other computers. Telecommunications is the art and science of communicating at a distance, especially by means of electromagnetic impulses, as in radio, radar, telegraphy, and telephone. The transmission of information can be voice, data, and pictures. Improvements in teleconferencing, voice and electronic mail (e−mail), electronic bulletin boards, satellite links, fax machines, fiber optics, and information banks are being developed in telecommunications technology. Microwave towers are visible for transmitting voice and data. Fiber optics cables are replacing copper cables because of increased transmission speed and capacity and reduced size. Multimedia and compound documents that combine written text, voice, and computer communications are being developed.

A computer sends and receives data and information in the form of bits. A bit is an electronic pulse (1) or the absence of a pulse (0). Within a computer, data are stored and processed in a parallel form 16, 32, 64, 128, or 256 bits at a time and in a serial form 1 bit at a time. The computers serial port (RS 232) converts parallel data into a serial form for transmission or converts serial data back into a parallel form.

Modems

A modem is an electronic device that carries and translates from binary to analog forms of data. The modem converts data from a binary on−off digital state that is used in the computer into an analog equivalent that can be telecommunicated. The name *modem* is derived from the conversion of digital data into analog data through a process known as *MODulation* and the reverse process known as *DEModulation*. The speed at which modems can send and receive information is measured by the baud rate. The baud rate is equivalent to the number of bits per second (bps) that the modem can transmit.

When a modem is used to connect a personal computer (PC) to a telecommunications network, the communication can be simplex, half−duplex, or full−duplex. When the communication is in only one direction, the mode is *simplex*. Communication between computers is in the *half−duplex* mode if only one computer can send information at any one time. The communication is in the *full−duplex* mode if both computers can send information at the same time. The *protocol* is the set of rules that two computers follow in sending and receiving information.

The telecommunications industry is evolving quickly. With the increasing use of fiber optics, wireless communications, and satellites as communication media, technology is evolving by replacing analog transmission with digital voice transmission. The transition to a digital standard, called an *integrated services digital network* (ISDN), makes possible the transmission of many types of signals (e.g., voice, video, and data). IT managers are faced with the herculean task of managing a mix of local area networks (LANs), Intranets, and Extranets. IT managers must keep up with the rush of bandwidth being used by e−mail, videoconferencing, and multimedia applets running across the Internet (Hammond, 1999).

IT Networks

IT networks use telecommunications to link two or more computers and allow them to share data, spread out the processing chores, or serve as huge repositories of information that is valuable to users. IT networks can be a LAN or a wide area network (WAN).

LAN

LAN is a system of computer hardware and software that links computers, printers, and other peripheral equipment into a network at a single location. LAN is suitable for transmission of data between offices in a building or between a range of buildings situated near one another (e.g., a university campus or an office building).

E−mail on a network is sending and receiving of messages, pictures, and documents to one or more persons. Linking PCs together with LAN can be difficult, especially if the PCs are not the same type or they are using different operating systems. The file server contains data and information files that other users can access and reuse.

LAN is configured as star, bus, or ring networks. In the star network, a host computer has multiple slave computers connected to it. Since the host controls all data communications, any communications between any two computers must be routed through the host computer. If the host fails, then the entire system goes down. Multiple PCs hooked to a file server form a star LAN.

A bus network has computers that tie into a main cable or bus with no one central computer. The failure of any one computer does not affect the overall performance of the network. To send a message to another computer requires only that the software be able to signal the correct computer to receive the message. An example of a bus network is the popular Ethernet system.

In a ring network, all computers are treated the same and intervening computers must process communications between two computers. To avoid having the system go down when a single PC fails, ring LANs often have ways to drop the single PC without interfering with the operation of the LAN.

WAN

WAN can range from a few city blocks to almost global. WAN consists of academic and research networks (private networks designed to provide communications between an organizations host computer and the employees and customers terminals) and value−added networks. All WAN computers use packet switching for telecommunications. In packet switching, the terminals are linked to the host computer through interface computers. The host computer breaks up long messages into data units called *packets*, which are then given to the interface computers to transmit through the network. The terminal at the destination receives the packets and reassembles them into a copy of the original message.

Academic and research networks interact between universities and other research institutions, like the Advanced Research Projects Agency Network (ARPANet). Commercial e−mail systems allow subscribers to send and receive electronic messages via the Internet.

