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NORTEL NETWORKS™

ISDN TECHNOLOGY REVIEW

PREWORK

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Table of Contents

Read This First vii

Why Take This Review? vii
Prework Objectives vii
Prerequisites viii
How to Use This Workbook viii
Follow These Steps for Each Lesson ix
Documentation ix
If You Need Help x

Lesson 1. Overview of ISDN 11
Lesson Objectives 11
What Does ISDN Stand For? 12
ISDN Standards 13
National ISDN 13
NI-1 and NI-2 13
Why National ISDN? 14
ISDN Interfaces: BRI and PRI 15
Comparison of PRI and BRI 15
Circuit-switched Data Compared to Packet-switched Data
for BRI 18
Characteristics of ISDN 19
Benefits of ISDN 20
Transmission Speed 20
Improved Voice Quality 20
Support for Multiple Devices 21
Bandwidth Scalability 21

Signaling 21
Compatibility with Packet Data 21
ISDN Integrated Services 22
Implementing ISDN for BRI. 25
Locations for Implementation 26
Distance Guidelines. 26
The Future of ISDN. 27
Check Your Learning 29

Lesson 2. BRI Hardware Components 35
Lesson Objectives: 35
Hardware Components in a BRI Communications System 36
Access 37
Switch 37
Customer Premise 37
D-Channel Handler 38
Location 38
Functions 39
Line Card 39
Location of Line Cards. 39
Functions 39
Enhanced Line Concentrating Module (LCME) 40
Line Group Controller (LGC). 40
U-loop 40
Functions 40
Distance Limitations of the U-loop. 40
Network Termination 1 41
Functions 41
Terminal Adapter 41
Functions 41

S/T Bus 42
Functions 42
Summary 43
Primary Hardware Components 43
DMS Switch Hardware Components 43
Other Hardware Components 43
Customer Premise Components 44
Check Your Learning 45

Lesson 3. BRI Logical Components 49
Lesson Objectives 50
Directory Number (DN) 51
Line Equipment Number (LEN) 51
Logical Terminal Identifier (LTID) 52
Fields That Make Up the LTID 53
Logical Terminal Class (LTCLASS) 54
Protocol Version Control (PVC) 55
Terminal Endpoint Identifier (TEI) 56
Primary Types of TEIs 57
Static TEIs (STEI) 58
Dynamic TEIs (DTEI) 59
User Assigned TEI (UATEI) 59
User or Network Assigned TEI (UNATEI) 60
Service Profile Identifiers (SPIDs) 60
SPID Suffix 62
Example of a SPID Suffix 62
Terminal Identifier (TID) 63
Additional Rules for BRAFS Terminal Type 63
FITs and NITs 64
Service Access Profile Identifier (SAPI) 65

What is Bearer Capability? 66
Bearer Capability Screening 66
Bearer Capability Routing 67
Check Your Learning 69

Lesson 4. Packet Switching 73
Lesson Objectives. 74
What is Packet Switching? 74
How Does Packet Switching Work? 76
Example of Packet Switching 76
Transmission Protocols 77
Packet Switching Architecture 78
Local Access Component (LAC) 79
Packet Assemblers/Disassemblers (PADs). 79
Packet Switching Node (PN) 80
The LPP-based DMS Packet Handler 80
Network Links (NL) 81
Network Management System (NMS). 81
What is Virtual Switching? 82
Packet Handler Identifiers. 83
Summary. 84
Check Your Learning 85

Lesson 5. Primary Rate Interface (PRI) 89
Lesson Objectives. 89
What is PRI?. 90
What is the Purpose of PRI?. 92
PRI Services. 93
Advantages of a PRI Network. 93
What is a PRI Trunk Group?. 94
Trunking Features 94

What is Bearer Capability? 95

Q.931 95

Differences Between BRI
and PRI 96

Check Your Learning 97

Appendix A. Related Information—How ISDN relates to the OSI Model 101

Layer 1—Physical Layer.............................. 102

Layer 2—Data Link Layer............................. 102

Layer 3—Network Layer.............................. 103

Glossary 105

Read This First

This review provides you with an overview of the terminology, concepts, and capabilities associated with Integrated Services Digital Network (ISDN).

Why Take This Review?

This workbook provides a technology overview of basic ISDN concepts—the workbook does not cover all aspects of ISDN.

If you have not had previous exposure to basic ISDN concepts or if you have not recently worked with ISDN, this workbook reviews information that is needed before you work with ISDN Basic Rate Interface (BRI) or Primary Rate Interface (PRI) translations, maintenance, service order, engineering, and provisioning.

Your job responsibilities determine whether or not you will apply all of the concepts presented in this review. But, the information presented will provide you with a solid foundation that will help you learn specific tasks that apply to ISDN.

Refer to the prework objectives and the individual lesson objectives for a complete overview of the course content.

Prework Objectives

After completing this prework, you will be able to answer these questions:

- What is ISDN?
- What standards govern ISDN?
- What are the basic characteristics of ISDN?
- What is BRI?
- What primary hardware components make up a BRI system?
- What primary logical components make up a BRI system?
- What is packet switching?
- What is PRI?

Prerequisites

Before you take this prework, you need to take this Nortel Networks Computer-Based Training (CBT) course:

- 0170 Introduction to Integrated Services Digital Network (ISDN)

– or –

- Have equivalent training or job experience

How to Use This Workbook

ISDN Technology Review is a self-paced course—which means you study the content at your own pace.

- Allow time to work through the material in a way that is most comfortable to you.
- As an estimate, it will take approximately 4 hours for you to work through the entire workbook—you can take more or less time to meet your individual needs.

Follow These Steps for Each Lesson

Read and work through the lessons in order because some parts of the lessons build on previously presented information.

- At the beginning of each lesson, objectives describe what you can expect to learn in that particular lesson.
- Read the sections within the lesson that you are studying.
- Follow directions for any questions that appear within the lesson.
  - *Check Your Learning* questions appear at the end of every lesson, so you can review the material that was presented.
- Check your answers to the questions on the page(s) following the last question.
  - If any of your answers are incorrect and you do not understand the correct answer, re-read the pages to which the question refers.
- Refer to the glossary at the end of this workbook for definitions of terms used throughout this course and for the meaning of acronyms and abbreviations.

Documentation

Always refer to the NTPs for the most current product information.

The following Northern Telecom Publications (NTPs) and specifications were used in the development of this workbook—use these documents as reference material after you complete this review.

NTP Title	NTP Number
National ISDN BRI Service Implementation Guide	297-2401-201
ISDN PRI Service Implementation Guide	297-2401-200
North American Translations Guide	297-8001-350
ISDN PRI Maintenance Guide	297-2401-502

If You Need Help

If you have a content-related question for an instructor, you can call the following numbers and select **Option 2**.

Please leave you name, the title of the workbook, and your complete telephone number. Your call will be returned within one business day.

- In North America 1-800-688-7246 (1-800-NT-TRAIN)
- International callers 919-997-7565
- Nortel Networks employees ESN 357-7565

Lesson 1

Overview of ISDN

Integrated Services Digital Network (ISDN) has become more popular since the advent of the World Wide Web. You need analog or digital facilities to obtain information from the Web.

One reason why ISDN is popular is that people are finding that analog modems do not offer acceptable data rates and downloading high-speed graphics is often slow. People choose ISDN because of its quick digital data transmission capabilities—so many service providers now offer ISDN as a faster alternative to the conventional modem.

What do you need to know about ISDN? This lesson will provide you answers to questions about ISDN that you need to know before you move on to the technical details about how ISDN works.

Lesson Objectives

After completing this lesson, you will be able to answer the following questions:

- What does the acronym ISDN stand for?
- What set of standards is ISDN governed by?
- What are the two types of ISDN interfaces?
- What is the difference between circuit-switched and packet-switched data?
- What are the basic characteristics of ISDN?
- What types of integrated services does ISDN provide?
- How is ISDN implemented?
- What is the future of ISDN in the telecommunications industry?

