Section 3: The ISDN-based Network Structure

Objectives

Upon completion of this section, you will be able to answer questions such as the following:

- How does ISDN make telecommunications more flexible?
- What are functional groups?
- What is a protocol, and how is it different from a standard?
- What are reference points, and why are they different in North America?

An Integrated Flexible Network

Recall that ISDN is a set of standards that governs the implementation of an integrated local voice/data digital network. It is important to keep in mind that these standards only address a customer's local loop access to the PSTN. Such standards were designed as a response to the demand for digital communications. Analog data transmission is slower than digital. Analog signals (voice or data) are more expensive to switch and more prone to error. Once technology for converting voice signals for digital transmission and switching was developed, a completely digital communication network became possible. Even though PSTN was designed to transmit analog signals, it often uses digital technology to complete that function. The development of ISDN standards extends this digital technology to the local loop. The local loop, or the *last mile* as it is sometimes called, is that part of the PSTN that runs between the telephone company's switching office and the customer's home. ISDN makes it possible to include the last mile in the overall digital network. Additionally, ISDN standards will allow for the manufacture of compliant customer-provided equipment (CPE) that will handle the analog to digital translation that now occurs on the PSTN.

As the basis for a combined voice-data digital communication network, ISDN promotes end-to-end digital connectivity the signal remains in digital form during its entire path through the network. Such an integrated network is also flexible. Flexibility, in this case, means flexibility of application. Customers may use an ISDN connection for voice, data, or video transmission. They may also configure their connection to suit changing needs. A business may need multiple voice terminal connections during business hours to communicate with customers along with high-speed data transmission during non-business hours. ISDN provides that kind of flexibility.

As pointed out in the previous section, ISDN is a constantly evolving set of standards. It is not equipment, but a set of standards that equipment must meet. ISDN is a set of design concepts that specify an architecture, a set of theoretical criteria for communication networks. The value of using abstract design as the basis for any integrated network system is that any manufacturer or service provider can implement its vision of integrated services while promoting universal connectivity.

Functional Groups

ITU developed functional groups as a way of describing an ISDN-based network structure. A functional group performs a specific set of tasks. ISDN describes the tasks of a functional group and how it interacts with other functional groups. Functional groups are the building blocks of the ISDN-based network structure. The ITU has defined the minimum number of functional groups necessary to create a network. ISDN has five functional groups NT1, NT2, TE1, TE2, and TA.

Network Terminating Equipment (NT)

The first two groups, NT1 and NT2, describe the functions of network terminating equipment. This equipment provides a receptacle to connect CPE to the network. The simplest network terminator is merely a set of connectors, sometimes nothing more than a box offering the customer receptacles for jacks. A more complicated NT may provide network performance monitoring and switching capabilities. Also, the NT defines the point where the CPE connects to the ISDN line. There are two types of functional groups for network terminating equipment.

- **NT1:** Network termination equipment for a single telephone line. This functional group is the telephone jack in the wall where the customer's terminal device is plugged in on one side, and the ISDN line connects to the other side.

- **NT2:** Network termination equipment with switching or line-concentrating capabilities. This functional group is often built into a private branch exchange (PBX) for serving multiple phone lines.

Terminal Equipment (TE)

The next two functional groups describe terminal equipment. Terminal equipment includes data terminals, computers, and voice terminals (telephones). There are two types of terminals defined under ISDN.

•1 **TE1:** A digital terminal that follows ISDN standards. Examples are:

— ISDN digital telephone

— ISDN digital data terminal

•1 **TE2:** Any other telephone or data terminal that does not follow ISDN standards and cannot connect directly to an ISDN-based network. Examples are:

— Personal computers with serial port

— Analog telephone

— Proprietary digital phone (for example, a PBX station set)

— Asynchronous terminal

— IBM 327X synchronous terminal

Terminal Adapter (TA)

The last functional group works in conjunction with the TE2 functional group. A terminal adapter (TA) is necessary to translate the communication standards of a TE2 (non-ISDN) into the ISDN standards. There must be a TA between any TE2 and an NT1 or NT2.

There are many types of terminal adapters to accommodate numerous types of non-ISDN equipment and communication standards in the marketplace. To connect an analog phone to an ISDN-based PSTN requires a terminal adapter capable of digitizing an analog telephone's signal. (See figure 3-1.) Another example is the RS-232 TA, a common adapter for connecting a personal computer or asynchronous terminals to an ISDN line. It converts the signals passing through the computer's RS-232 serial port into an ISDN-compatible signal. (See figure 3-2.) There are many devices on the market today that combine the functions of the TA and the NT1 and allow multiple non-ISDN devices to plug into a single ISDN line.

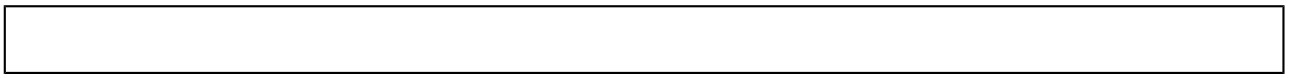

Figure 3-1. To connect a non-ISDN analog telephone to an ISDN line requires a terminal adapter capable of digitizing the analog signal.

