Networking and Distributed Computing

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Abstract

The essence of distributed computing is expressed in terms of the numerous possible ways to set up a networked environment and in the benefits realized by multiple users. The benefits of networking include cost savings, especially when resources are shared, and an increased cohesiveness of the corporate cultural environment since individuals can be “connected” despite the physical distances between them.

If a manager wants to effectively use networking to enhance business practice, he or she should understand essential knowledge about networks including the different types of networks, network topologies, and hardware components of a network.

A case study provides a discussion of a company that went from having no computers when they started from one office in 1986, to 230 computers in 22 offices in six cities at the present time. A company network allows the geographically dispersed employees to share important data and to communicate with each other.

Networking and Distributed Computing

Businesses in the United States exchanged an estimated $17 billion in goods and services in 1999 (Guinness, 2000). As businesses expand operations globally, it is important that they are able to effectively manage the increased information flow. The construction of networks allows the distribution of computing to enhance business operations without regards to geographical boundaries.

The broad concept of networking should not be considered a static body of knowledge regarding the combining of two or more computers with connections of various hardware and cables. Rather, networking is a dynamic process. If a company expands or downsizes, modifications need to be made. If the number of users remains constant for a period of time, new technology and expanded uses of the network require modifications. So, in essence, a network *evolves* over time.

A network can be as simple as a file transfer program that runs between two computers at home, or it can be as complex as that used by an investment banking company that transfers real-time data via fiber optic cable. Regardless of what type of network is used, the same basic goal is required of each—to ensure that data is shared speedily and reliably and that its integrity is maintained. To accomplish this goal, a network should therefore be able to do the following (Hayden, 1998): (a) information must be transmitted reliably and consistently, (b) information must be transmitted corruption-free, (c) multiple computers or workstations must be able to identify each other across the network, and (d) there must be a standard way of naming and identifying the parts of a network.

Networks can be either private or public. Private networks are those representing users that wish to keep data within the organization, and may need to do so for many reasons including privacy (e.g., memos, e-mail messages, letters) and protection of trade secrets (e.g., proprietary formulas, business plans, databases). Other companies may have private sections of the network, but may also wish to share other parts of the network with the public.

Public networks are those allowing the sharing of some or all of the data on the servers. The Internet is an example of a very large public network. Not all data on the Internet is available to every user, however, and subscription fees are required to access some sites.

Benefits of networks

There are many benefits of a network from a management perspective. Besides the obvious benefits of sharing data and applications, networks (a) can improve efficiency among workers, (b) can help standardize policies, procedures, and practices among users, thereby fostering a sense of unity among employees, and (c) can bring together a multitude of ideas from employees that are geographically dispersed.

Network components

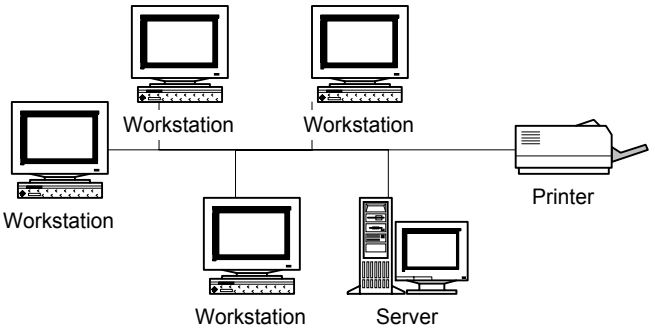
Table 1 provides a brief description of the components of a network. Note that not all networks use all of the components listed in Table 1. For instance, a peer network will not have a central server. While a client/server network will have a central server and two or more client computers, a peer network allows any of the connected computers to be clients or servers as needed. Peer networks are useful for small networks and would not, therefore, require the use of routers, bridges and switches.

Table 1 Network Components	
COMPONENT	DESCRIPTION or FUNCTION
Workstation	The computer or terminal on which a user works
Server	A computer with resources shared by other computers
Client	A computer that uses the client's resources
Hub or Concentrator	A device that provides the network with a single point of contact for all other connected devices
Routers	Devices that move & manage data between networks
Cabling	Wires that connect devices to the network
Bridges	Devices that connect two or more networks together so that they form one logical network
Repeater	A device that amplifies and cleans up digital signals and forwards them to their destination
Network adapter	An adapter card in a computer that allows it to communicate on a network
Network printer	A printer shared by multiple users
Switch	A switch is essentially a technology that allows a connection between two computers to have a dedicated channel at any specific time.

Basic network topologies

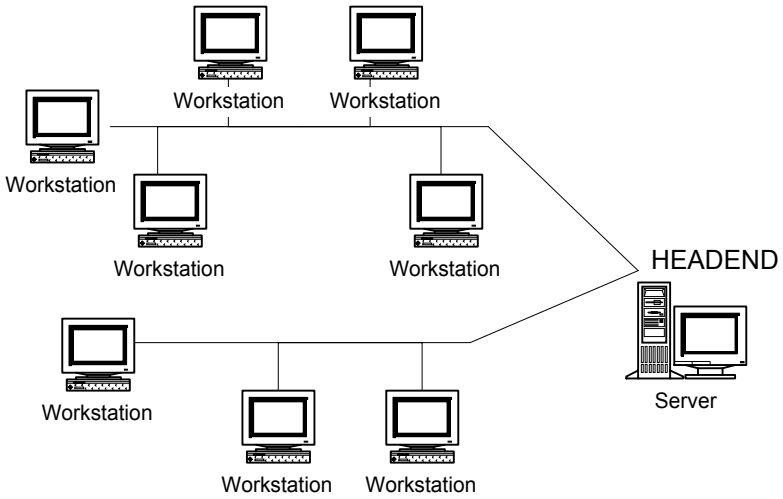
The three basic types of network topologies are bus, star, and token ring. Bus and star topologies are often used for Ethernet networks, which are the most popular types of networks (Hayden, 1998). Ring topologies are used for Token Ring. Figure 1 shows the setup for the bus topology. *Bus* topology is referred to as such because of the serial nature of its connections (Hayden, 1998). One of the advantages of bus topology is its simplicity. All computers are connected to the wire (usually coaxial cable), and once they are connected, all that is needed is to install the network software on each computer. The main disadvantage of a bus network is that if one of the links between any of the computers is disabled or broken, the network is down.