What Does ISDN Stand For?

Integrated Services Digital Network (ISDN) is a fully digital, standardized, technology.

ISDN allows for simultaneous, integrated voice and data capability over 2-wire digital loops and 4-wire digital trunks. These loops and trunks can access circuit-switched voice and data networks, packet-switched networks, and network services databases.

Note: You will learn more about circuit-switched and packet-switched networks later in this lesson.

What ISDN stands for explains a lot about what ISDN provides:

Integrated Services	Offers a wide range of services that combine voice and data capabilities
Digital	Uses digital communication, which is clearer and faster than analog
Network	Provides the benefits of digital communications—paves the last bit of the digital network with a digital connection

ISDN Standards

Like any technology, standards for ISDN must be followed for effective deployment.

National ISDN

ISDN providers conform to **National ISDN**, which refers to the set of ISDN standards that apply to North America.

Note: The International Telephone and Telegraph Consultative Committee (CCITT), now known as the International Telecommunications Union (ITU), is a United Nations organization that coordinates and standardizes international telecommunications. ITU led the original effort that produced the initial, basic guidelines for implementation of ISDN.

NI-1 and NI-2

In the early 1990's, an industry-wide effort to establish specific ISDN implementation standards produced National ISDN 1 (**NI-1**).

- Before you buy any expensive hardware and software, you want to make sure that everything you buy is compatible.
- With this same idea in mind, **NI-1** was established by Bellcore as a set of standards to ensure that users know that the equipment and software products they buy are compatible with a particular ISDN switch.
- Recently, the industry has adopted more comprehensive ISDN standards known as National ISDN 2 (**NI-2**), which build on the foundation established by the NI-1 standards.
- The final phase of ISDN standards is National ISDN 3 (**NI-3**). NI-3 will provide further standardization of interface protocols and services to expand ISDN functionality.

Why National ISDN?

Important to sellers of communication products.

National ISDN is important to everyone who sells communications products because it provides for the following:

- Wider access to high-speed data communications
- A new market for high-performance Customer Premise Equipment (CPE) and networks
- New applications

Addresses areas of importance to operating companies and users.

National ISDN commitments address the following three major areas:

- **ISDN user equipment**, such as computers, data terminals, and telephones, and services
- **Standard operating company procedures and systems** for the operation, administration, and maintenance of ISDN services and equipment
- **Standard communications** among ISDN-capable switches to extend ISDN services throughout the public switched network

With National ISDN standards in place, operating companies like you work for have a practical ISDN service they can market, and the users are assured of stable terminals and service.

Note: For more information about National ISDN, visit this web site: http://www.bellcore.com/NIC (NIC stands for National ISDN Council)

ISDN Interfaces: BRI and PRI

Recall that ISDN can deliver integrated voice and data services—it was designed to function at 64 kbps with separate channels.

This speed is the digital sampling rate of analog transmissions (8000 samples per second with 8 bits per sample).

Think of ISDN as a digital transmission pipe that carries these two separate channels:

- a **B-channel** for user information—the data
- a **D-channel** for administrative signaling purposes

The number of B- and D-channels depends on what type of access interface is used.

The two types of ISDN access interfaces offered in North America are:

- **Primary Rate Interface (PRI)**
- **Basic Rate Interface (BRI)**

Each interface provides different amounts of bandwidth and enables the "pipe" to carry a different number of channels

Comparison of PRI and BRI

Go back to the analogy of ISDN as a digital transmission pipe that carries channels:

- PRI is the "large" pipe that carries 24 channels, or high bandwidth
- BRI is the "small" pipe that carries 3 channels, or lower bandwidth

The following table summarizes some of the differences between PRI and BRI.

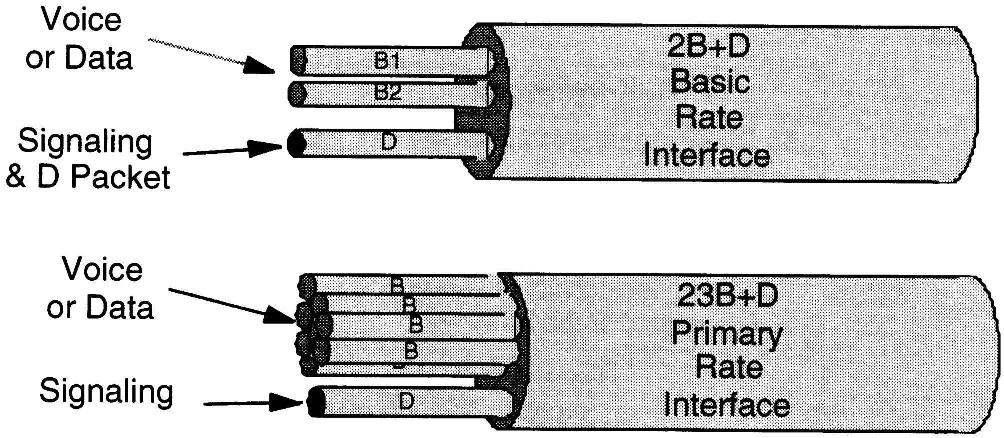
Table 1 Comparison of Characteristics of PRI and BRI

Primary Rate Interface (PRI)	Basic Rate Interface (BRI)
Higher bandwidth	Lower bandwidth
In North America • Offers up to 23 B-channels (64kbps) and one D-channel (64 kbps) • Commonly known as 23B+D	• Offers two B-channels at 64 kbps and one D-channel at 64 kbps • Commonly known as 2B+D
Internationally • Offers 30B+D (30 B- channels and one D-channel)	
B-channels can be combined to provide a higher rate of transmission. • In North American, the combination of all 23 B-channels and the D-channel allows a transmission speed of 1.544 Mbps (equivalent to a T-1 circuit)	The two B-channels can be combined into one channel to provide a higher rate of transmission. • Offers up to 128 kbps
All channels can be used at the same time.	All channels can be used at the same time.
	Designed to transmit the most amount of data possible over copper wires—160 kbps.
	Any combination of up to a maximum of 8 devices or terminals can be configured on the loop to share the two available B-channels.
Targeted to big businesses that have large network needs.	Best suited for home and small business applications.
Used to link private networking facilities (such as Private Branch Exchange [PBX], Local Area Network [LAN] facilities, and host computers with standardized architecture. • The architecture acts as a bridge between private switching equipment and the public network	

Other lessons in this course provide more detail about PRI and BRI.

Figure 1 illustrates the difference between PRI and BRI.

Figure 1 Two Types of ISDN Interfaces



An important benefit is that ISDN allows for multiple, simultaneous phone conversations.

For instance:

- A voice conversation can be established to a different location using one B-channel
- A circuit-switched data conversation can be established to a different location on the second B-channel
- A third conversation can be established to yet another location using a packet-switched device on the D-channel

Circuit-switched Data Compared to Packet-switched Data for BRI

Most ISDN applications currently use circuit-switched data.

For BRI, data can be transmitted through ISDN BRI lines in two ways—**circuit-switched** and **packet-switched**.

Circuit-switched	Packet-switched
An ISDN circuit-switched data call is • Switched through the same telephone network as a voice call and terminates to another data device at the other end.	An ISDN packet-switched data call • Routes from the local telephone switch into a separate network of packet switches.
The ISDN B-channels can be defined as circuit-switched *or* packet-switched.	
	The ISDN D-channel can *only* be defined as a packet-switched channel. • An example of packet-switched data is a point-of-sale credit authorization.

Note: You will learn more about packet-switched data later in this course.

Characteristics of ISDN

Now that you know some information about ISDN, you can see that if you or your customer's application has the following needs, then ISDN is a good choice because ISDN offers:

- Inexpensive access to fast packet services like Automatic Teller Machines (ATMs)
- Simultaneous use of data, voice images, and video—all on the same facilities, which reduces the need for additional equipment
- Speedy intra-company and inter-company communications, which reduces communication time
- An economical alternative to expensive leased lines, which helps reduce costs
- A high-speed alternative to analog dial-up service
- A redundant backup for network integrity and disaster recovery

Benefits of ISDN

You already know that digital telephony offers many benefits over analog telephony.

