

Chapter 1: Introduction to Computer Networks

A computer network is an interconnection of various computers to share software, hardware, resources, and data through a communication medium between them. Any computer networking communication needs a sender, a receiver, a communication medium, protocols, and an operating system to establish networking and transfer data. A network model describes the organization of various computers in a network for using resources. Networks provide the benefits of exchanging information or data, sharing resources, reducing system costs, increasing reliability, and creating a flexible working environment.

Chronology of Significant Computer-Network Developments

In the late 1950s, early networks of computers included the U.S. military radar system. In 1960, the commercial airline reservation system went online with two connected mainframes. In 1965, Western Electric introduced the first widely used telephone switch that implemented true computer control. In 1969, the first four nodes of the ARPANET were connected using 50 kbit/s circuits. In 1972, commercial services using X.25 were deployed. In 1973, Robert Metcalfe wrote a formal memo at Xerox PARC describing Ethernet. By 1995, the transmission speed capacity for Ethernet increased from 10 Mbit/s to 100 Mbit/s. In 1998, Ethernet supported transmission speeds of a gigabit. Subsequently, higher speeds of up to 100 Gbit/s were added.

A computer network's communication can be based on centralized, distributed, or collaborative computing. Centralized computing involves many workstations or terminals connected to one central mainframe or another powerful computer. Distributed computing interconnects one or more personal computers and allows various services like data sharing, hardware sharing, resource sharing, or network sharing. Collaborative computing is the combination of centralized and distributed computing.

The local area network communication can be constructed by using a server-based model or a peer-to-peer model. In peer-to-peer networks, the individual clients share data and resources, but no one computer is treated as a server.

LAN (Local Area Network) is a small network that covers a limited area. MAN (Metropolitan Area Network) is created by combining various local area networks. WAN (Wide Area Network) is the biggest network providing global connectivity.

The physical arrangement of computers in a communication network is called topology. Star topology connects every system to a central controller called a hub, transmitting all data through it. Bus topology uses a single cable as a backbone, with all nodes attached using T connectors. In a ring topology, failure of one computer disrupts the entire network. Mesh topology connects multiple devices with redundant pathways. A fully connected network topology ensures all devices are connected to each other.

Computer networks play an important role in providing services to large organizations and individuals. Organizations can track inventories, monitor productivity, process orders, and conduct billing across different locations. The major uses of computer networks include resource and information sharing, data protection, cost-effectiveness, communication, security systems, e-commerce, and mobile users.

Network Models

The client-server model consists of multiple workstations or PCs that act as clients requesting services from a centralized server. The server has high storage and processing capabilities, providing services to

clients. In peer-to-peer networks, computers share data and resources without a dedicated server. Active networks or software-defined networking (SDN) allows software to dynamically control and manage network functions, providing flexibility and programmability.

Protocols and Standards

Protocols define how data is communicated across networks, specifying message formats, timing, and error-handling rules. Network protocols include TCP/IP, HTTP, FTP, SMTP, and DNS. Standard organizations such as IEEE, ANSI, ITU, ISO, and W3C establish networking guidelines.

The OSI (Open Systems Interconnection) model consists of seven layers: physical, data link, network, transport, session, presentation, and application. The TCP/IP model, which is widely used on the internet, consists of four layers: link, internet, transport, and application. Encapsulation and decapsulation occur as data moves through these layers, with headers and control information added or removed at each layer.