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Local area networks - enhancing microcomputer productivity.

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Abstract- Local area networks (LANs) are computer communication networks linking microcomputers within a distinct geographical area. LANs offer microcomputer users the utility and capabilities of mainframe multi-user systems. LANs also offer flexibility because individual workstations can be used independently as stand-alone systems. LANs enable microcomputers to share hardware, allowing for a higher utilization rate of peripheral devices and substantial cost savings. LANs also allow the sharing of data and software. Multiple users can access a central database simultaneously, eliminating the need for multiple copies and reducing inefficiency. Additionally, LANs enable microcomputers to share data processing tasks, providing the data processing capabilities of a mainframe systems.

To overcome these deficiencies, an increasing number of users are installing local area networks (LANs). A LAN is a communication network that links microcomputers within a limited geographical area. A microcomputer attached to the LAN, commonly referred to as a workstation, is able to share hardware, software, and data with other microcomputers. This capability creates a data processing environment for the microcomputer similar to that of larger mini- and mainframe computer systems.

LAN Technology

Hardware and Software. The hardware elements that comprise a LAN are illustrated in Figure 1. A LAN consists of two or more microcomputers, electrical cables, at least one network server, and an interface board for each microcomputer. Zero-slot LANs do not use an interface card; however, their data-carrying capacity is generally reduced substantially. The interface board is installed in one of a microcomputer's expansion slots as illustrated in Figure 1. Electrical cable is connected to the interface card creating a communication pathway from the microcomputer to every other microcomputer and server attached to the network.

LAN servers are microcomputers that provide or share a data processing resource with other workstations. For example, a disk server provides disk storage and/or access to stored data. Network servers are usually powerful microcomputers used in either a dedicated or nondedicated mode. As its name implies, a dedicated server is used exclusively to manage a network resource. Conversely, a nondedicated server may be used as a workstation while concurrently providing a server function. However, under heavy network demands, its performance as a workstation and as a server may deterioate substantially. Other resources commonly managed by network servers include letter quality printers, digitizers, plotters, and modems

A LAN, like any computer, is managed by its operating system. A LAN's operating system manages the hardware on the LAN, controls access to the network and its resources, as well as implements and coordinates users' requests. The performance of a LAN is determined, in part, by the characteristics of its operating system. currently, several operating systems are widely used. This offers a greater opportunity for finding a LAN suitable for the user's unique operating and data processing requirements since no single operating system is optimal for all business environments. The hardware and software elements previously described are integrated through network topology, transmission media, and protocol to form a LAN. These technological issues are an integral part of a network and determine, in

needs to use a LAN, an awareness of their role permits a more knowledgeable application of LAN technology. It also aids in understanding network problems and determining an appropriate solution.

Topology. Network topology refers to the configuration used to physically link workstations and servers. The three most commonly used topologies are the ring, star, and bus. As illustrated in Figures 2 and 3, a ring uses a closed loop while a star uses a central hub as the communication pathway between network nodes. A bus, Figure 1, uses a central cable connected by shorter drop cables to link each workstation and server to the network.

The communication configuration of each topology has certain advantages and disadvantages. A ring is the simplest topology for a network protocol to manage. However, it tends to be the most unreliable, since the failure of a workstation or cable break disrupts network communication, thereby disabling the LAN. A star topology reduces this risk by employing a dedicated pathway from each workstation to the central hub. The failure of the workstation at the central hub, however, will disable the network. A bus topology requires less cable than a comparable ring or star and is the most flexible topology for adding or deleting workstations and servers from the network. However, a break in its cable may disable the network.

Transmission Media. Twisted pair and coaxial (commonly called "coax") cables are the most popular electrical mediums used to connect workstations and servers. Twisted pair and coaxial cables are illustrated in Figure 4. Both radiate their signal outside the cable, making it easy for a potential eavesdropper to intercept. Conversely, the radiation emitted by other electrical sources such as phone lines or fluorescent lights is received and transmitted as background noise. This interference may distort cable's signal and introduce errors into its transmission.

Maturing technologies for implementing a LAN include fiber optics and infrared. Fiber optic cable is significantly superior to both twisted pair and coax in data-carrying capacity, immunity from electrical interference, and transmission distance. Since it does not radiate a signal outside its cable, fiber optics is the most secure type of electrical medium currently available. The major disadvantages of fiber optics is its significantly higher cost and skill required to install and implement.

Network Protocol. Each workstation sends and receives data over a single communication medium, i.e., the network cable. Protocols are the methods used to manage the network's communication traffic. The two most commonly used protocols are carrier sense multiple access with collision detection (CSMA/CD) and token passing. CSMA/CD requires workstations to monitor network communication and transmit only when the network is free. When two or more workstations transmit simultaneously, each workstation detects the collision, stops transmitting, waits a predetermined length of time, listens for a clear channel, and retransmits. Under light communication loads CSMA/CD provides an efficient method of controlling network traffic. However, as network communication increases, its efficiency deteriorates, i.e., more and more time is spent recovering from data collisions.

Token passing sends a stream of data along with a token, a series of bits recognized by each workstation. Only the workstation with the token is permitted to transmit. Token passing, effectively, avoids, the data collisions inherent in CSMA/CD and other protocols. Consequently, it is more efficient under heavy data communication loads. However, if the token is lost or modified, network communication may be disrupted.