ISDN was developed for the purpose of extending those digital benefits all the way to the customer premises. Look at the highlighted items below that review the benefits of ISDN:

Transmission Speed

The traditional modem was used to allow computers to communicate with one another over telephone lines using analog transmission. When a computer sends data, the digital data must first be converted to analog form by the modem, then converted back to digital form once the data is received by the switching equipment. **This process is simply inefficient.**

- ISDN uses digital signaling, which enables multiple digital channels to be transmitted over the same analog lines.

FAST!

- The BRI standard can support uncompressed data transfer speeds of 128 kbps, and the PRI standard can support data transfer rates of 2.048 Mbps.

EVEN FASTER!

- With the use of data compression, BRI transfers can exceed 500 kbps.

Improved Voice Quality

ISDN uses a form of modulation called Pulse Code Modulation (PCM), which uses auditory masking to hide noise. Users get a clear and quiet voice connection.

The clarity is so good that ISDN is being used to relay broadcast quality audio.

Support for Multiple Devices

Without ISDN, simultaneous transmissions from more than one device (like a telephone, computer, and fax machine) in a business or home is not possible unless there is a separate line for each of these devices (which is very expensive).

ISDN saves money.

Since ISDN enables multiple channels to exist over the same line, more than one device can share a single phone line—each device has its own identity (Directory Number [also called a DN]).

Bandwidth Scalability

ISDN allows B-channels to be combined together to provide higher bandwidth for applications that require it.

ISDN provides flexibility.

The process of combining channels is known as **channel aggregation** or **inverse multiplexing**. This combination of channels is used in applications that require the transfer of large files, such as graphics, movie files, or video conferencing.

Signaling

To notify the end user that there is an incoming call, the digital switch transmits a digital packet on a separate signaling channel (the D-channel).

- The packet does not disturb any established calls.
- The packet establishes the connection very quickly.
- The packet also indicates the identity of the calling party, the type of call (data/voice), and what number was dialed.

Compatibility with Packet Data

ISDN allows users to interconnect with packet data networks (such as those that use X.25 protocols). This capability opens the door for many new applications from point-of-sale credit card authorizations to inexpensive security systems for offices and campus dormitories.

ISDN Integrated Services

Remember that part of the name ISDN stands for "integrated services"—meaning a mix of voice *and* data services.

Look at the highlighted items below to see the integrated services that ISDN is best suited for.

Note: The benefits of ISDN keep re-appearing!

Online Services and Internet Access

Internet and online services continue to grow at a phenomenal rate and have become important tools for most of today's businesses.

Users need fast services that can handle graphically intense interfaces like Netscape and Microsoft Explorer.

- Many users find that analog modems do not offer acceptable data rates and that the download rates are slow.
- So, many service providers have begun to offer ISDN as a faster alternative to the analog modem.

File Transfer

ISDN can be used to interconnect personal computers (PCs) at different sites to transfer large files. This type of connection is useful for graphics and printing, where large files are constantly transferred between computers.

Group 4 Fax

Fax machines are the universal means for businesses to communicate and send documents between various locations.

Note: Group 4 is a fax standard that allows analog fax machines to transmit over ISDN lines.

- The advantage of using an ISDN line is that the sender is able to send faxes by means of a fax server to multiple recipients who do not have separate fax lines.
- The fax server receives the fax and attaches it to an e-mail, which is sent to all addressees.
- So, what is the benefit? Group 4 fax eliminates the need for each person to have a separate fax machine and fax line, which obviously saves money.

Remote PC Connections

Connection of remote PCs to Local Area Networks (LANs) through ISDN lines is a low-cost way to improve communications.

You probably already know that telecommuting and temporary networking are popular among businesses and workers. Any work that can be done at the office can now be done from a remote location.

With ISDN, PCs can communicate with the network for e-mail and file transfer purposes. Remote users can also use the connection for high-speed database access and to download graphics.

Backup for Leased Lines

When necessary, ISDN lines can be inverse multiplexed to provide higher transfer rates.

- This trait makes ISDN a cost-effective solution to connect multiple LANs in comparison to private lines.
- Inverse multiplexing of ISDN lines to provide a high transfer rate can temporarily serve the network until the leased line is back in service.

Teleconferencing and Video Conferencing

With ISDN to the individual desktop, you can participate in a teleconference without ever having to leave your desk. Face-to-face meetings are not always needed when ISDN helps people effectively communicate in different ways.

Many companies are taking advantage of these services, which reduce the costs for business travel and lodging.

Implementing ISDN for BRI

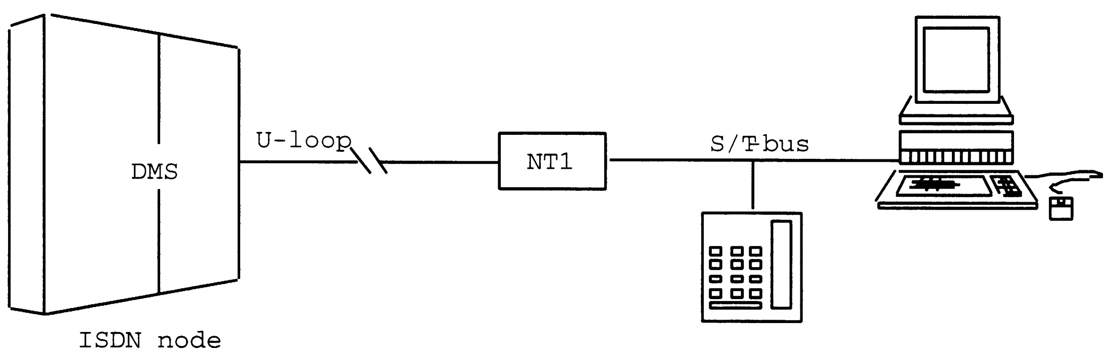
You have already learned about some of the things that make ISDN work. Here is some more information that can help you understand the implementation of ISDN.

Follow along with Figure 2, which provides a diagram of a basic ISDN BRI configuration:

- The portion of the ISDN between the **Network Terminator (NT1)** and the DMS switch (or other switch) is known as the **user loop** (also called the **U-loop**).
- The segment of the ISDN line from the NT1 to the terminating Customer Premise Equipment (CPE) is referred to as the **S/T bus**.

Note: Keep in mind that multiple devices can connect simultaneously to the ISDN line on the S/T bus. Also, some CPEs have a built-in NT1 that allows CPEs to connect directly to the U-loop. The built-in NT1 eliminates the need for a separate NT1.

Figure 2 Basic ISDN Configuration



Locations for Implementation

To work properly, ISDN is implemented in the central office, the local loop (or access), and on the customer (or user) premises. The central office switch needs an upgrade for hardware and software.

- The local loop must be cleaned up to reduce noise.
- On the customer premises, a network termination device and a terminal adapter (for any non-ISDN ready devices) are installed.
- Re-routing and re-wiring are done when necessary.

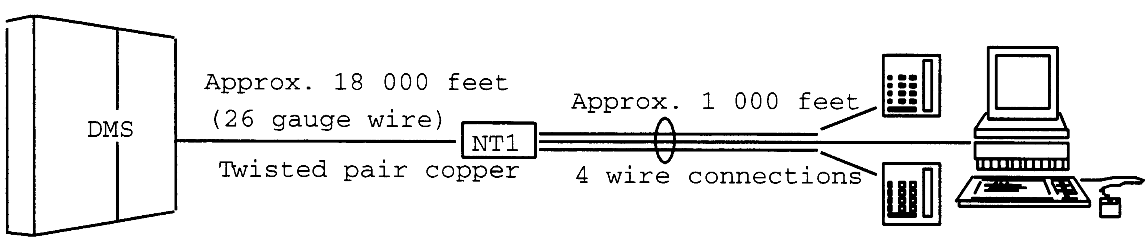
Distance Guidelines

ISDN BRI is designed to work under specific distance guidelines.