Figure 1
Bus topology



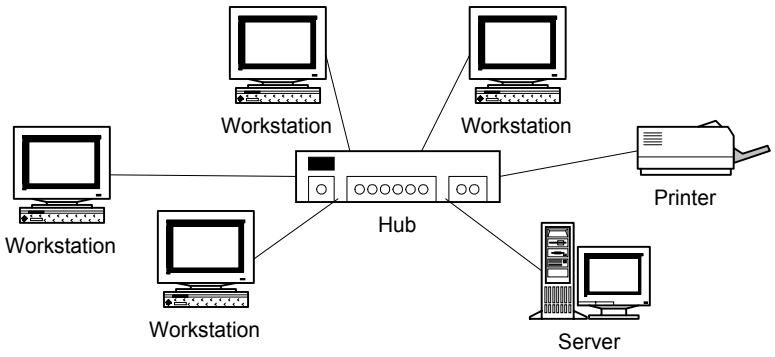
A hybrid bus topology is the tree topology (Figure 2). A tree network is characterized by one headend that branches out with two or more branches. Each branch may have additional branches.

Figure 2
Tree topology



Star topologies are for networks that are more complex than those that use bus topologies. With star topology (Figure 3), all computers connect to the hub, which in turn manages intercomputer communications.

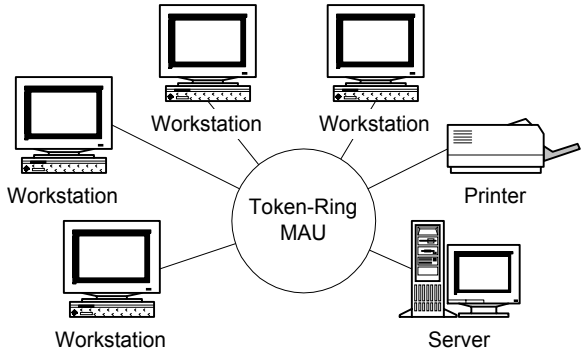
Figure 3
Star topology



The main advantage of a network constructed on star topology is that it is more reliable than a network constructed on bus topology. With bus topology, the disabling of one computer is enough to bring down the entire network. Since each computer connects to the hub on star topology, the disabling of one workstation will not affect any of the other workstations. Also, with star topology, it is easy to add a new workstation without having to bring down the entire system temporarily.

The third main type of network topology is ring topology (Figure 4). While the star topology has all workstations connect to a hub, the ring topology has all workstations connect to a Multistation Access Unit (MAU). The MAU performs the same function that

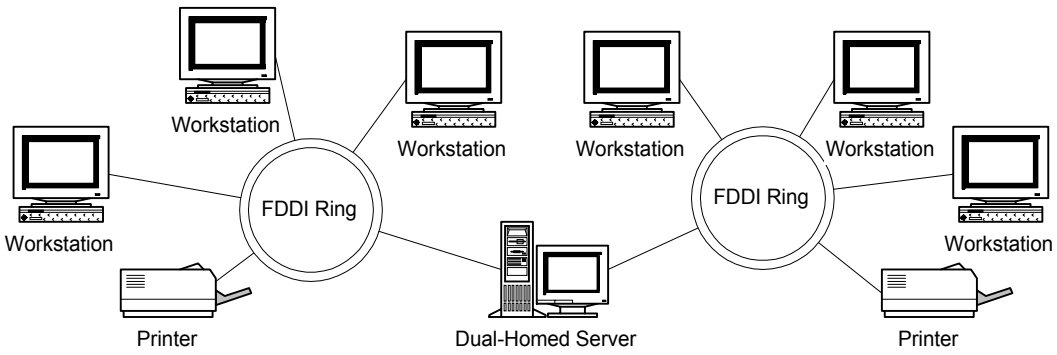
Figure 4
Token Ring topology



a hub does, except that it is used for Token Ring networks rather than Ethernet networks.

For high-end applications, such as those used by stock traders who highly value real-time data, a Fiber Distributed Data Interface (FDDI) network may be chosen (Figure 5). Because they use fiber cables instead of copper coaxial cables, FDDI networks are very fast.

Figure 5
FDDI Ring topology



Physical vs. Logical network

A physical network is a combination of the physical components (i.e., hardware) that make up the connections. In contrast, a logical network describes the *way* the network is set up and the manner in which users access the network and is what users see when they work at their terminals. Essentially, the logical network includes anything that is *not* hardware, including communication protocols and the manner in which data is organized on the servers.

Types of networks

There are several different types of networks. The different names typically reference a distinction in the distance that the network encompasses.

Tiny Area Network A tiny area network (TAN) is typically a two- or three-computer network, and is usually set up in homes or other non-business locations. TANs are most often used in the home where two or more family members have a computer terminal and want to share resources. TANS are also helpful for business employees who want to replicate their office computer environments at home.

Local Area Network A local area network (LAN) describes a group of computers linked at a singular site, and can have hundreds or even thousands of users. LANs typically have the following characteristics: (a) they occupy only one physical location (e.g., one building; or several offices on one floor of one building), (b) they all have high-speed data transfer rates, typically transferring data as fast as 10 megabits per second, (c) all data is part of the network, and (d) they can be peer networks or client/server networks. A TAN is actually a LAN in the sense that all connections are within one building or within one residence. But a TAN is usually used to describe only the smallest and most basic home network setup, with transmission speeds typically no faster than a 56Kbps modem.

Metropolitan Area Network When companies want to stay networked after expanding operations beyond one building, they may consider a metropolitan area network (MAN). A MAN typically uses high-speed leased telephone lines that offer full LAN-speed data transfer. Instead of leased telephone lines, some companies choose to use radio, microwave, laser, or optic fiber data transmission units (Hayden, 1998). While a LAN may only have one shared printer, it probably would be more convenient for users in a MAN to have a printer nearby-at least one in each building for a two-building setup.

A MAN network would be typical of a company that has offices in several nearby buildings, or within one community.

Campus Area Network A campus area network (CAN) is similar to a MAN but has full network-speed bandwidth coursing between all of the LANs on the network. Some CANs are distributed over a limited local geographical area (e.g., a college campus).

Wide Area Network A wide area network (WAN) is essentially a series of LANs (or MANs) connected by routers. A WAN is necessary when LANs become too geographically scattered to maintain full LAN speeds. High-speed phone lines are used to connect the LANs. WANs are often constructed when it is important that geographically dispersed users have access to a common pool of information. Unlike LANs and MANs, WANs almost always use routers. Because most of the activity of a WAN takes place within the LAN or MAN that is connected to it, routers make sure that the LANs and MANs get the information that needs to be directed to them.

Intranet When networks use Internet standards or web-based technology to connect, they are considered an Intranet. Essentially, an intranet is a way to connect various LANs, MANs, and WANs. As the Internet grows in popularity, so do the reasons for using Web-based technology.