Network Administrator. A LAN, like any computer system, must be managed to achieve optimal results. Responsibility for managing the network is usually delegated to an individual with computer, administrative and, perhaps most importantly, people skills. The LAN administrator is responsible for managing the network. This involves superivising the daily operations of the LAN such as start-up, monitoring the hardware and software to see that it is functioning properly, and periodically copying user files for backup purposes.

One of the most important tasks of the network administrator is to serve as a resource person for system users. A significant amount of the administrator's time will be spent training users, diagnosing and helping them resolve hardware and software problems, and directing them to reference and technical manuals. A LAN administrator is also responsible for network security. The administrator, in effect, is responsible for all aspects of network usage and performance. A capable administrator is crucial to the daily operations of a LAN and ensuring that it fulfills its data processing role.

Network Services

Hardware Sharing. A most tangible benefit of a LAN is the ability of workstations to share expensive

accounting office with seven microcomputers configured with peripherals as indicated in Figure 5. Without a LAN, a total of 18 hard disks, printers, and modems are used. With a LAN, a much smaller number of larger and more powerful peripherals are used to provide the same services to a larger number of users.

Sharing Data and Communication. A major limitation of stand-alone microcomputer systems is their inability to share and cooperate in data processing tasks. For example, for several microcomputer users to access a database simultaneously, each user must have a copy of the data file. As users modify their files, different versions of the data are created. Uncontrolled, this leads to errors in the database as well as errors in reports produced from it. Stand-alone systems are similarly limited in their ability to exploit the productivity provided by large integrated software packages. For example, an expensive integrated accounting package in a public accounting firm may be needed by several accountants to prepare a client's financial, payroll, and tax reports. However, only one accountant can access the program and data files with a stand-alone system. These limitations have generally confined stand- alone systems to personal-productivity tasks. Larger and more integrated data processing tasks are generally delegated to multi-user systems such as mini and mainframe systems.

The communication capability of a LAN enables workstations to share data as well as hardware and software. Workstations on a LAN are able to access data from a central database stored on the network's disk server. Record and file locking are available on most network operating systems to prevent users from accessing a record currently being updated. These facilities permit multiple users to simultaneously access a database while maintaining data integrity. For example, with a LAN several auditors can perform different audit tasks on a common set of client data files. Equally important, the firm's tax accountants can access the adjusted financial data to determine the tax liability and deferred tax balance needed to complete the audit.

Each auditor and tax accountant can work with the same set of client data files, thereby reducing data redundancy and inefficiency associated with using multiple copies of the same data. The ability to share data and data processing tasks permits microcomputer users to perform any data processing tasks normally delegated to large multi-user systems.

Electronic Mail and Office Automation. Electronic mail is a major, although frequently overlooked, benefit of a LAN. Most network vendors provide the ability to compose and send messages to another user or group of users of the LAN. A significant benefit of electronic mail is the reduction in "telephone tag"--i.e., leaving a message for someone to call back because they were out when you returned their call. A second major benefit of electronic mail is the cost and speed of information dissemination. The cost of sending an electronic message and the time required for its transmission are both negligible. If LANs are linked to mini- and mainframe computer systems, electronic mail is a potentially powerful means of integrating corporation wide communication.

LANs with modems provide unique communication capabilities. Partners and managers from the audit site can receive and send messages and files over the phone. Partners and managers can interact with audit personnel and review audit data, working papers, and audit problems as if they were at the client's office.

Other benefits of a LAN include the integration of microcomputers into mini- and mainframe computer networks. A LAN provides the communication facilities for linking an accounting firm's or client's separate computer and data processing resources to form an integrated system. A LAN is also a means of linking intelligent office equipment such as word processors, copying, and fax machines into an integrated office system. A LAN's operating system and communication medium provide the control and communication functions necessary to implement office automation.

Stand-Alone System. Up to this point we have examined the benefits of a microcomputer in a multi-user environment. However, a most important advantage of LAN is that work stations can operate independently of the network. Unlike a terminal on a mini- or mainframe system, a workstation is still a computer system under the control of the user. Consequently, it can still be used as a stand-alone system. For many users, this capability will be crucial since personal productivity tasks constitute a significant portion of their work.

The relationship of a LAN to a mainframe computer and stand-alone system is illustrated in Fiure 6. Listed below the symbols representing a mainframe and microcomputer system are some advantages of each data processing environment. A LAN extends the operating capabilities of a microcomputer system to include many of the attributes of larger multi- user systems. Consequently, a LAN workstation is able to exploit the advantages of both data processing environments.

Microcomputer technology has and will continue to have a significant impact upon accountants' productivity. Its application to personal- productivity tasks such as financial analysis have resulted in significant increases in accountants' efficiency and effectiveness. However, microcomputer usage is constrained by the limited abiality of the microcomputer to communicate and share data processing resources and tasks with other computer systems.

To overcome these deficiencies, more users have been installing LANs. Their communication and control functions extend the operating capabilities of the microcomputer to that of a larger multi-user system. However, unlike a terminal on a mini or mainframe system, a workstation may be used independently of the network as a stand-alone system. A LAN thus enables microcomputer users to exploit many of the advantages of both a multi-user and a stand-alone system. This capability substantially enhances the microcomputer's usefulness at current data processing tasks as well as provides opportunities to exploit newer and much more powerful applications.

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