Figure 3 illustrates the approximate maximum wiring distances. It is possible that you will see some of the wiring distances in your own offices.

Note: Depending on the specific ISDN configuration, the permissible differences can and do vary. More information about wiring guidelines is available in the *National ISDN BRI Service Implementation Guide (297-2401-201).*

Figure 3 Approximate Wiring Distances



The Future of ISDN

So, where is ISDN going? Will you continue to see ISDN in the future?

Although National ISDN standardizes the basic elements of ISDN, there is still room for innovation and value-added services. Network providers can invent a new ISDN service, or a computer manufacturer can enhance its ISDN products. Over time, many of these enhanced services make their way into the standard feature set.

Most of the individual capabilities of ISDN can be duplicated with other technologies today—although remember that ISDN delivers the capabilities over a single line.

> The real ISDN revolution is that ISDN is available all across North America with a set of standardized services.
>
> This standardization frees users from the premium costs of proprietary solutions. Essentially, advanced data services are available to anyone within the reach of a telephone.

What about National ISDN?

National ISDN has revitalized the ISDN industry, stimulating the demand for ISDN services and promoting the supply of ISDN hardware and software.

- In the past, the lack of ISDN equipment such as telephones, data terminals, and compatible software had a negative effect on widespread deployment of ISDN.
- Many telephone operating companies were reluctant to market ISDN without a wide choice of compatible products.

National ISDN continues to drive widespread ISDN deployment and development. So, you will continue to see ISDN used, as well as other technologies.

Check Your Learning

Now you have a chance to review what you have learned about ISDN.

Please complete the following questions. You can refer back to the material covered in this lesson to help answer any of these questions.

1. What does the acronym ISDN stand for?

   a. I Still Don't Know

   b. Innovations Subscribers Don't Need

   c. Industry Strength Data Network

   d. Integrated Services Digital Network

2. What is National ISDN?

   a. An effort to standardize ISDN

   b. An ISDN interstate network

   c. Nortel Networks own brand of ISDN

3. ____________ and __________ are the two types of ISDN access interfaces.

4. Which one of the following statements is **not** true about PRI?

   a. PRI is a digital transmission pipe.

   b. PRI is the larger pipe of the two ISDN interfaces.

   c. PRI has 24 channels.

   d. PRI has 3 channels.

5. Which one of the following statements is **not** true about BRI?

   a. BRI is the smaller pipe of the two ISDN interfaces.

   b. BRI has 24 channels.

   c. BRI has 3 channels.

   d. BRI is a digital transmission pipe.

6. _____ provides two B-channels plus one D-channel.

   a. ISDN

   b. Basic Rate Interface

   c. Primary Rate Interface

   d. Packet-switched data

7. ISDN provides the subscriber with access to two types of switching technologies. List the two switching technologies:

   a. ______________________________

   b. ______________________________

8. Circuit-switching is used exclusively for voice calls. Packet-switching is used exclusively for data calls.

   True or False (If false, correct the statement)

9. Which one of the following is **not** a characteristic of ISDN?

   a. Can have up to three simultaneous transmissions on one ISDN line

   b. Not as reliable as a dial-up analog connection

   c. Cost-effective alternative to expensive leased lines

   d. Provides a redundant backup for network integrity and disaster recovery

10. Which one of the following services is **not** provided by ISDN?

    a. Group 4 Fax

    b. Telecommuting

    c. Internet access

    d. File transfer

    e. Television broadcasts

11. Where is ISDN implemented?

    a. On the customer premises

    b. At the central office

    c. In the local loop

    d. All of the above

Answers

The correct answers are highlighted below.

1. What does the acronym ISDN stand for?

   a. I Still Don't Know

   b. Innovations Subscribers Don't Need

   c. Industry Strength Data Network

   d. Integrated Services Digital Network

2. What is National ISDN?

   a. An effort to standardize ISDN

   b. An ISDN interstate network

   c. Nortel Networks own brand of ISDN

3. **Primary Rate Interface (PRI)** and **Basic Rate Interface (BRI)** are the two types of ISDN interfaces.

4. Which one of the following statements is **<u>not</u>** true about PRI?

   a. PRI is a digital transmission pipe.

   b. PRI is the larger pipe of the two ISDN interfaces.

   c. PRI has 24 channels.

   d. PRI has 3 channels.

5. Which one of the following statements is **<u>not</u>** true about BRI?

   a. BRI is the smaller pipe of the two ISDN interfaces.

   b. BRI has 24 channels.

   c. BRI has 3 channels.

   d. BRI is a digital transmission pipe.

6. _____ provides two B-channels plus one D-channel.

   a. ISDN

   b. Basic Rate Interface (also called BRI)

   c. Primary Rate Interface

   d. Packet-switched data

7. ISDN provides the subscriber with access to two types of switching technologies. List the two switching technologies:

   a. Circuit-switched

   b. Packet-switched

8. Circuit-switching is used exclusively for voice calls. Packet-switching is used exclusively for data calls.

   True or **False** (If false, correct the statement)

   Circuit-switched can handle voice <u>or</u> data.

9. Which one of the following is **<u>not</u>** a characteristic of ISDN?

   a. Can have up to three simultaneous transmissions on one ISDN line

   b. Not as reliable as a dial-up analog connection

   c. Cost-effective alternative to expensive leased lines

   d. Provides a redundant backup for network integrity and disaster recovery

10. Which of the following services is **<u>not</u>** provided by ISDN?

    a. Group 4 Fax

    b. Telecommuting

    c. Internet access

    d. File transfer

    e. **Television broadcasts**

11. Where is ISDN implemented?

    a. On the customer premises

    b. At the central office

    c. In the local loop

    d. All of the above

If you had trouble answering the questions or you missed questions—review this lesson before you proceed.

Lesson 2

BRI Hardware Components

In the previous lesson, you learned about the two ISDN subscriber interfaces—Basic Rate Interface (BRI) and Primary Rate Interface (PRI).

You will be working with two primary types of BRI components—hardware and logical components. To understand the hardware and logical ISDN components, you need to first become familiar with the terms and acronyms used in IDSN systems.

As you review the ISDN hardware components presented in this lesson, you will be introduced to the most common ISDN terms and acronyms.

Lesson Objectives

After completing this lesson, you will be able to answer the following questions:

- What are the ISDN hardware components in a BRI communications system?
- What is the function of a D-Channel Handler?
- What is the function of the line card?
- What is an LCME and an LGC?
- What is the U-loop?
- What is an NT1?
- What is the function of the terminal adapter?
- What is the S/T bus?

Hardware Components in a BRI Communications System

As you learn more about the hardware components within an ISDN BRI loop, keep the following concepts in mind:

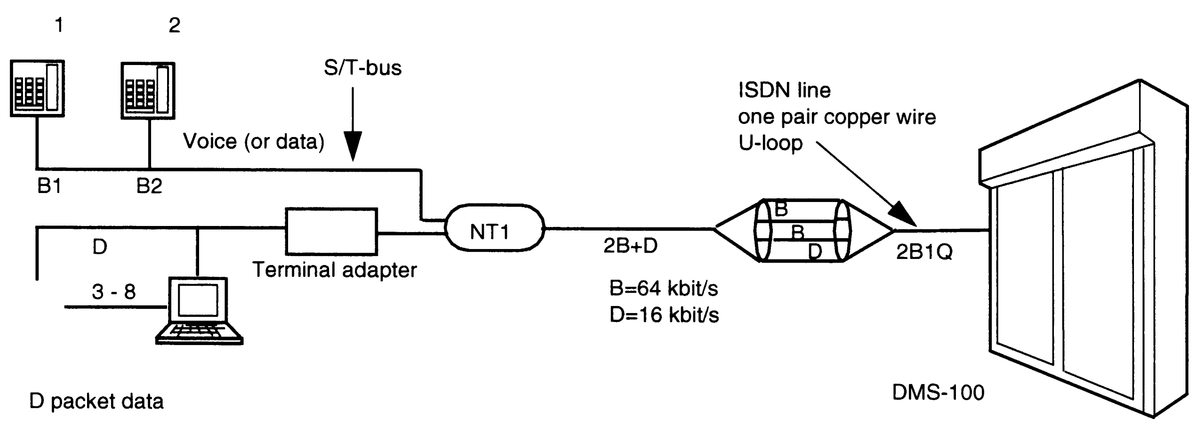
- BRI uses standard 2-wire telephone lines to connect ISDN terminals at the customer premises to an ISDN node.
- BRI provides ISDN access over three individual channels:

  — Two B-channels   referred to as 2B+D
  — One D-channel

- The D-channel is used for call control information for the two B-channels, as well as for low-speed packet data.
- The B-channels can be used for voice, circuit-switched data, or high-speed packet switch data transmission.