Extranet Similar to an intranet, in that Internet standards are used, is an extranet. An extranet, however, is typically set up by a company that wishes to allow access to some parts of its network by its vendors, suppliers, distributors, customers, or business partners. Extranets allow companies to save money by permitting access to its business partners without having to pay for costly direct connections to their systems.

With the use of the Internet to gain access to the extranet, business partners typically enter the extranet with a username and password.

Virtual Private Network The number of computers connected to the Internet has doubled every year since 1987. The global figure is around more than 300 million at the present time, but there may be many more computers hidden behind corporate firewalls designed to exclude hackers (Guinness, 2000). A virtual private network (VPN) describes a *method* for connecting users of a network (or networks) that uses the vast resources of the Internet to carry data. The term *virtual* is used because it is not a network created with the use of leased lines; rather, everything is carried over the Internet. The term *private* is used because data that is carried over the Internet is encrypted until it reaches an authorized destination.

Data Transmission

Packet switching is a very important concept for networking. Its technology involves the converting of data into *packets*, which are small fixed-length pieces. The upper limit on packet length is about 1000 bytes (Stallings & Van Slyke, 1998). If a source has a message longer than 1000 bytes to send, it is broken up into a series of smaller packets. The X.25 packet switching standard uses packets of 128 bytes each (Laudon & Laudon, 2000). Packet-switched data is important for the following reasons: (a) it allows more than one stream of data to travel over a transmission medium at one time, (b) it ensures error-correction, which means that data that is transmitted is free of errors, and (c) it allows data to be sent from one computer to another over whatever route is open within the network.

Many packets of data can be sent from multiple machines without confusion because each data packet has (a) a source address, (b) a destination address, (c) a sequence number, and (d) a checksum to ensure that the data is free of errors.

With Ethernet, any computer that has data can transmit that data until it senses a bottleneck with another computer. In contrast, with Token Ring and FDDI networks, a single special packet called a *token* is passed around the network. When a computer has data to transmit, it waits until the token is available, gets hold of it, and transmits a data packet while simultaneously releasing the token to the next computer in line.

Protocols

A Protocol is a specific set of rules regarding the sending and receiving of packets of data across a network through network connections. Protocols take care of the translation of data from user applications to the logical network topology.

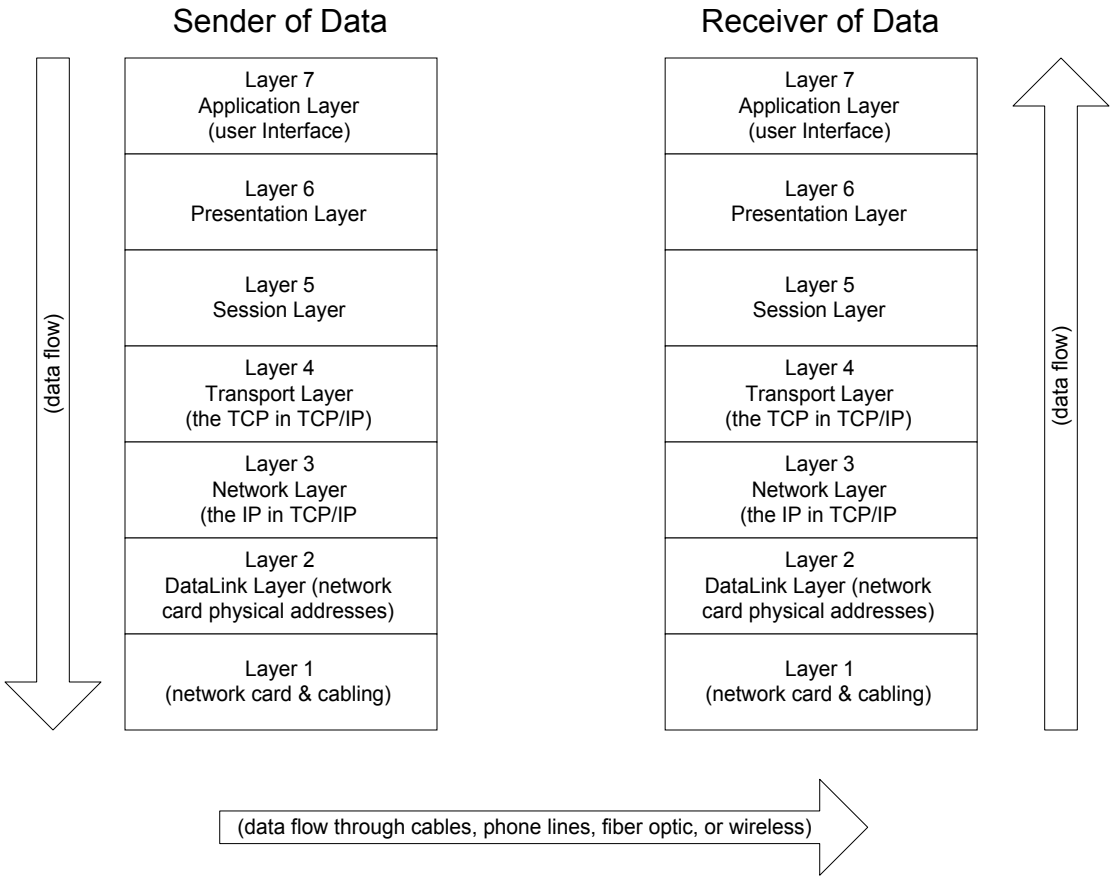
The most common network protocols are Transmission Control Protocol/Internet Protocol (TCP/IP), Internetworking Packet Exchange (IPX), and Network Basic Input-Output System/NetBIOS Extended User Interface (NetBIOS/NetBEUI). Of these network protocols, TCP/IP is the most popular, for two reasons. Not only is it the protocol that carries data traffic over the Internet, but it is also an open standard—no single company has proprietary control of it.

OSI Model The most popular theoretical model of networking is the Open Systems Interconnect (OSI) model. The seven-layer OSI model describes how a network should perform. The seven layers are briefly described as follows. Layer 7 is the application layer, and is what the user actually sees on their computer screen. Layer 6 is the presentation layer and deals with the way that different systems represent data that is

sent, and is equivalent to a translator. Layer 5, the session layer, handles the actual two-way communications between systems. Layer 4 is the transport layer and ensures that each packet of data gets to its proper destination. Layer 3, the network layer, provides a method of addressing so that when a computer sends a data packet, it is sent to a valid logical address. Layer 2 is the data-link layer and is a group of rules pertaining to how the layer 1 components communicate with layer 3. Layer 1 is the physical layer and is concerned only with the physical components of the network (e.g., network cards, cables, concentrators).

