4 Communication Equipment and Network Software

Chapter Objectives

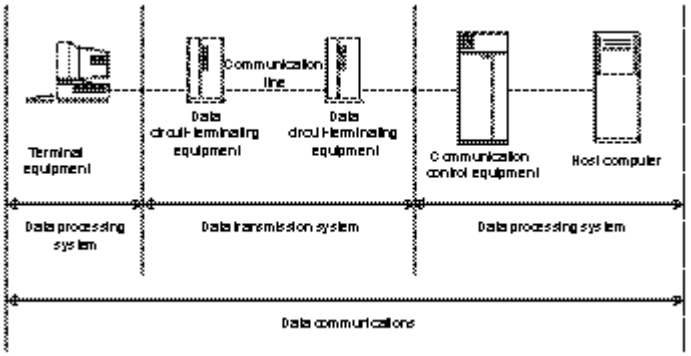
The elements making up network systems are broadly divided into hardware and software. The hardware elements are the communication equipment and devices comprising the network system, and the software elements are the network software that controls the network.
In this chapter you will learn about the elements that comprise a network.

① Understanding transmission media, and the types and roles played by communication equipment, such as DTE, DCE.
② Understanding the types and roles played by network software, such as network operating systems.

4.1 Communication Equipment

In today's information society exchange of information (data transmission) is supported by communications networks. Communication networks enables exchange of information between computers placed in remote locations. The devices making up these networks is called communications equipment. It is also true to say that the development of today's networks would not have been possible without the development of communications equipment.
Figure 4-1-1 shows the basic structure of a communication network.

Figure 4-1-1 Basic structure of a communication network

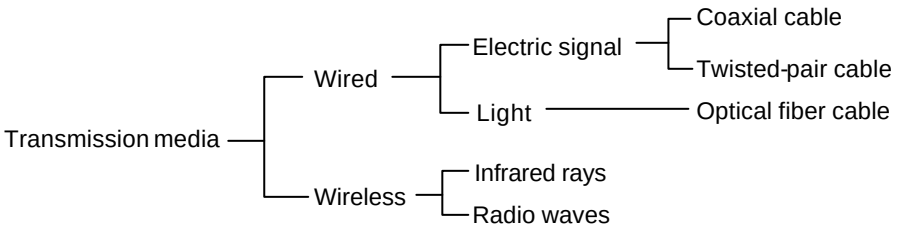


Communication cables used for the communication lines, data circuit-terminating equipment, transmission control equipment, and other peripheral equipment are explained in the following.

4.1.1 Transmission Media (Communication Cables)

Transmission media is indispensable for the conduct of data communication. This section explains transmission media and the physical transmission lines (communication cables) employed for communications using transmission media.
Transmission media is broadly divided into wired and wireless types depending on whether or not physical transmission lines (communications cables) are used.

Figure 4-1-2 Types of transmission media



(1) Wired

Some of the representative transmission media used in wired communication are:

- Twisted-pair cable
- Coaxial cable
- Optical fiber cable

The construction and characteristics of these are explained in the following:

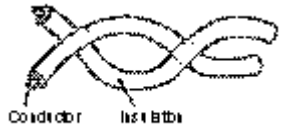
<Characteristics of wired communication>

- This is communication using communication cables, and it is used in a wide range of fields covering telephones, facsimile, communication networks, etc.
- The transmission capability is limited by the transmission media.
- In general, cables are resistant to noise.

① Twisted-pair cable

Twisted-pair cable is composed of two insulated conductors twisted around each other, and this structure prevents crosstalk.

