Network Security And Firewalls Essay, Research Paper

Network, in computer science, techniques, physical connections, and computer programs used to link two or more computers. Network users are able to share files, printers, and other resources; send electronic messages; and run programs on other computers.

A network has three layers of components: application software, network software, and network hardware. Application software consists of computer programs that interface with network users and permit the sharing of information, such as files, graphics, and video, and resources, such as printers and disks. One type of application software is called client-server. Client computers send requests for information or requests to use resources to other computers, called servers, that control data and applications. Another type of application software is called peer-to-peer. In a peer-to-peer network, computers send messages and requests directly to one another without a server intermediary.

Network software consists of computer programs that establish protocols, or rules, for computers to talk to one another. These protocols are carried out by sending and receiving formatted instructions of data called packets. Protocols make logical connections between network applications, direct the movement of packets through the physical network, and minimize the possibility of collisions between packets sent at the same time.

Network hardware is made up of the physical components that connect computers. Two important components are the transmission media that carry the computer’s signals, typically on wires or fiber-optic cables, and the network adapter, which accesses the physical media that link computers, receives packets from network software, and transmits instructions and requests to other computers. Transmitted information is in the form of binary digits, or bits (1s and 0s), which the computer’s electronic circuitry can process.

Network Connections

A network has two types of connections: physical connections that let computers directly transmit and receive signals and logical, or virtual, connections that allow computer applications, such as word processors, to exchange information. Physical connections are defined by the medium used to carry the signal, the geometric arrangement of the computers (topology), and the method used to share information. Logical connections are created by network protocols and allow data sharing between applications on different types of computers, such as an Apple Macintosh and an International Business Machines Corporation (IBM) personal computer (PC), in a network. Some logical connections use client-server application software and are primarily for file and printer sharing. The Transmission Control Protocol/Internet Protocol (TCP/IP) suite, originally developed by the United States Department of Defense, is the set of logical connections used by the Internet, the worldwide consortium of computer networks. TCP/IP, based on peer-to-peer application software, creates a connection between any two computers.

Media

The medium used to transmit information limits the speed of the network, the effective distance between computers, and the network topology. Copper wires and coaxial cable provide transmission speeds of a few thousand bits per second for long distances and about 100 million bits per second (Mbps) for short distances. Optical fibers carry 100 million to 1 billion bits of information per second over long distances.

Topology

Common topologies used to arrange computers in a network are point-to-point, bus, star, and ring. Point-to-point topology is the simplest, consisting of two connected computers. The bus topology is composed of a single link connected to many computers. All computers on this common connection receive all signals transmitted by any attached computer. The star topology connects many computers to a common hub computer. This hub can be passive, repeating any input to all computers similar to the bus topology, or it can be active, selectively switching inputs to specific destination computers. The ring topology uses multiple links to form a circle of computers. Each link carries information in one direction. Information moves around the ring in sequence from its source to its destination (see Computer Architecture).

Local area networks (LANs), which connect computers separated by short distances, such as in an office or a university campus, commonly use bus, star, or ring topologies. Wide area networks (WANs), which connect distant equipment across the country or internationally, often use special leased telephone lines as point-to-point links.

Sharing Information

When computers share physical connections to transmit information packets, a set of Media Access Control (MAC) protocols are used to allow information to flow smoothly through the network. An efficient MAC protocol ensures that the transmission medium is not idle if computers have information to transmit. It also prevents collisions due to simultaneous transmission that would waste media capacity. MAC protocols also allow different computers fair access to the medium.

One type of MAC is Ethernet, which is used by bus or star network topologies. An Ethernet-linked computer first checks if the shared medium is in use. If not, the computer transmits. Since two computers can both sense an idle medium and send packets at the same time, transmitting computers continue to monitor the shared connection and stop transmitting information if a collision occurs. Ethernet can transmit information at a rate of 10 Mbps.

Computers also can use Token Ring MAC protocols, which pass a special message called a token through the network. This token gives the computer permission to send a packet of information through the network. If a computer receives the token, it sends a packet, or, if it has no packet to send, it passes the token to the next computer. Since there is only one token in the network, only one computer can transmit information at a time.

Network Operation and Management

Network management and system administration are critical for a complex system of interconnected computers and resources to remain operating. A network manager is the person or team of people responsible for configuring the network so that it runs efficiently. For example, the network manager might need to connect computers that communicate frequently to reduce interference with other computers. The system administrator is the person or team of people responsible for configuring the computer and its software to use the network. For example, the system administrator may install network software and configure a server’s file system so client computers can access shared files.

Networks are subject to hacking, or illegal access, so shared files and resources must be protected. A network intruder could eavesdrop on packets being sent across a network or send fictitious messages. For sensitive information, data encryption (scrambling data using mathematical equations) renders captured packets unreadable to an intruder. Most servers also use authentication schemes to ensure that a request to read or write files or to use resources is from a legitimate client and not from an intruder (see Computer Security).

Future Technologies and Trends

The wide use of notebook and other portable computers drives advances in wireless networks. Wireless networks use either infrared or radio-frequency transmissions to link these mobile computers to networks. Infrared wireless LANs work only within a room, while wireless LANs based on radio-frequency transmissions can penetrate most walls. Wireless LANs have capacities from less than 1 Mbps to 8 Mbps and operate at distances up to a few hundred meters. Wireless communication for WANS use cellular telephone networks, satellite transmissions, or dedicated equipment to provide regional or global coverage, but they have transmission rates of only 2000 to 19,000 bits per second.

New networks must also meet the growing demand for faster transmission speeds, especially for sound and video applications. One recently developed network, called an Asynchronous Transfer Mode (ATM) network, has speeds of up to 625 Mbps and can be used by either LANs or WANs.

In February 1996 Fujitsu Ltd., Nippon Telephone and Telegraph Corporation, and a team of researchers from AT&T succeeded in transmitting information through an optical fiber at a rate of 1 trillion bits per second-the equivalent of transmitting 300 years of newspapers in a single second. This was accomplished by simultaneously sending different wavelengths of light, each carrying separate information, through the optical fiber. If it can be integrated into a network, this new technology will make it easy, inexpensive, and incredibly fast to send information, such as video and memory-sensitive three-dimensional images.