Figure 6 illustrates how the OSI model describes how a user sends data through a network to be received by another user. Data goes down through the OSI layers on the sender's computer. After the data is processed by the OSI software on the sending computer, data crosses the network on physical media (e.g., cables, phone lines). Then the data goes up through the OSI layers on the receiving computer and the user interface at the receiving end allows the receiver to see what was sent.

Figure 6
The OSI Model: a depiction of the sending and receiving of data



Planning

According to Hayden, the process of creating a network involves the four stages of planning, designing, implementing, and tuning. Also important is the sound management of the network once it is fully functional. Comprehensive planning will minimize future problems with the network. It is during the planning stage that the logical network is outlined. The types of users should be categorized (e.g., salesperson, administrator, secretary, business partner, etc.). The number of each type of user should be noted, and the type of software application each will need to use should be considered.

Also to be addressed are the following: security issues, shared resources (e.g., printer), whether or not to include Internet access, and whether or not to include a mail server and/or a file server.

Planning should include consideration from a user's perspective. The better that users' needs are understood, the better the network can be designed to accommodate those needs. Management should also determine which departments within a company need to communicate with other departments. For example, the accounting department in a particular company may need *all* numbers-related data from *all* other departments, but the sales department may need only the numbers-related data of their customers and suppliers.

The network design stage includes the task of capacity planning. Capacity planning deals with making sure that connectivity issues are well thought out. If leased phone lines are needed to connect the LANs within a WAN, for example, it is important that sufficient transmission speed is chosen. During the design stage, compatibility issues are also dealt with to make certain that a user who transmits data from one system can be certain that the receiver's system can interpret the data.

The implementation stage involves the physical construction of the network components. This stage follows directly from the plans of the design stage. Thus, the importance of the design stage is that it includes *all* components that will be needed.

The tuning stage is necessary to correct any unexpected problems that may have arisen in the implementation stage. If the planning and design stages were properly managed, then there should only be minor flaws to correct at this stage.

Once the system is operational, ongoing maintenance looms important. Centralized management of the network saves time and money by allowing the network administrator to do many things from his or her own terminal (e.g., troubleshooting; installing software on a user's terminal). Sometimes, however, it is necessary for the network administrator to physically visit a location for problem solving, especially if the problem is hardware-related, or if company is expanding to include new users.

Network Security

Network security is an important issue for management to consider. When a network is set up, clear rules should be defined and published regarding what users are and are not allowed to do. Also, security measures must be taken to ensure that outsiders or disgruntled former employees[1] cannot access the system. Questions a network administrator should ask (Hayden, 1998) include (a) are the servers physically secured in a room?, (b) does each user have a unique password?, (c) are passwords changed regularly?, and (d) are all logins and logouts and all file activity logged at the server?

Alexander (1996) listed seven sins, which, if disregarded, can result in needless harm to a system. The first sin is *failing to use common sense when choosing passwords*. It is best to choose a password that another person cannot easily guess.

The second sin is *failing to back up important data and information*. Backing up data takes very little time compared to the amount of time it will take to reconstruct or retrieve data that is lost.

The third sin to avoid is *failing to protect a computer and files from thieves*. It is important to have a secure environment (e.g., locked doors) where equipment is kept to reduce the chances that thieves will be able to gain access.

[1] According to Alexander (1996), most computer crime is carried out by current or former employees.

The fourth sin is *failing to take the possible threats to a computer and files seriously.* Just knowing that equipment failure or thievery is *possible* should be enough to motivate people to implement at least a minimum level of security.

The fifth sin is *failing to act with common sense*. People guilty of this sin do things like write their password down on a piece of paper near their terminal, spill coffee on their terminal, and download suspicious files from people they do not know.

The sixth sin is *failing to monitor your system for signs of unauthorized use*. According to Alexander (1996), a surprising number of people have installed security controls but have never gone back to check to see if the system is operating as expected.

The seventh sin to avoid is *failing to use antivirus software*. Antivirus software is relatively inexpensive, and can help prevent infection by one or more of the thousands of computer viruses that have been deployed by inconsiderate individuals.

Case Study

Company Description Superior Views Real Estate (a pseudonym) has been in business since 1986. The portentous vision of its management, coupled with hard work, has allowed the company to expand from one office in 1986 to 22 offices (21 sales offices and one corporate office) at the present time. The employees at the first office did not even have one computer when business commenced. Now there are 230 computer terminals (i.e., workstations) that are used by management, sales agents and support staff. All of the computer systems are networked. All sales agents, and most staff members, have computer terminals that connect to a LAN at each office. All offices in a given city are connected as a MAN, and each city connects to all other cities as a WAN.

Although Superior Views Real Estate has been in operation since 1986, its expansion to multiple locations has occurred relatively recently. This has benefited the company in several ways and has helped them avoid some of the problems that could have occurred had they tried to expand without proper planning and without the availability of the most current hardware and software. For instance, since each individual office was properly networked before the company expanded to additional offices, each office was fully functional as a sound and representative microcosm of the overall networked system.

Superior Views' maintenance costs are relatively low and major problems are prevented because the systems are routinely checked and analyzed. There are no application backlogs at Superior Views Real Estate because the systems have been improved incrementally. Also, since the major expansion efforts have been recently

implemented, there were no old computer systems to replace; new and efficient systems[2] were chosen for each location.

Prior to the actual networking of the company's systems, information systems analysis commenced. An inventory of current systems was examined, including both hardware and software. The planning stage included the creating of rough sketches of the systems and desired functions that were needed.

Mr. Simon, Chief Executive Officer, and Mr. Phillips, Information Technology Director, worked together to design and implement the systems that are described in this case study. Elements of bottom-up planning[3] were used at Superior Views Real Estate, and basic information models were created. Information models provide a formal basis for developing tools and techniques used in information systems development (Siau, 1999). Suggestions for features needed on the Superior Views systems were offered to management from licensed sales agents within the company. For instance, after asking sales agents at Superior Views Real Estate how customers could be better served, several individuals suggested that adding floor plans and surveys of all the company's property listings to an accessible file system or database would be helpful. Management carefully considered this and other suggestions, and acknowledged practical benefits that could be realized by networking the company's systems. Another suggestion made by sales agents was to have property information managed in such a way that if one agent, for instance, made a price change to a property listing on his or her computer, then all computers would reflect the change.

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[2] Each computer workstation has at least a Pentium 233 MHz processor or better.

[3] Bottom-up planning is an information systems planning methodology that identifies information systems projects based upon solving operational business problems (Hoffer & George & Valacich, 1999).