Figure 4-1-3 Twisted-pair cable



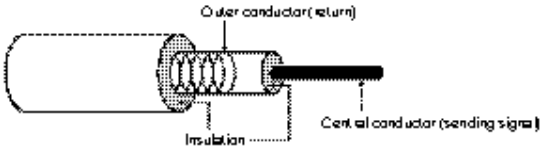
<Characteristics>

- Is less resistant to electromagnetic induction than coaxial cables and crosstalk or attenuation may occur
- Installation of cables is extremely easy
- The maximum transmission speed is several 10 Mbps (recently, types allowing about 100 Mbps have been introduced)
- Can be used with telephone subscribers' lines and LAN

② Coaxial cable

A coaxial cable consists of a central conductor inside an insulation tube surrounded by an outer conductor. The central conductor is for sending signals, and the outer conductor acts as a return path for signals carried by current. A coaxial cable may be used as a single cable, and sometimes several or several tens of cables are used together.

Figure 4-1-4 Coaxial cable



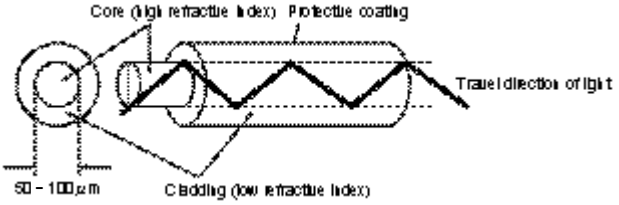
<Characteristics>

- Slightly susceptible to crosstalk and attenuation, and shows superior characteristics for high frequency signal transmission
- Installation of cables requires time and effort
- Maximum transmission speed is 100 Mbps.
- Used for trunk networks, CATV, LAN (Ethernet), etc.

③ Optical fiber cable

An optical fiber cable is made up of optical fibers each of which consists of two common-axis glass fibers (core and cladding) having different refractive indexes. Laser light pulse introduced into the fiber travels down the length of the fiber reflecting off to zig-zag along the inner surfaces.
An optical fiber cable consists of a bundle of optical fibers having the structure shown in Figure 4-1-5.

Figure 4-1-5 Optical fiber



<Characteristics>

- Information is transmitted in the form of light pulse instead of conventional electric signals.
- Compared to conventional telephone lines, optical fibers have a transmission capacity about 6000 times higher.
- Fiber is immune to electromagnetic interference and crosstalk.
- Lightweight and compact.
- Cable installation is easy but technicians must undergo technical training.
- Very resistant to thunder and noise
- Transmission speed is 100 Mbps or higher.
- Used in nationwide trunk networks (ISDN, etc.) and trunk LAN (FDDI, etc.), and the use of fiber cables is expected to become even more prevalent.

(2) Wireless

Wireless communication is employed where it is difficult to install cables (e.g., on remote islands) and in office environments.

<Characteristics of wireless communication>

- Comprise communication using radio waves and light, and is divided into satellite communications and terrestrial wireless communications.
- Installation of cables is not required, so wide-area communication is possible.
- Susceptible to electromagnetic interference and threat of tapping and bugging
- In the case of satellite communications, a relatively large transmission delay (about 250 milliseconds) occurs due to the distances involved. (For details, see Section 3.6.2 Telecommunications services in WAN.)
- Long waves, short waves, microwaves, infrared waves, etc. are used.
- Employed in mobile telephone systems and satellite communications, and wireless LAN using infrared rays, etc.

4.1.2 Peripheral Communication Equipment

Peripheral communication equipment is the general term for equipment and devices used for data transmission employing transmission media. Using these devices in the right places enables fast and reliable data transmission.

Peripheral communication equipment includes:

- Data terminal equipment
- Data circuit-terminating equipment
- Multiplexing equipment
- Switching equipment
- Branching equipment
- Distributing equipment

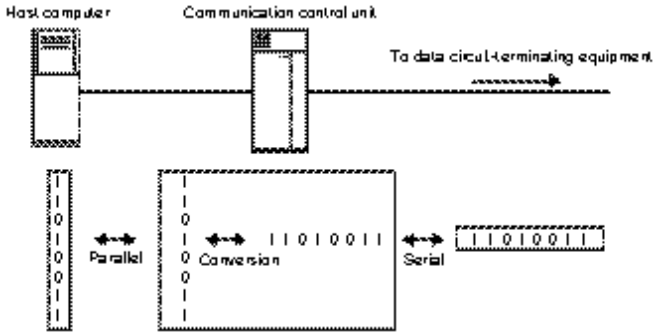
(1) Data terminal equipment (DTE)

Data terminal equipment is the general term for host computers, terminal equipment, and transmission control equipment that make up the data processing system with communication capabilities.