The best way for you to gain an understanding of the hardware components that make up an end-to-end communications system is to look at an overview diagram. Figure 4 shows a simple ISDN BRI loop.

Figure 4 ISDN Physical Equipment and Connections



Access

The ISDN pipeline provides access to voice and data services. This illustration shows you a BRI line with three channels.

Keep in mind that the limit for the access distance is 18,000 feet. You will find a definition for "U-loop" in the following section.

Note: The distance limit varies, depending on factors that can interfere with the transmission quality of the one-pair copper wire U-loop.The distance can be extended through the use of ISDN repeaters.

Switch

The DMS (or other) switch is attached to the ISDN BRI line on one end. In this diagram, the DMS switch provides an ISDN BRI interface circuit.

Customer Premise

The Customer Premise Equipment (CPE) is attached to the ISDN BRI line on the opposite end.

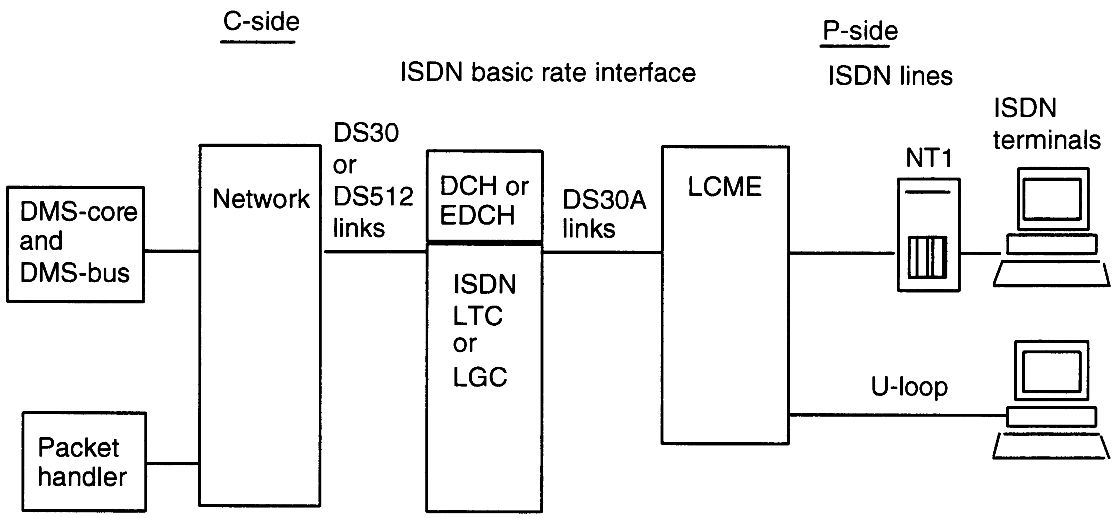
The Customer Premise portion of the configuration must have a

- Network termination (or NT1)
- A terminal adapter (or ISDN modem)
- At least one device such as a computer, ISDN phone, or a fax machine

Now that you have a general overview of a typical ISDN configuration, you are ready to learn about the individual hardware components in greater detail.

If you understand the role of each of the components within an ISDN configuration, you will have the technical background you need to engineer and provision your company's ISDN systems. As you read about each of these components, you may find it useful to refer to Figure 5. Feel free to reference this figure along with Figure 4 shown at the beginning of this lesson.

Figure 5 Typical ISDN Hardware Layout



Legend

DCH	D-channel handler
EDCH	Enhanced D-channel handler
LCME	Enhanced ISDN line concentrating module
LGC	line group controller
LTC	line trunk controller
NT1	Network termination 1

D-Channel Handler

The D-channel handler (DCH) provides the main interface to all BRI D-channels that are Time Division Multiplexed (TDM) in a ratio of 4:1 at the ISDN Line Concentrating Modules Enhanced (LCME).

Location

- DCH is a physical circuit pack that resides in the DMS SuperNode ISDN switch.

Functions

- Routes all incoming and outgoing D-channel information from all associated BRI subscriber lines
- Directs low-speed packet-switched data and Q.931 call control messaging for circuit-switched traffic to the Packet Handler (PH)

Note: The D-channel supports up to eight devices on a single BRI line.

Line Card

This course uses the DMS-100 switch for all examples.

The line card (LC) is the digital circuit board used by the DMS switch to physically connect to the wires that go to the ISDN Customer Premise Equipment (CPE).

Location of Line Cards

- Housed in the Enhanced Line Card Module (LCME) within a central office
- Line cards are either the NTBX27 or NTBX26 in the DMS switch

"NT" numbers are Product Engineering Codes (PECs).

Functions

- Supports conversion of digital line coding format (2B1Q) used on the loop to digital coding format used by the DMS switch
- Works as part of the DMS switch when you perform maintenance and diagnostic procedures on the ISDN line
- LC addressed in the DMS switch by a Line Equipment Number (LEN)
- DMS switch uses the LEN to assign unique identity to the LC that supports a single ISDN loop

Enhanced Line Concentrating Module (LCME)

The LCME terminates ISDN lines coming from the U-loop and the S/T- bus. The LCME also provides access to the ISDN B, D, and M channels. As mentioned earlier, the LCME houses the NTBX27 and NTBX26 line cards.

Line Group Controller (LGC)

The LGC provides access for customer voice and data traffic to the circuit-switched and packet-switched networks. The LGC is a peripheral module that provides:

Q.931 is a communications protocol

- D-channel handling and processing
- Call processing for different types of lines including ISDN and Q.931 call processing
- Maintenance and diagnostic capabilities

U-loop

The U-loop is the wiring between the line card in the DMS switch and the customers' premises.

Functions

Two-wire interface that provides a point-to-point physical connection over a digital subscriber line.

Distance Limitations of the U-loop

- U-loops can be anywhere between 15,000 and 18,000 feet, depending on outside plant conditions.
- Line repeaters can extend the U-loop beyond 18,000 feet.

Network Termination 1

See the next section for a definition of S/T bus.

The Network Termination 1 (NT1) is a device connected to the U-loop (see Figure 4 at beginning of this lesson) that converts the signals being transmitted on the 2-wire U-loop to a 4-wire S/T bus.

Functions

The NT1

- Is the first piece of CPE in the link between the DMS switch and the user
- Defines the BRI connection as a recognized node of the network
- Terminates the physical and electrical functions of the ISDN interface
- Can provide power to the ISDN devices

Note 1: The ISDN line must be terminated first before any devices such as computers, LANs, phones, or fax machines can be added.

Note 2: The NT1 only works with the terminal adapter or ISDN-ready devices.

Terminal Adapter

As you work with ISDN equipment, Terminal Adapters are sometimes referred to as **digital modems** or **ISDN modems**.

Terminal Adapters (TAs) (see Figure 4 for the location) are devices used to convert the signals of the ISDN loop to a format that can be used by either an analog telephone, computer, or another intelligent device.