Each of the individual offices at Superior Views Real Estate was set up as a LAN. LANs are relatively inexpensive, easy to install, and basically provide a way to interconnect numerous computers across short distances. For a basic LAN, all that is needed is a circuit board in the computer, a connecting LAN-to-circuit board cable, and connecting LAN-to-cable hardware (Comer, 1997). Also, LANs are really designed for use at one physical location, usually within one building, primarily due to the need to keep a strong connecting signal. A LAN without Web technology is going to fall short of the benefits offered by systems with Web technology, so Mr. Phillips implemented a company Intranet that uses Web technology[4].

Mr. Phillips considered both data-centered and process-centered planning when coordinating the information systems of the company. According to an empirical study by Howard, Bodnovich, Janicki, and Liegle (1999), data-centered and process-centered methodology were equally efficient in procuring solutions for systems with data-intensive problems and/or needs. Superior Views chose a data-centered network because of the data-intensive characteristics of the real estate business. Property inventories change daily, and each individual property has numerous facts (e.g., legal description, deed date, zoning data) and property-description elements (e.g., roof type, foundation type, appliances) that must be included to fully and accurately represent it to the public and to other real estate agents.

Choosing a standard software package reduces the costs of design, testing, installation, and maintenance work required to build a system (Laudon & Laudon, 2000). Mr. Phillips chose a standard software package, Windows NT, as the operating system

[4] All sales agents and most staff members can access the company Intranet. But to prohibit "surfing" and to ensure that productivity is at a high level, Internet access is not allowed at the workstations.

for all of the company computer workstations. The features of Windows NT were deemed appropriate for the needs of the company.

The basic applications of the systems described in the next section were part of the planning of the logical network.

- Accounting. Each office manager has password-protected access to the accounting records for his or her office. The Chief Operating Officer of the company is the only one who has full access to all accounting records from all offices.
- Invoicing, Accounts Receivable, Accounts Payable. As bills come due, the systems are coordinated such that all payments are made in a timely manner. If the manager of one office location makes a payment for office supplies, the payment is recognized immediately on the system.
- E-mail. Each sales agent can communicate with all other sales agents at any of the 21 sales offices via e-mail.
- The company Intranet allows sales agents to keep up to date with the latest corporate news, and provides them with suggestions for improving sales ability, and offers a summary of company training procedures.
- Property database. All of the company's listings are entered into the property database. Basic facts are listed for each property, and surveys and floor plans are also included for many of the listings. An agent at one of the Dallas offices may have a prospective buyer who wants to purchase a home in the Austin area. That agent can look on the property database and offer basic information about some of the listings offered in that market. Although it is impractical for any agent to properly serve a buyer in another city, having access to that city's company listings can be the first action that an agent would take for the benefit of a buyer prior to referring that buyer to an associate agent in the buyer's preferred city.
- Sales data. Agents and managers can access sales data for any of the offices in any of the cities. Agents can learn from the success strategies of other offices, and can benefit by having demographical data provided by each individual office. For instance, a particular office may be located in an area where a predominance of the home purchases are by first-time buyers. As the agents in that office refine their tactics for serving first-time homebuyers, they can share that tactical information with other company agents in different cities.
- Word processing. Agents and staff members can use the word processing features to write letters, memos, proposals, etc.
- Browser. Each computer has a Web browser to enable agents and staff members to access the features of the company Intranet.

Topology diagrams of the company systems (and all other diagrams in this research paper) were created using Visio® Technical (version 5.0 for Windows), a

technical drawing software. Hardware diagrams include icon representations for computers, servers, routers, ISDN lines, cables, modems, power racks or power management, Ethernet technology, operating software, and switches.

TCP/IP is the communications protocol used and it provided the basis for the installation of a company Intranet on the systems of Superior Views Real Estate. TCP/IP controls the flow of packets[5] of information from one computer to another.

Superior Views Real Estate has offices in six cities at the present time. A wide area network (WAN) encompasses the 21 sales offices in Nashville, San Diego, Orlando, Denver, Tulsa, and Atlanta. The corporate office is located in Atlanta. Table 2 lists the cities and office locations. Office names are identified by location (viz. the street name where the office is located). Each office is networked with Ethernet, the leading LAN technology (Comer, 1997). The Ethernet in each office consists of a cable to which computers attach, and each computer has an interface board that connects the computer to the Ethernet.

The basic connection scheme for computers, offices, and cities is as follows. All computers within one office connect to each other via the office LAN. All offices in one city connect to each other through the MAN with 128K CIR[6] ISDN[7] lines. All six cities "connect" to each other via an AT&T frame relay[8] system, thereby creating the WAN. The physical hardware components for this frame relay system are located at AT&T's sites. The word "Hub" next to any office name in Table 2 represents the one designated

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[5] As mentioned in the section on packet switching, a packet is a single unit of data sent from one computer to another computer across a networked system (Ambegaonkar, 1997).
[6] CIR = committed information rate, or the bandwidth that is allowed (by AT&T) for transmission of data.
[7] ISDN stands for Integrated Services Digital Network, and is a standard for dial-up network access that can integrate voice, data, image and video services.
[8] Frame relay is a shared network service that is faster than packet switching (Laudon & Laudon, 2000). Frame relay packages data into frames that are similar to packets, but it does not offer error correction.

office of a particular city that acts as a “hub” through which that city’s systems connect to the AT&T frame relay. The

Table 2
Offices of Superior Views Real Estate

CITY	OFFICE NAME
Atlanta	Corporate (Hub)
Atlanta	South Lamar
Atlanta	Oltorf
Atlanta	North Lamar
Atlanta	Burnet
Atlanta	Parmer
Orlando	Bitters
Orlando	Huebner (Hub)
Orlando	Perrin Bietel
Nashville	Trinity Mills (Hub)
Nashville	Mockingbird
Nashville	Skillman
Nashville	Beltline
Tulsa	Westheimer (Hub)
Tulsa	FM 1960
Tulsa	Richmond
San Diego	Lake Mead (Hub)
San Diego	Henderson
San Diego	Sahara
Denver	Chandler
Denver	Tempe (Hub)
Denver	Phoenix Bell

specific router that allows this connection to the AT&T frame relay is the Cisco 3620 router, the largest and most powerful router used within Superior Views Real Estate’s systems.

The best way to understand the systems at Superior Views Real Estate is to realize that there are three organizational topology levels: (a) level one: one company WAN, (b) level two: six city MANs, and (c) level three: 21 office LANs. Included with this case study in the Appendix are several drawings depicting the three topological levels.