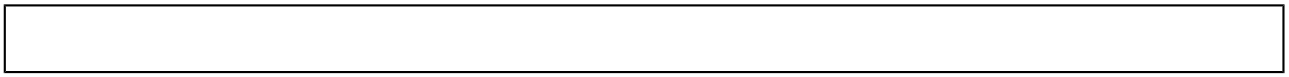

Figure 3-2. To connect a non-ISDN data terminal to an ISDN line requires a terminal adapter capable of translating the terminal's output into an ISDN-compatible signal.

Functional groups define the parts, the terminal, and the terminal interface of the customer-owned portion of the ISDN-based network and the standards for how functional groups interact with each other and with the public switched telephone network.

Reference Points

The ITU devised reference points to describe the protocol standards required for the signal as it passes from one functional group to another. Recall that standards govern how a manufacturer designs equipment so that it will be compatible with other manufacturers. For example, the standards for an electrical plug ensures that it will fit properly into the wall socket of your home. A protocol governs how the electricity passes through the plug and wire to the appliance. In ISDN, a protocol describes how the digital signal is sent to the next functional group. When a signal leaves a functional group, it must follow a particular set of rules in order to communicate properly with the next functional group.

There are three reference points used in North America the R interface, the S/T interface, and the U interface. Each reference point describes the protocol standards relevant to the interface. For example, the S/T interface reference point describes how a signal passes from an TE1 functional group to an NT1 functional group. The signal passing between the TE1 and NT1 must conform to the protocol standards for the S/T interface.

The following are the three key reference points for ISDN service in North America. The ITU developed the first two, and the ANSI committee developed the third. The North American standards of ISDN are slightly different from European and Asian standards.

R interface: defines the connection of non-ISDN terminal equipment, or TE2, to network

termination equipment, such as NT1.

S/T interface: defines the connection of ISDN terminal equipment, such as TE1 or TA, to network termination equipment, such as NT1 or NT2.

U interface: defines the connection of network termination equipment (NT1 or NT2) to the network. In European and Asian countries, this reference point is unnecessary. The government controls telephone networks that guarantee interface compatibility. In the United States, the U interface marks the end of the network for regulatory purposes.

Depending on the design of a particular piece of ISDN-compliant equipment, a reference point may not be associated with a specific piece of equipment or communication port. Manufacturers may integrate equipment functions into a single piece of equipment, such as combining a terminal adapter and an NT1 into a single unit. Consider the following examples (figures 3-3 and 3-4) illustrated in ISDN terms.

Telephone companies offer local and long distance dial-up service through the PSTN. Any telephone or data communication device that can be reached by dialing its phone number is part of the PSTN. While a business may have its own private network, communication beyond that network requires access to the PSTN. The part of the network not connected to the PSTN can follow its own communication protocols and standards. However, it must follow ISDN standards for terminals and terminal interfaces at the point where it connects to the PSTN.

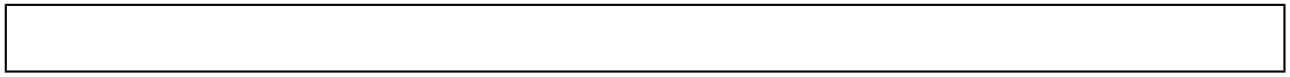

Figure 3-3. In this example, the TE1 functional group is the ISDN telephone. The NT2 functional group tasks are handled by the PBX. The PBX has integrated the NT2 because it has switching capabilities.

Figure 3-4. In this example, the TA functional group is the terminal adapter. It does the necessary signal conversions and provides the S/T interface with the NT1 unit.

Summary

- ISDN is a constantly evolving set of standards for integrated voice/data communications.
- ISDN standards allow individual manufacturers to design their own equipment while promoting universal connectivity.
- Functional groups describe the customer-owned parts of ISDN-based network structure.
- Reference points describe the protocol standards between functional groups. As a digital signal moves through an ISDN-based network structure, it must follow a particular set of rules in order to properly communicate between functional groups.

Progress Check

1. Where does ISDN extend digital technology?

A. Analog CPE

B. PSTN

C. Local loop

D. Functional groups

Answer: C

2. ISDN-compliant CPE handles what function?

_____
_____
_____

Answer: Analog to digital translation

3. How is an ISDN-based network flexible?

_____
_____
_____

Answer: Customers may use an ISDN connection for voice, data, or video. They may also configure their connection to suit their needs.

4. What do functional groups describe?

A. Network terminating equipment

B. Terminal equipment

C. Terminal adapters

D. ISDN-based network structure

Answer: D

5. What are the functional groups in figure 3.5?

Insert diagram here.

Figure 3.5

A_____

B_____

Answers:
A. TE1
B. NT1

6. What are the functional groups in figure 3.6?

Insert diagram here.

Figure 3.6

A_____

B_____

C_____

Answers:
A. TE2
B. TA
C. NT1

7. What are the functional groups in figure 3.7?

Figure 3.7

A_____

B_____

Answers:
A. TE1
B. NT2

8. What do reference points describe?

_____
_____
_____

Answer: Reference points describe the protocol standards required for the signal to pass from one functional group to another.

9. What is the reference point in figure 3.8?

Insert diagram here.

Figure 3.8

A. S/T

B. U

C. R

Answer: B

10. What are the reference points in figure 3.9?

Insert diagram here.

Figure 3.9

A. R and S/T

B. S/T and U

C. U and R

Answer: A