SuperNet is the network being designed by a team of U.S. government, academic, and industry researchers to achieve a high−speed nationwide network that offers a glimpse of the Internets future. The network will provide end−to−end transmission speeds of 2.5 million bpsmore than 1000 times faster than the current Internet. The program is responsible for commercialization of high−speed optical switches currently being

deployed by a long−distance carrier. The next phase of the research program will focus on protocols and network management tools that will guarantee end−to−end quality of service and security for high bandwidth applications.

The SuperNet backbone will connect 100 users via six regional research networks that range in speed from 2.5 million bps to 20 million bps. Researches will be able to reserve huge amounts of bandwidth for demanding real−time applications, such as telemedicine, distance learning, and videoconferencing. The network management algorithms and control strategies that result from this effort will make it easier and more cost−effective for corporate customers to run high−bandwidth applications (Marsan, 1999).

Internet Technology

Internet technology consists of connected computers that allow information to be sent and received around the world. The Internet offers access to the World Wide Web (WWW). Wireline leverage technologies, such as hypertext transfer protocol (HTTP) for display of active server pages (ASPs) with dynamic content in the form of hypertext markup language (HTML) or extensible markup language (XML), optimize user experience.

Wireless Technology

Wireless technology means accessing information anytime, anywhere. Accessing real−time organization data and e−mail and facilitating enhanced communications among practitioners are valuable advantages of wireless technology. In the United States, wireless technology has evolved from first generation to second generation.

The first generation is analog cellular, which consists of circuit−switched data (CSD), including a voice channel dedicated to data (just like a landline modem or a fax machine) and the ability to connect a phone via a cable to a notebook computer or personal digital assistant (PDA). Because of a dedicated connection, message length is not limited. An advantage of CSD is that dedicated connection time billing makes sense for larger files if speed is decent. However, this is a potentially costly way to use the Internet because CSD speed is in the range of approximately 4800 bps to 9600 bps and users are normally paying on a per−minute basis. Thus for short messages CSD can be inefficient.

The second generation of wireless technology consists of time division multiple access (TDMA) and global system for mobile (GSM) communication. An analog line dedicates a channel to a single user, whereas digital subscribers take turns using a channel. The TDMA speed range is from 9600 bps to 64,000 bps. Therefore the number of users may be increased by three compared with analog because three conversations share the same frequency. A benefit of TDMA is that battery life is extended because the phone transmits one third of the time. TDMA technology is the foundation for digital but is not a global standard because it is not used in Europe at this time.

GSM is similar to TDMA, with worldwide roaming and data rates of 9600 bps. It is the standard for most cellular systems on the personal communication service (PCS) band. Currently, over 130 countries that use GSM use GSM1900 (on different frequencies), code division multiple access (CDMA), and TDMA.

Challenges to the Project Manager

Although the value of wireless technology is limited because of issues such as slow connection speeds and user mobility, it can be a tool to complement a wireline application. The wireless web uses wireless application protocol (WAP), handheld device markup language (HDML), wireless markup language (WML),

HTML, and other emerging standards and tools. Disadvantages are high cellular phone rates, limited screen space, and virtually no graphic capability. The challenge for the project manager is to work with both information and technical architects to build an application and a user interface. This will deliver content at a low cost to the mobile user while continuing to provide rich content and full functionality without budget cost overruns (www.wapforum.org).

As a project manager, a web site may not need to employ an open architecture; however, it may be advantageous to consider an architecture that costs the client more up front but is able to handle a wireless component, especially as applied functionality improves. Verification of transmission, or letting the sender know that the receiver got the message, is important. Equally important is authentication, or verification of the identity of the sender.

Wireless Data Providers

Paging

The paging network delivers a broad array of coverage for a low volume of data at a relatively low cost. Paging comes in three types: one−way, two−way, and 1.5−way paging. One−way paging is the least expensive of the paging alternatives, offers the best coverage, and is one of the easiest solutions to deploy. However, it is only viable for sending information to users; it provides no way of verifying whether a message was delivered. Most of the same limitations apply to 1.5−way paging, with the notable exception of its being able to acknowledge the receipt of a message.

All devices using the two−way network are automatically switched between basic and full coverage, and the user is notified when the coverage area changes. Among the paging solutions, two−way presents the most compelling options. Truly interactive applications can be developed to facilitate effective two−way interactions. The carrier that offers two−way paging is somewhat limited as compared with one−way and 1.5−way.