① Communication control unit (CCU)

A communication control unit performs serial-parallel conversion of data (assembly/disassembly of characters) at the time of transmission or reception. CCU is a data communications system using general-purpose computers, and also performs data error control, controls multiple lines, etc.

Figure 4-1-6 Data assembly and disassembly in a communication control unit (CCU)



(2) Data circuit-terminating equipment (DCE)

Data circuit-terminating equipment is the general term for equipment that connects data terminal equipment with communication lines. It has the function of converting the signals sent from the data terminal equipment into signals suitable for transmission.

① Modem (Modulator/DEModulator: MODEM)

A modem is a data circuit-terminating device used when data transmission is conducted with an analog line. This device modulates digital signals into analog signals, and demodulates analog signals into digital signals.

② DSU (Digital Service Unit)

A DSU is a data circuit-terminating device used when data transmission is conducted with a digital line. This device converts the digital signals used internally in the computer into digital signals suitable for transmission.

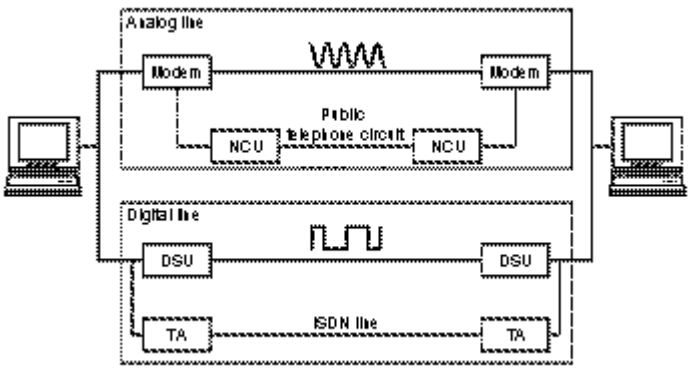
③ NCU (Network Control Unit)

A NCU is a data circuit-terminating device used when data transmission is conducted using a public telephone circuit. The NCU has dial functions for connecting to the line and the other party. Recently, the NSU is often found built into the modem and TA.

④ TA (Terminal Adapter)

A TA is a data circuit-terminating device used when data transmission is conducted using ISDN lines. The TA converts the signals of devices not compliant with ISDN lines into signals suitable for ISDN lines. Recently, the DSU is often built into the TA.

Figure 4-1-7 Data circuit-terminating equipment



(3) Other peripheral communication equipment

① Multiplexing equipment

Multiplexing equipment combines several low-speed communication lines into one high-speed communication line or divides one high-speed communication line into several low-speed communication lines. It is also called MUX (MUltipleXer).
Frequency division multiplexing (FDM) equipment and time division multiplexing (TDM) equipment are representative multiplexing equipment.

② Switching equipment

Switching equipment is equipment placed inside company buildings, etc. and it is used for switching lines. It is also called PBX (Private Branch eXchange) and has conventionally been used with public telephone circuits (to distribute calls received from outside lines, and switch extension lines, etc.). Recently, digital PBX equipment handling digital information are widely used.