Functions

- Without a Terminal Adapter, each device that you need to access with an ISDN BRI line must have its own adapter—so you can see why TAs are important.
- Up to eight ISDN TAs can be connected to the loop—however, the TAs must all share the facilities of the loop.

S/T Bus

A physical terminal is any device connected directly to the S/T bus.

The Sets and Terminals bus (S/T bus) (also called a passive bus) is an 8-wire interface, which can support multiple physical connections. The S/T bus is the wiring that connects the ISDN S/T interface terminals to the NT1.

Functions

- The S/T bus terminates the U-loop.
- Each S/T bus provides two B-channels and one D-channel.
- The length of the S/T bus depends on the specific terminal configuration and the wire gauge.

However, this distance must not exceed 3280 feet or (1km).

Summary

Now, briefly review what you have learned about the hardware components of a BRI communications system.

As you review the various components, you can refer back to the diagram of a typical ISDN BRI loop shown at the beginning of this lesson.

Primary Hardware Components

The three primary hardware components of a simple ISDN BRI loop include:

- The **switch** (which for this course is a DMS)
- **Access** is the ISDN BRI transmission pipe (2B+D)
- **Customer Premise Equipment (CPE)**, which includes the NT1, the Terminal Adapter, and any devices connected to the ISDN service

DMS Switch Hardware Components

The following components are housed within the DMS switch:

- **D-channel handler**
- **Line Card**
- **Line Concentrating Module Enhanced (LCME)**
- **Line Group Controller (LGC)**

Other Hardware Components

Two other important components that are a part of the ISDN BRI loop include:

- The **U-loop,** which is the wiring between the **line card** in the DMS switch and the CPE
- The **S/T bus,** which is the wiring that connects the ISDN S/T interface terminals to the NT1

Customer Premise Components

The Customer Premise side of the ISDN BRI loop has three basic components:

- **Network Termination 1 (NT1)**, which terminates the physical ISDN connection
- The **Terminal Adapter**, which converts the signals of the ISDN loop to a format that can be used by non-ISDN devices, computers, or other intelligent devices
- **Computers (such as PCs)** and **phones** are attached to the BRI line

Now that you know about BRI hardware components, you are ready to move to the next lesson, which explains BRI logical components.

Check Your Learning

Now you have a chance to review what you have learned about BRI hardware components.

Please complete the following questions. You can refer back to the material covered in this lesson to help answer any of these questions.

1. Name the three primary hardware components of an ISDN BRI loop.

   a. ____________________________

   b. ____________________________

   c. ____________________________

2. Match the hardware component with its function.

Hardware Components	**Functions**
_____ D-channel handler	a. Wiring between the line card in the DMS switch and the customers' premises
_____ Line Card	b. Terminates the physical and electrical functions of the ISDN interface
_____ LCME	c. Peripheral module that provides D-channel handling and processing
_____ LGC	d. Houses the NTBX27 line card
_____ U-Loop	e. Device used to convert the signals of an ISDN loop to a format that can be used by an analog phone or other intelligent device
_____ S/T-Bus	f. Routes all incoming and outgoing D-channel information from all associated BRI subscriber lines
_____ Network Termination	g. Terminates the U-loop
_____ Terminal Adapter	h. Supports conversion of digital line coding format (2B1Q) used on the loop to digital coding format used by the DMS switch

Answers

1. The three primary hardware components of an ISDN BRI loop are:

   — **Switch**

   — **Access (the transmission pipe 2B+D BRI)**

   — **Customer Premise Equipment (CPE)**

2. Match the hardware component with its function.

Answer	Hardware Components	Functions
f	D-channel handler	a. Wiring between the line card in the DMS switch and the customers' premises
h	Line Card	b. Terminates the physical and electrical functions of the ISDN interface
d	LCME	c. Peripheral module that provides D-channel handling and processing
c	LGC	d. Houses the NTBX27 line card
a	U-Loop	e. Device used to convert the signals of an ISDN loop to a format that can be used by an analog phone or other intelligent device
g	S/T-Bus	f. Routes all incoming and outgoing D-channel information from all associated BRI subscriber lines
b	Network Termination	g. Terminates the U-loop
e	Terminal Adapter	h. Supports conversion of digital line coding format (2B1Q) used on the loop to digital coding format used by the DMS switch

If you had trouble answering the questions or you missed questions—review this lesson before you proceed.

Lesson 3

BRI Logical Components

In order for ISDN equipment to work, two types of components must work together—hardware (which you just learned about) and the "logical" components (to make it simple, the "software").

Like the hardware components, the logical components on an ISDN loop contain many acronyms and terminology. The more familiar you become with these terms and acronyms, the better you will be able to understand ISDN as a whole.

Hang in there! ISDN is just one of those areas that is plagued with terms and acronyms. Your understanding of ISDN terminology will help you with engineering and provisioning ISDN within your own company.

Recall—within ISDN there are B-channel devices and D-channel devices. In BRI, B-channel devices include:

- Circuit-switched voice and data devices
- High-speed packet devices

In BRI, D-channel devices include:

- Low-speed packet devices

In addition to the D-channel handling low-speed packet devices, the D-channel also transmits call control information. ISDN uses a series of identifiers to make the logical connections on an ISDN loop function properly. Identifiers work in conjunction with the call control information that transmits over the D-channel. This lesson explains the function and purpose of ISDN's primary identifiers, and at the same time introduces various terms and acronyms.

Lesson Objectives

After completing this lesson, you will be able to answer the following questions:

- What is a DN and a LEN?
- What function does the LTID perform?
- What is PVC?
- What is the function of a TEI?
- What are the primary types of TEIs?
- What is the function of a SPID and SPID suffix?
- What is a TID?
- What are FITs and NITs? What is the primary difference between them?
- What function does the SAPI provide?
- What is Bearer Capability and how does it relate to BRI?

Directory Number (DN)

Essentially no difference exists between an ISDN directory number and any other DN.

A directory number is a unique 10-digit number used to identify a subscriber's call origination or termination point. A 3-digit area code and 7-digit telephone number make up the 10 digits.

Example of the 10 digits of a DN

2147182111

3-digit area code 7-digit telephone number

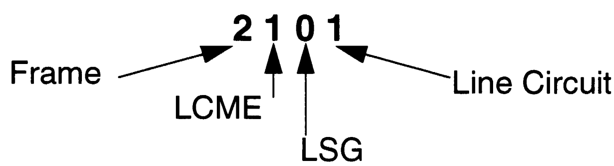
Line Equipment Number (LEN)

A Line Equipment Number (LEN) identifies the physical location of a line card that terminates a subscriber loop in a specific DMS SuperNode switch.

The LEN consists of four numbers in the following number ranges:

Frame:	0–99
LCME:	0 or 1 Line Concentrating Module Enhanced (for ISDN)
LSG:	0–15 Line Subgroup
Line Circuit:	in even LSG (0–31) in odd LSG (0–27)

Example of a LEN



Logical Terminal Identifier (LTID)

How does the DMS switch distinguish between different devices?

The convention used in the DMS switch is the concept of a **Logical Terminal Identifier** (**LTID**), also known as a **Terminal Service Profile** (**TSP**).

Use this analogy—if you think of an ISDN line as a street, each LTID is a house address on the street. Each house on the street represents an ISDN device. When information is delivered to the ISDN line, the LTID defines the type of information and to which house address it is delivered to.

Because a single ISDN line card can support up to eight physical devices, a logical representation is needed to define the devices within the telephone switch. The LTID performs this function.

The logical terminal is defined in the DMS switch and assigned all the characteristics of the line. Table 2 gives you a quick synopsis of some of the characteristics assigned to the LTID.

Table 2 Characteristics Assigned to the LTID

Type of Identifier	Characteristics Assigned
LTID	• Directory number (DN) of line • Number of keys for the line • Features assigned to each key

Fields That Make Up the LTID

The LTID is made up of two fields:

- Logical Terminal Group (LTGrp) — Identifies a group of subscribers
- Logical Terminal Number (LTNum) — Identifies the individual subscribers in a group

The criteria for a **Logical Terminal Group** is as follows:

You will use this information when you datafill facility-related tables for BRI translations.