Packet

The two major caveats for paging are speed and cost. Most paging networks perform at less than 2.4 kilobytes (kb) per second, and this is only viable for a small amount of information. Although paging networks are useful for sending small amounts of information, they are not reliable for mission−critical applications and were not designed for data transfer. To address these issues, two packet data networks were developed specifically for mission−critical wireless data needs. Because of the tremendous cost of deploying these networks and the limited base of customers demanding this type of service, packet data networks are expensive. The advantages of packet data over paging are the intrinsic error detection and correction capabilities for which these networks were designed to handle.

Cellular

Although cellular data networks were built for voice data transfer, the migration toward cellular data networks is progressing at a staggering pace. Cellular data networks offer several advantages over paging and packet data networks. The primary advantage is that cellular networks can effectively carry both voice and data on a single device. However, wireless data access using cellular data networks is expensive.

Satellite

Few wireless applications justify the cost and limitations inherent in satellite systems. The only advantage of using satellite networks for wireless data communications is for remote areas that cannot be covered by any other network (Hayden, 2000).

Wireless Devices and Platforms

Application interfaces are developed for multiple devices and platforms. For example, a PDA has a larger viewing screen than a mobile phone. Some of the wireless devices and platforms are discussed as follows:

- Wireless application protocol (WAP)enabled digital phones
- PDAs and handheld computers
- Windows CE
- Two−way pagers
- Global positioning system

WAP−Enabled Digital Phones

Wireless information services may be deployed on WAP−enabled telephones. WAP is a new standard but is becoming a widely accepted protocol. Developers prefer a single standard because they can write to a single open standard and carriers do not have to support multiple communication protocols, manufacturers, and users who do not have to make a corporate or personal decision about devices with one protocol or another. WAP is an open standard that allows wireless devices to communicate independently of vendor or wireless networks and thus can more easily access information and Internet services.

WAP is a network−independent standard that will operate on GSM, CDMA, and TDMA. It offers secure access to the Internet and is optimized for low bandwidth, high latency, and stability. Although the limited display size may not allow all of the content available on other hardware platforms, WAP−enabled telephones provide a broad selection of devices and networks and are already becoming prevalent among a wide user base. However, they are currently not supported by many devices.

PDAs and Handheld Computers

The Palm Vx runs the standard Palm operating system and may be used for other Palm−certified applications, such as address books and calendars. The Novatel Minstrel V modem uses any of the cellular digital packet data (CDPD) wireless networks in the United States. The Palm and the modem contain rechargeable batteries.

The Windows CE A Win CE HPC device coupled with a Sierra Wireless AirCard−300 will be used as one of the hardware platforms. The HP660−compatible device must be on the list of approved devices for the AirCard−300. The AirCard−300 is a CDPD PCMCIA modem containing external rechargeable batteries, but it also is able to draw power internally from certain Win CE HPC devices.

Two−Way Pagers: RIM 850 and 950 Pagers

The Research−In−Motion (RIM) 950 interactive pager can use the BellSouth Wireless Data (Mobitex) network and the Blackberry messaging service. RIM also makes a model 850 version of the pager, which operates on the ARDIS network. The 850 has a different and broader coverage area in the United States. Future devices from RIM are anticipated and may become ideal candidate platforms for wireless information services. As paging support for GPRS wireless networks becomes available, these devices will become a significant option for international usage as well (Motorola, RIM). The strengths of the RIM pager are the

small size and light weight of the device, large penetration, and two−way capabilities such as e−mail, Internet access, and messaging. The weaknesses of the RIM pagers are their small work and display area, limited usage, and difficulty of data entry.

Global Positioning System

The global positioning system (GPS) determines the code phases (pseudoranges) for the various GPS satellites. GPS determines the time of applicability for the pseudoranges and demodulates the satellite navigation message. Users compute the position of the receiving antenna using the pseudoranges, timing, and navigation message data. The satellite navigation message and its inherent synchronization bits are extracted from the GPS signal after it has been acquired and tracked. To serve a larger area, the GPS reference receiver is replaced by feeds from a wide area reference network (WARN) of distributed receivers.

The WARN server retrieves and stores data from the GPS reference receivers and provides aiding data to mobile units. The server also performs navigation solutions (calculates longitude, latitude, and altitude) after receiving pseudorange measurements from the handset.