The LAN in the Atlanta corporate office has a computer lab for the company that houses the servers and the main backup systems. The diagrams for this and other offices show a “Cisco 10/100 switch.” Either a 10 megabits (MB) or a 100 MB Cisco switch is used, depending upon the specific network card in the client computers. The switch is like a junction that allows computers to communicate with each other.

The router choices, as diagrammed, are identified by the following brand names and model numbers: Cisco 804, Cisco 1601, Cisco 3620, Ascend P50, or Ascend 1800. The larger model numbers (e.g., Cisco 3620) represent routers that are more powerful and more expandable than the routers with smaller model numbers (e.g., Cisco 804).

Overall, Superior Views Real Estate has an outstanding network construction. The coordinated efforts of the Chief Operating Officer and the IT Director ensured that all necessary levels of systems design were carefully planned.
Their methodology for planning and implementation was exemplary.

As plans are currently being considered to expand to several new offices in a new city location, the company will be able to add to an already highly efficient system. Superior Views Real Estate is a polestar of excellence in the real estate profession, and they have improved profitability as a result of their strong leadership and a willingness to implement all of the tools necessary to succeed in the highly competitive business of residential real estate sales. Superior Views Real Estate realizes that the real estate profession is an intensive people-business, and the personal approach is unquestionably integral to their success. But by implementing systems that help sales agents improve performance, and also allow management to maintain a sense of unity with numerous offices, they have chosen a successful path for the future.

Conclusion

Networking has proven to be a very useful tool in the management of employees that are geographically dispersed. There are many ways to set up a network, and management should be aware of the alternatives available to the company. Once a company decides to implement networking, it will realize the benefits of distributed computing, including the cost savings of shared resources.

As businesses grow and expand operations to multiple locations, they must consider utilizing current technology in order to have the best opportunities for remaining competitive in an increasingly competitive marketplace. Effective communications and networking technology help make geographically dispersed companies more manageable, and help them to minimize barriers between departments and branch offices.

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Appendix

The network types of the systems of Superior Views Real Estate are listed below. All six cities comprise one WAN. All offices within each city comprise one MAN. Each office location has its own LAN setup. Each "hub" city is also identified.

(Atlanta MAN): Corporate LAN (Hub to AT&T Frame Relay)
South Lamar LAN
Oltorf LAN
North Lamar LAN
Burnet LAN
Parmer LAN

(Orlando MAN): Bitters LAN
Huebner LAN (Hub to AT&T Frame Relay)
Perrin Bietel LAN

(Nashville MAN): Trinity Mills LAN (Hub to AT&T Frame Relay)
Mockingbird LAN
Skillman LAN
Beltline LAN

(Tulsa MAN): Westheimer LAN (Hub to AT&T Frame Relay)
FM 1960 LAN
Richmond LAN

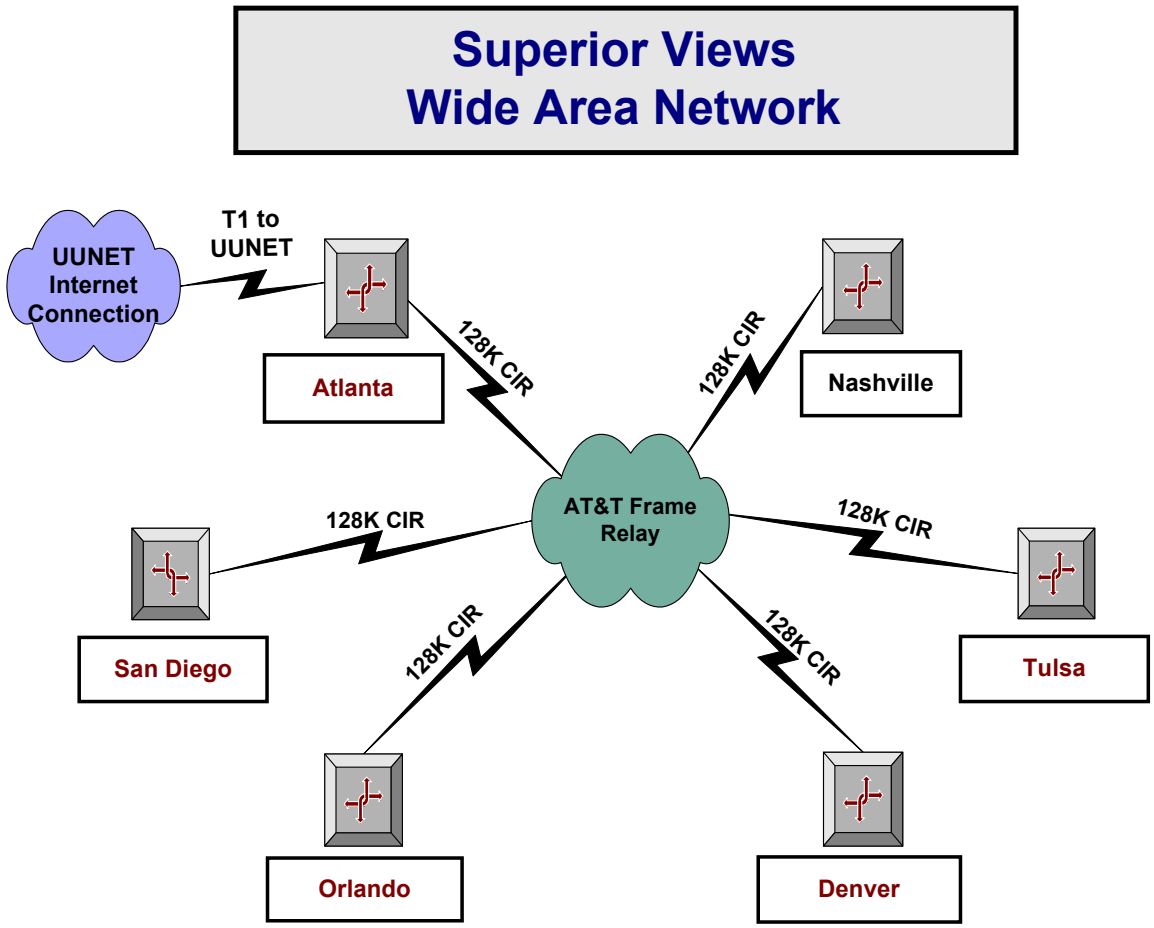
(San Diego MAN): Lake Mead LAN (Hub to AT&T Frame Relay)
Henderson LAN
Sahara LAN