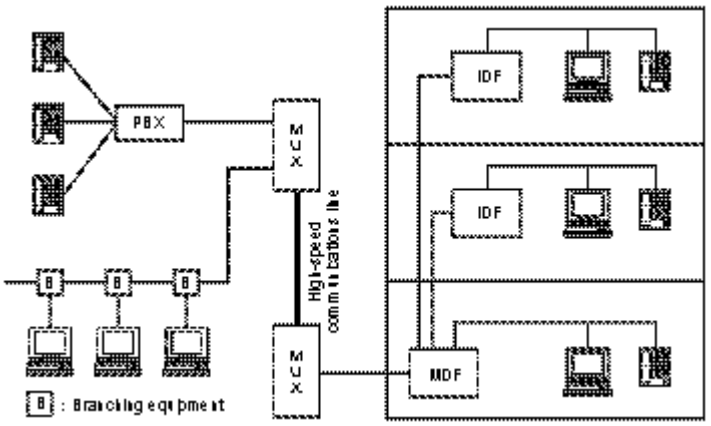
③ Branching equipment

Branching equipment is used when connecting multiple terminals to the same communications line in the multi-point configuration. Transceivers, etc. used for bus-topology LAN configuration belong to this category of equipment.

④ Distributing equipment

Distributing equipment is used to concentrate wiring of each floor when constructing networks inside buildings. The network is constructed by distributing cables from the MDF (Main Distributing Frame) to the IDF (Intermediate Distributing Frame) located on each floor.
Figure 4-1-8 shows a layout example with the various peripheral equipment employed.

Figure 4-1-8 Peripheral communications equipment



4.2 Network Software

A network need to be managed in an integrated manner from both hardware and software viewpoints. Network software is the general term for applications for networks management.
Network software is divided into:

- Network management systems
- Network OS

4.2.1 Network Management

The five functions required for network management are defined as:

- Configuration management
  Collection and management of information on current network resources as well as on changes in network configuration.
- Fault management
  Monitoring system errors to perform automated recovery process as well as to notify to prevent possible failure so as to make proactive remedy possible.
- Security management
  Monitoring the state of access to the network to protect against illegitimate access to the resources (eavesdropping, illegal use, impersonalization, etc.).
- Performance management
  Monitoring response time and traffic load to manage and maintain the performance of the network.
- Service charge management
  Monitoring and analysis of information indicating the use of network resources and help management of deciding service charges to users.

A network management software is installed to take advantage of these functionalities.

(1) Network management software

Network management systems encompass systems using the SNMP (Simple Network Management Protocol) and proprietary management systems developed by software vendors.
Representative network management systems are:

- Sun Net Manager
- Net View
- NMS

① Sun Net Manager

Sun Net Manager is a network management system developed by Sun Microsystems, Inc. in the USA. It uses SNMP and is mainly used on TCP/IP networks. Network is managed by UNIX workstations and third party products based on this technology have also been developed.

② Net View

Net View was developed by IBM in the USA and is a vendor-developed network management system that is mainly used on a host computer-centric networks. As an integrated system for management by a host computer, it provides a variety of functionalities.

③ NMS (Network Management System)

NMS is a vendor-developed network management system developed by Novell, Inc. in the USA that is mainly used for personal computer LAN. It is used for management of the company's network OS called Netware (explained later).

(2) Network management tools

Network management tools are tools used for collection and analysis of information used for network management.
Network management tools are divided into:

- SNMP management tools
- Vendor-specific management tools

SNMP management tools are compliant with the standard protocol SNMP. These systems use LAN analyzers, etc. to measure traffic, evaluate the performance of equipment by sending pseudo packets, and identify the cause of errors by using ping commands.
Vendor-specific management tools are tools developed by individual vendors. There is little compatibility between these tools and they are not suitable for networks in which the products of several vendors are

mixed. However, in the case of networks built around one vendor, these tools are often more efficient than SNMP compliant tools.

4.2.2 Network OS (NOS)

Network OS (Network Operating System (NOS)) is basic software that already contains the basic functionalities required for building effective network.
The basic NOS functions are:

- Data sharing: Allow sharing of external storage devices such as hard disks on a LAN.
- Printer sharing: Allow sharing of printers on a LAN.
- Security management: Management of users' access right and usage, etc.

Which NOS to introduce must be decided based on considerations of the scale of the LAN to be built, the performance level demanded for the network system, etc.