Enhanced GPS (EGPS) improves on conventional GPS performance by offering the following (Krasner, 1999):

- Allows improved sensitivity and acquisition times and enhances system accuracy by using a snapshot and the processing power of digital signal processing (DSP)
- Shares processing functions between the DSP built into most wireless handsets and a network server operating within a carriers network
- Uses information available from the wireless network itself
- Processes only a snapshot of data in software rather than processing it continuously in hardware

Uses of Wireless Technology

Adults in the United States use wireless technology for the following: 67% access e−mail remotely, 67% use GPS to get directions, 63% browse the Internet, 59% take digital pictures and send them to family members and friends, and 57% conduct a videoconference (*USA Today*, January 2000).

Future of Wireless Technology

The wireless market for web−enabled devices (e.g., mobile phones, PDAs, and two−way pagers) is growing at a much faster rate than the Internet. The research firm Yankee Group predicts that the number of worldwide wireless subscribers with Internet access will reach 15 million by the end of 2000. Motorola has shipped close to 5 million wireless Internet−enabled phones. Sprint has more than 7 million wireless customers, including about 2.5 million with Internet−enabled phones. AT&T has 12.2 million U.S. wireless users. Nokia began selling its Internet−enabled phones in the United States in the Fall of 2000. By 2003, more than 500 million data−enabled mobile phones, more than 20 million PDAs, and more than 100 million pagers will be in the marketplace, leading to a wireless base of 1 billion. In 1998 the PC market install base consisted of 298 million, and the expected growth by 2003 is an install base of only 550 million.

The future of wireless technology is to move to packet−switched connections and combine high−bandwidth and high−speed mobile access with wireless Internet services. This enables much richer applications, including videoconferencing, Internet and Intranet access, instant messaging, and interactive application sharing. This will initially be able to leverage existing spectra but ultimately will need new spectra to achieve necessary speeds.

The future of wireless technology will focus on increasing data flow and voice capacity with an eye on eventually replacing the wired phone service and continue challenges that include security issues, seamless data transmission, and an unprecedented demand for communications services.

Cellular Communications

Cellular communications relies on specific radio frequencies to carry information. Three frequency bands800 MHz, 1900 MHz, and 2400 MHzhave been designed by the U.S. Federal Communications Commission (FCC) as available for cellular services.

When a user activates a cellular phone, the signal travels to a tower equipped with a receiving antenna. The area covered by the antenna is called a *cell*, and cells vary in size, depending on terrain and capacity demands. Service providers place the equipment in locations so that coverage areas overlap.

As a user moves from one towers range to another, a process known as a *hand−off* takes place so there are no transmission breaks. The antenna works with a special−purpose computer, known as a *mobile telephone switching office*, that monitors all call activity. The computer also has an output line that feeds into a wired telephone line, connecting a caller to the public telephone network.

Cellular equipment suppliers have begun working with standard bodies to boost transmission speeds. The wideband CDMA standard, which is used to distinguish data transmission from voice transmission on cellular networks, should enable manufacturers to increase the top speeds of cellular signals from 14.4 to 64 kb/sec on uplinks and to 384 kb/sec on downlinks.

Virtual Private Networking

Virtual private networking (VPN) technology uses tunneling, encryption, authentication, and access−control technology to transmit data securely over the Internet or another public backbone, such as a service providers Internet protocol network or a providers backbone. VPN is quickly becoming a secure, cost−effective communication solution for a wide array of applications. VPN is replacing modems and leased lines as the preferred method for remote access.

The three types of VPN are remote access, Intranet, and Extranet. A remote−access VPN connects telecommuters or other mobile users to an organizations internal network; an Intranet VPN connects fixed locations, such as branch offices, to the internal network; and an Extranet VPN gives an organizations business partners, such as contractors, limited access to internal networks.

The classic remote−access use of VPN technology illustrates how the technology works. A remote user dials into a service provider and establishes a link to an organizations headquarters over the Internet or the providers network. The user then authenticates himself or herself for authorization to gain access to the organizations internal servers.

VPN technology is based on tunneling technology, which is used to transfer data between two similar networks over an intermediate network. One type of data packet encloses or encapsulates another data packet to shroud it from potential electronic eavesdropping, thus creating a private tunnel over a public backbone. The packets are encrypted so that the data are protected from an authorized user who may try to capture them during transmission (*Federal Computer Week*, p 17, July 19, 1999).