(Denver MAN): Chandler LAN
Tempe LAN (Hub to AT&T Frame Relay)
Phoenix Bell LAN

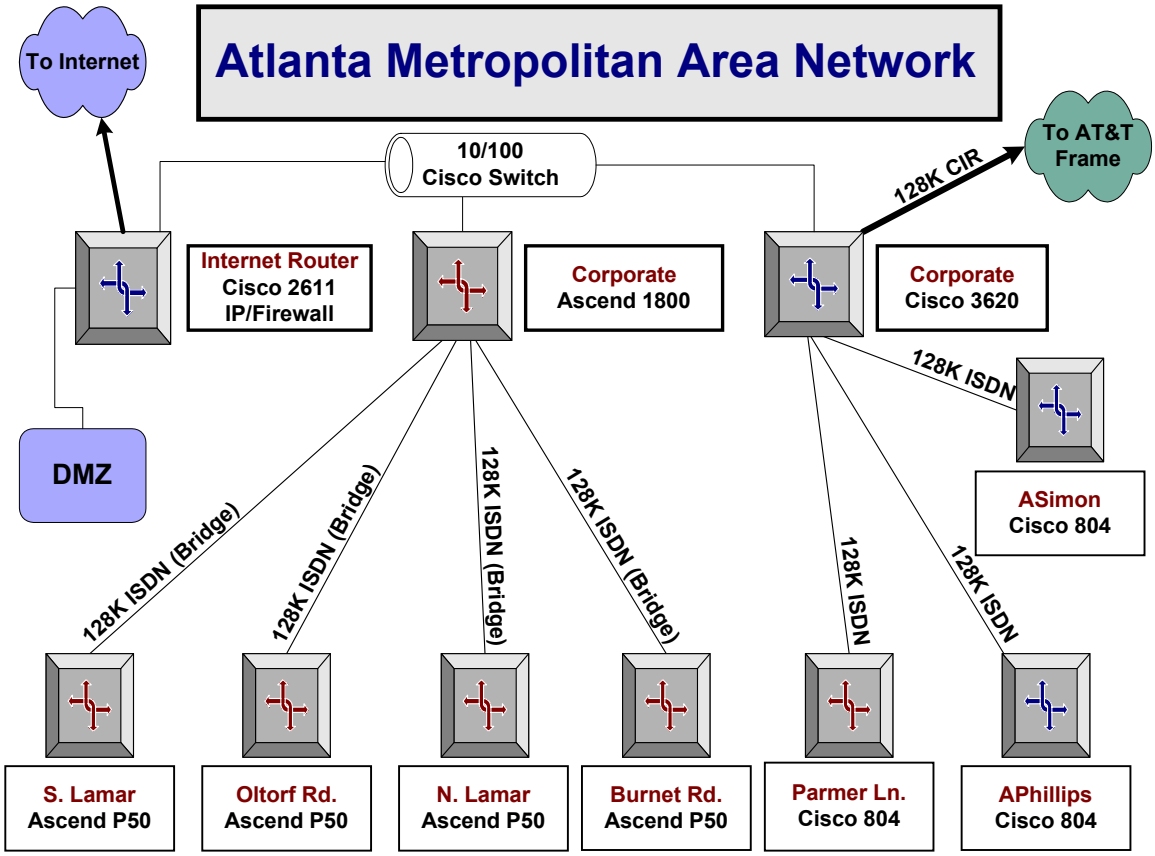
The diagrams of the network of Superior Views Real Estate that follow are:

1. Company-wide WAN, showing all six cities
2. MAN of home city (Atlanta)
3. Corporate office LAN, located in Atlanta
4. Computer lab at corporate office in Atlanta
5. Example office LAN

The diagram below shows the company-wide WAN for Superior Views Real Estate. All six cities are connected through 128Kbps phone lines to the AT&T frame relay. The diagram shows only one city being connected to the Internet. In fact, only the corporate office of the Atlanta MAN has access to the Internet. Access to the Internet was prevented at all other offices to disallow nonproductive "surfing."