(1) Functions and characteristics of network OS

The two representative network operating systems are:

- Netware
- Windows NT

① Netware

Netware is a network operating system that was developed by Novell, Inc., and it is the most commonly used system for sharing of data and printers on personal computer LAN systems. In relation to security it offers functions such as disc mirroring, transaction tracking, etc.
In addition to the dedicated Netware protocols, such as IPX, SPX, the NOS also supports standard protocols like TCP/IP and OSI, and vendor-specific protocols such as SNA (IBM Corporation), AppleTalk (Apple Computers, Inc.), etc.

② Windows NT

Windows NT is a network operating system that was developed by Microsoft Corporation in the USA. To be exact, this is an operating system designed for use in network environments. This NOS inherits the Windows operating environment and it enables preemptive multitasking and protected memory for safety and reliability.
Representative functions comprise:

- Virtual memory
  By allocating virtual memory space to each application, system errors of one application will not affect other applications.
- NTFS (NT File System)
  In addition to the capability for setting security for each file, the file management system also has functions for recovering damaged files.

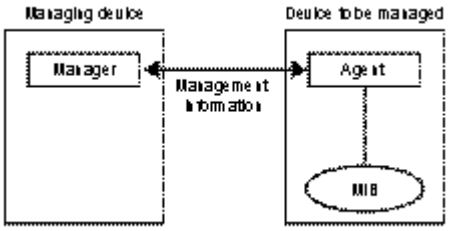
Windows NT uses the NetBEUI (IBM Corporation) network protocol.

(2) Network management protocol (SNMP)

SNMP (Simple Network Management Protocol) is the most typical network management protocol. SNMP is used on TCP/IP network, but many systems conform to this protocol.
SNMP is comprised of:

- Manager
  Management program operating on the managing device.
- Agent
  Program operating on the device to be managed.
- MIB (Management Information Base)
  Defines the structure of the database with the information to be managed.

Figure 4-2-1
SNMP image model



Management by SNMP is performed by the exchange of information between the manager and the agent (the UDP protocol is used for this exchange).
There are three types of exchanges taking place between the manager and the agent.

- Information collection
  To collect the information for management, the manager sends the "Get Request" packet. In response to this, the agent provides the information by the "Get Response" packet.
- Setting information
  To set the information for management, the manager sends the "Set Request" packet. In response to this instruction, the agent modifies the setting and confirms the setting by the "Set Response" packet.
- Interruption from object under management
  By sending the "Trap" packet, the agent can request an interruption to the manager.

Exercises

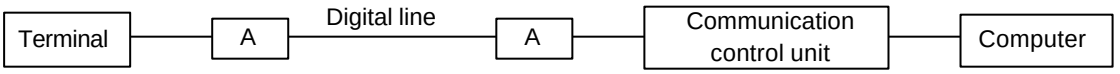
Q1 **Which of the following explanations of devices used in data communications systems covers DTE?**

A. It is a switching device used in line switching technique.
B. It is a computer or terminal having communications capabilities.
C. It is a device that performs multiplexing slow speed or medium speed signals, and transmits to the other party using a high-speed digital line.
D. It is a device that coordinates signal format between a data transmission line and a terminal. It is also called a circuit-terminating device.
E. It is a device that disassembles packet data into non-packet data, and vice versa, using the packet switching.

Q2 **Which of the following explanations of devices comprising networks describes communication control unit (CCU)?**

A. The computer converts the signal translated from character string to bit string into a digital signal suitable for transmission.
B. Dials the telephone number of the terminal in order to call up the terminal.
C. Performs modulation of digital signals into analog signals and vice versa.
D. Performs assembly and disassembly of transmission data and error control of the data.

Q3 **What is the name of the circuit-terminating device A in the following diagram of a digital line?**



A. DSU B. DTE C. NCU D. PAD

Q4 **Which is the device for connecting public telephone circuits with extension telephones and interconnecting extension telephones?**

A. IDF B. MDF C. MUX D. PBX

Q5 **Which is the network management protocol widely used on TCP/IP network environments?**

A. ARP B. MIB C. PPP D. SNMP