- The group name must be alpha or alphanumeric.
- An LTGrp can have up to 1.022 logical terminals.
- A maximum of 32 LTGrps can be defined in DMS Table LTGRP (Line Terminal Group).

Remember—Each ISDN device in the circuit-switched network has a unique LTID.

The circuit-switched network is also referred to as **Exchange Termination** (**ET**).

Table 3 provides you with some samples of LTIDs:

Table 3 Sample LTIDs

LTID	=LTGrp	LTNum
ISDN 100	=ISDN	100
SEARS 25	=SEARS	25
ABCCO 22	=ABCCO	22

Most of the concepts in this lesson are assigned to the logical terminal.

Logical Terminal Class (LTCLASS)

The LTCLASS classifies each ISDN terminal based on the type of messaging that is exchanged between the terminal and the circuit switch.

The LTCLASS has one of three values:

BRAFS	Indicates functional signaling.
	Functional signaling is the most common and current type of signaling and is the focus of this course.
BRAKS	Stands for Basic Rate Access Keyset Stimulus.
	Is a stimulus logical terminal.
BRAMPT	Indicates a Meridian feature transparency terminal.

Note: Nortel Networks no longer supports the BRAKS terminal. As of software releaseBCS37 it was manufacture discontinued.

You will see these terms again later in this lesson when Service Profile Identifiers or (SPIDs) are discussed.

Protocol Version Control (PVC)

SERVORD (Service Order) prompts you for PVC information.

The **Protocol Version Control** (**PVC**) is a required parameter for all ISDN lines.

PVC ensures that the DMS switch and the ISDN Customer Premise Equipment are communicating with each other by using the same version of ISDN messaging protocol.

The setting for this parameter is **Functional Issue 2** for both National ISDN (NI-1) and (NI-2) services.

Note: When ISDN was first introduced, vendors had their own version of the signaling protocol. Many areas were subject to interpretation when the initial ISDN specifications were published.

Nortel Networks first protocol version is referred to as PVC 0. PVC 1 was then introduced, which was more in line with NI-1 standards and specifications. The current version of Nortel Networks ISDN is **PVC 2**.

Terminal Endpoint Identifier (TEI)

Call control signaling for the B-channels and data transmission by way of D-channel packet service are supported by a complex protocol. This lesson does not provide protocol details, but it is helpful for you to understand several of the protocol components. One of these components is the **Terminal Endpoint Identifier** (**TEI**).

This lesson does not cover the OSI model in detail.

You can find an explanation of the OSI model in Appendix A.

The BRI line can have up to eight devices connected to it, and each device that messages on the D-channel must have its own TEI. This level of communication is also known as Layer 2, which refers to the seven-layer Open System Interconnection (OSI) model.

The TEI is used by the circuit-switched network (sometimes referred to as Exchange Termination or ET) for routing information to and from one of the eight devices on an ISDN subscriber line. Each of the eight devices (maximum) must have a unique TEI to distinguish it from the other devices for addressing on the line.

Note: The TEI does not apply to a high-speed packet-switch data device. A high-speed packet-switched device does not need a TEI because it has a nailed-up B-channel to the Packet Handler (PH).

Primary Types of TEIs

This lesson covers the primary types of TEIs. Other types of TEIs are less common. You can find information on all TEIs in the *National ISDN BRI Service Implementation Guide* (297-2401-201).

The four most common types of TEIs you are likely to see on the job are:

Static TEI (STEI)	Manually defined, both in the switch and during configuration of the CPE
Dynamic TEI	Automatically defined by the switch
User Assigned TEI (Dynamic)	Manually assigned during configuration of the CPE
User or Network Assigned TEI (Dynamic)	TEI can be assigned by the network or the CPE

Each device includes its TEI in all call control packets sent to the DMS SuperNode. The DMS switch reads the TEI of a specific ISDN LEN and finds in its memory banks a uniquely associated LTID for that device.

Static TEIs (STEI)

The subscriber programs a TEI value to a terminal when the terminal is initially configured. The terminal sends this TEI to the network as part of every D-channel message.

Table 4 summarizes the characteristics of Static TEIs.

Table 4 Characteristics of Static TEIs

TEI Type	Characteristics
Static TEIs	• Fixed value • Does not change without modification to the DMS switch and CPE • Value is randomly assigned by the operating company and must be duplicated in the CPE • Values range from 0–63 • Used by packet-switched device

Nortel Networks recommends the following numbering scheme for Static TEI administrative purposes:

- TEI 0 for PRI trunks
- TEI 1 and 2 for B-channel circuit switch
- TEI 21–26 for D-channel packet switch

Dynamic TEIs (DTEI)

A Dynamic TEI (DTEI) has a value that is negotiated between the DMS switch and the CPE.

- A DTEI is requested on power-up by a CPE configured for DTEI.
- Once the TEI is assigned, the dynamic set uses that TEI until such time as the TEI has been lost, for example, if the ISDN set loses power or other failures occur.

Table 5 summarizes the characteristics of DTEIs.

Table 5 Characteristics of Dynamic TEIs

You will learn about FITs later in this lesson.

TEI Type	Characteristics
Dynamic TEIs	• Ranges in value from 64–26 • DMS switch assigns a TEI in ascending order upon request from the CPE • After reaching 126, the next TEI will be 64 and the cycle repeats • Supported on functional signaling (or BRAFS) devices • Used by circuit-switched voice and data **Fully Initializing Terminals** (**FITs**)

Each device includes its TEI in any call control packet sent to the DMS switch. The DMS switch then reads the TEI off of a specific ISDN LEN, and finds in its memory banks a unique LTID for that device.

User Assigned TEI (UATEI)

This TEI is dynamic in the DMS switch in the range of 0–63, and static in the CPE. Only a **few** Terminal Adapters use UATEI.

User or Network Assigned TEI (UNATEI)

You will learn about NITs later in this lesson.

As the name implies, the CPE or the network can assign the TEI Network assigned TEIs are used by circuit-switched voice and data **Non-Initializing Terminals** (**NITs**).

Keep in mind, that TEI values can be repeated many times on the DMS switch, but never on a single ISDN loop within the DMS switch.

Service Profile Identifiers (SPIDs)

A SPID is only required with a dynamic TEI.

The **Service Profile Identifier** (SPID) (pronounced just like it looks — "spid") is used to map an LTID in the DMS switch to the proper CPE connected to the ISDN loop.

The SPID contains the following components:

- Serving NPA (area code) of the set
- Seven-digit Primary DN (key#1) of the set
- SPID suffix (if programmed)
- Two-digit Terminal Identifier (TID) (if programmed)

A SPID is different from a TEI because a SPID uniquely identifies a terminal to an ISDN switch, whereas a TEI identifies a logical terminal only on one line.

The SPID is used to identify the terminal while the ISDN switch accesses the profile and updates the features of the terminal.

Here is how the TEI, SPID, CPE, and DMS switch do their handshaking:

1. After power up, the CPE assigns dynamic TEIs.
2. After TEI is established between the CPE and DMS switch, the Terminal Adapter sends a message to DMS switch and registers the SPID being used on that particular TEI.
3. If the SPID value matches the SPID defined on the LTID (on the ISDN loop), the DMS switch sends a message back to the CPE to confirm acceptance of the SPID.
4. Now the DMS switch knows which device is ready to send or receive calls from that point forward.

This level of communication is also known as "Layer 3," once again referring to the seven-layer OSI model.

The number used as a SPID is the 10-digit PDN of the circuit-switched device. In some cases, a suffix needs to be applied to the SPID.

The SPID format is the terminal's 10-digit **Prime Directory Number** (**PDN**).