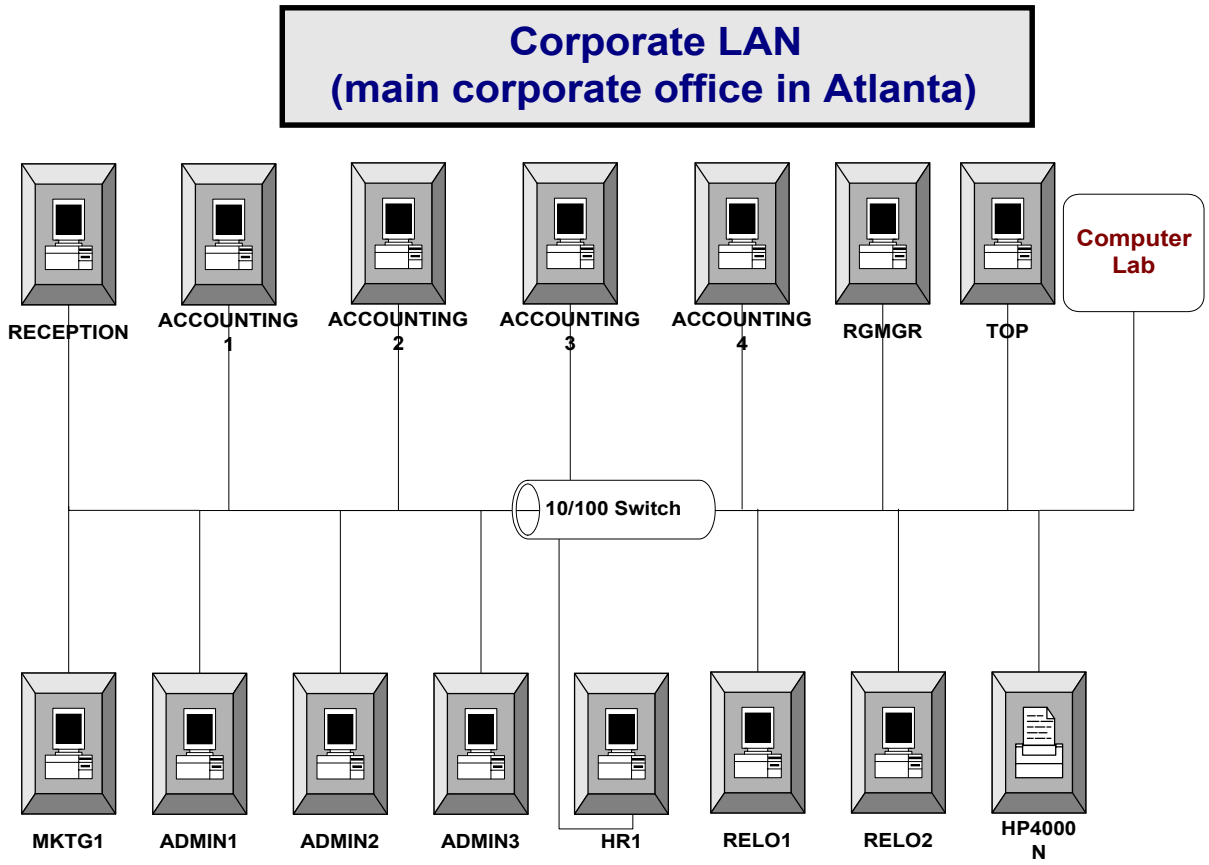


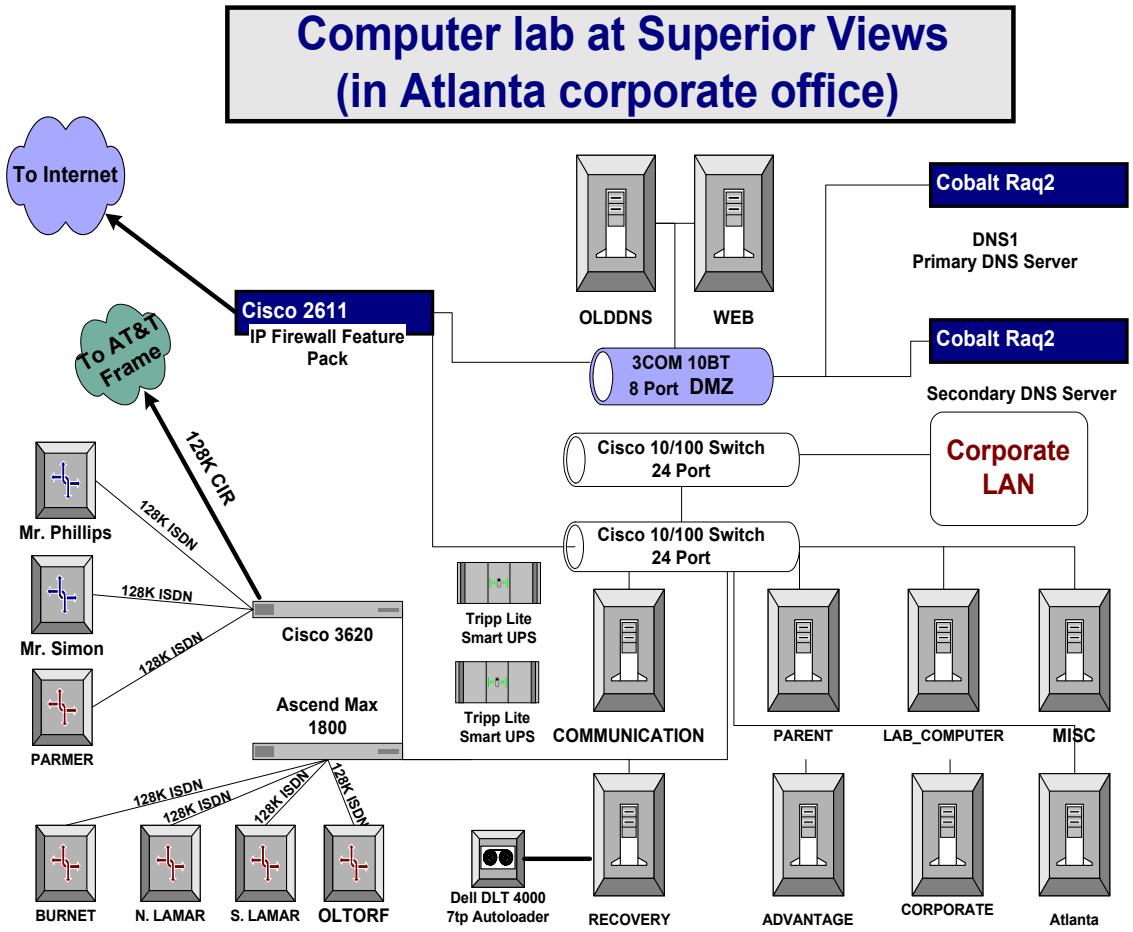
The Atlanta office of Superior Views Real Estate is the home office. Each local office in every city can connect to the corporate office via 128Kbps ISDN lines. Only the corporate office of the Atlanta MAN has full access to the Internet.



Although similar to other city offices in that Ethernet is used, the following depiction is unique for the corporate office in that there are no sales agents in this office.

Only management and staff in the following offices or departments work in the corporate office: reception, accounting, regional manager, marketing, administration, human resources, and relocation.





Notes for servers and backup device:

SERVER name: COMMUNICATION, make: DELL Poweredge 4200, RAM: 256 mg, Processor: Pentium II 300 MHz, Operating System: WindowsNT 4.0, hard drive: three 9 gigabyte hard drives

SERVER name: PARENT, make: DELL Poweredge 4200, RAM: 512 mg, Processor: two Pentium II 333 MHz, Operating System: WindowsNT 4.0, hard drive: three 9 gigabyte hard drives

SERVER name: MISC, make: DELL Poweredge 1300, Processor: Pentium II 300 MHz, Operating System: WindowsNT 4.0

SERVER name: RECOVERY, make: DELL Poweredge 1300, Processor: Pentium II 300 MHz, Operating System: WindowsNT 4.0

SERVER name: ADVANTAGE, make: DELL Poweredge 2200, Processor: Pentium 233 MHz, Operating System: WindowsNT 4.0

SERVER name: LAB COMPUTER, make: DELL Poweredge 2200, Processor: Pentium II 233 MHz, Operating System: WindowsNT 4.0

SERVER name: COPRORATE, make: DELL Poweredge 2200, Operating System: WinNT 4.0

SERVER name: WEB, make: DELL Poweredge 2200, Function: Internet Web Server, Operating System: WindowsNT 4.0

SERVER name: OLDDNS, make: DELL Poweredge 2200, Operating System: WindowsNT 4.0

SERVER name: ATLANTA, make: DELL Poweredge 2200, Function: Intranet Web Server, Operating System: WindowsNT 4.0

SERVER names: COBALT RAQ2, function: primary domain name server (DNS) and secondary DNS

BACKUP name: DELL DLT 4000, specs: 7 tapes, autoloader, 120/240 gigs

Except for the corporate office, all other offices are LAN networks of the same basic configuration as is the diagram of the Beltline office, located in Nashville. Therefore, only this one example is shown. Each sales agent has his or her own workstation. A data server and printer are shared. All office LANs within each city are connected to make a city WAN. Each office can also connect to the corporate office in Atlanta by a 128Kbps ISDN line.