Example of a PDN
9194814484

SPID Suffix

A SPID suffix is required when the same Primary Directory Number appears on more than one terminal. One example is when there is a Multiple Appearance Directory Number (MADN) or a hunt group on key 1.

The SPID suffix is usually a 2-digit number (but can be 1 to 8 digits), applied at the end of the SPID. A suffix is required when the PDN of a given set is not unique. An example of this would be the presence of a Multiple Appearance Directory Number (MADN) on the set.

SPIDs are programmed into the ISDN telephones, but only the TEI type and the SPID suffix are programmed into the switch during service order—the 10-digit PDN for the device is already known.

Example of a SPID Suffix

- Two phones have the **PDN 919 481 4484**.
- To provide a unique SPID for each device, add the numbers **01** and **02** to the end of each PDN.

919 481 44840401		919 481 44840402	
SPID	SPID Suffix	SPID	SPID Suffix

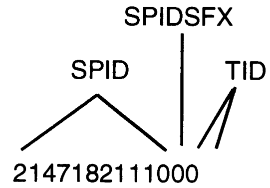
Note: In DMS software release NA009, the SPID suffix has been replaced with what is known as a **Terminal Service Profile Identifier (TSPID)**.

The TSPID is used for all LTIDs except those associated with Basic Rate Access Meridian Feature Transparency (BRAMFT) terminal types.

Terminal Identifier (TID)

When used, the **Terminal Identifier** (**TID**) is programmed at the end of the dynamic terminal's SPID and SPID suffix. The combination of the SPID, suffix, and TID are grouped together to form the "Full SPID" of the logical terminal.

A TID is required when ***PVC=2*** is assigned to a **BRAFS** set.



Additional Rules for BRAFS Terminal Type

All of this information is useful when you work in Service Order (SERVORD).

- In software release NA009, the SPID format for BRAFS terminal types changes.
- **Free Format SPIDs** are now used, which provides for SPIDs of **3-20 digits**.
- Each terminal is assigned a TSPID of **1–18 digits**.
- **SPID = TSPID + TID (2-digits)**
- SPID is assigned manually or by using the Automated SPID selection feature.

Note: For additional information on the Automated SPID selection feature, you can reference the *National ISDN BRI Service Implementation Guide* 297-2401-201.

FITs and NITs

There are two types of ISDN terminal interfaces available on the DMS SuperNode platform—**Fully Initializing Terminals** (**FITs**) and **Non-Initializing Terminals** (**NITs**).

Of the two terminal types, FITs are older. NITs did not exist until the adoption of National ISDN 2/3.

FITs and NITs can be both circuit-switched voice or data devices.

The difference between FITs and NITs is summarized below:

FITs	NITs
FITs request the service profile (which is the SPID), DN, and features from the DMS switch.	A NIT does not request the service profile, DN, and features from the DMS switch. NITs establish a TEI to communicate, but do not use a SPID.

The rules for provisioning FITs and NITs have changed with each new software release from NA007 to NA010. Refer to the *National ISDN BRI Software Implementation Guide* 297-2401-201 for specific guidelines.

Note: With NA009, you can provision up to **eight** (**any combination** of) FITs and NITs on one LEN.

Service Access Profile Identifier (SAPI)

The **Service Access Profile Identifier** (**SAPI**) (pronounced "sappy") indicates the basic type of message being transmitted on an **ISDN line D-channel.**

SAPI is used by the D-channel handler:

The SAPI is the key to integrated circuit-switching and packet-switching services over a common facility.

- **SAPI 0** messages indicate standard call control messages, such as call setups, digits dialed, and features activated.
  — Circuit-switched voice or data devices (FITs or NITs) have a SAPI of 0.
- **SAPI 16** messages indicate a D-packet message is being sent.
  — Low-speed packet (data) devices have a SAPI of 16.

See Appendix A for a description of OSI model layers.

- **SAPI 63** messages indicate Network Management Service Layer 2 messaging.
  — This provides the means for a dynamic ISDN service to request a TEI from the DMS switch and for the DMS switch to periodically query the ISDN services on the line.

What is Bearer Capability?

Bearer Capability (BC) defines the type of bearer service which a subscriber can access.

- For example, a subscriber of a 500/2500 set has access to voice services.
- However, a subscriber of an ISDN terminal has access to several different services. Each service requires a specific BC that depends on the type of device used by the subscriber.

Note

Calls made between ISDN terminals do not require the use of different DNs to terminate on the appropriate Call Appearance (CAP) of an ISDN terminal.

A BRI Functional Service (BRAFS) set possesses a specific BC, which can be used by the DMS SuperNode to screen and route the call as required. BRAFS sets can also screen an incoming call by comparing the calling party's BC with the BC of the called ISDN service.

Bearer Capability Screening

Through the use of BC call screening provided by the network, the DMS SuperNode can enhance the BC screening process by preventing an invalid BC call from being offered to the ISDN set.

This type of call screening is optional.

- If the BC of the terminator is incompatible with the BC of the call, the call is not completed and the terminator is not alerted to the incoming call.
- The calling party is routed to treatment.

Bearer Capability Routing

The Bearer Capability of a BRAFS set can also be used by the DMS SuperNode to determine a translation route based on the BC at the time of call setup.

For example, two given ISDN circuit-switched LTIDs attached to the same LEN, assigned to the same Meridian Digital Centrex (MDC) customer group with identical subgroup and NCOS values can be routed differently based on the BC.

- A circuit-switched voice service (BC SPEECH) can be routed over a 56 kbps trunk group and the circuit-switched data (BC 64KDATA) can be routed to a 64 kbps trunk.

Check Your Learning

Now you have a chance to review what you have learned about BRI logical components.

Please complete the following questions. You can refer back to the material covered in this lesson to help answer any of these questions.

1. Using the information provided in this lesson, complete the following table on BRI call types. For clarification, the table asks five different questions about four different BRI call types:

   — What information is traveling across the B- and D-channels?

   — What type of TEI does this BRI call type use (if any)?

   — Does this BRI call type need a SPID?

   — What is the SAPI for this BRI call type? Recall, SAPI is used by the D-channel handler.

When you are done, compare your table to the one provided on the Answers page. You will be able to use your completed table as a job aid in the future.

Table 6 BRI Call Types

BRI Call Type	D-Channel Info?	B-Channel Info?	TEI Type?	SPID Needed?	SAPI?
Circuit-Switched Voice/Data (FIT)					
Circuit-Switched Voice/Data (NIT)					
High-Speed Packet Data					
Low-Speed Packet Data					

Answers

Here are the answers to the questions in the review.

BRI Call Type	D-Channel Info?	B-Channel Info?	TEI Type?	SPID Needed?	SAPI?
Circuit-Switched Voice/Data (FIT)	*Call Control Info*	*Voice and Data*	*Dynamic*	*Yes*	*SAPI 0*
Circuit-Switched Voice/Data (NIT)	*Call Control Info*	*Voice/Data*	*User or Network Assigned*	*No*	*SAPI 0*
High-Speed Packet Data	*N/A*	*Data*	*N/A(it is nailed up)*	*No*	*N/A*
Low-Speed Packet Data	*Data/Call Control*	*N/A*	*Static*	*No*	*SAPI 16*

If you had trouble completing this chart, take a moment to go back and review the material in this lesson before you move to the next lesson.

Lesson 4

Packet Switching

Remember, a call through an ISDN switch is totally digital from one ISDN subscriber to another.

In a previous lesson you learned the difference between the two types of ISDN switching—circuit-switching and packet-switching (that also relate to circuit-switched data and packet-switched data).

An ISDN **circuit-switched data call** is switched through the same telephone network as a voice call and terminates to another data device at the other end.

- Two types of circuit-switched information are processed—voice and circuit-switched data (a terminal connected to a telephone line).

An ISDN **packet-switched data call** routes from the local telephone switch into a separate network of packet switches

- An example of packet-switched data is a point-of-sale credit authorization.

PRI will be covered in greater detail in another lesson.

So far in this review, you have primarily learned about the circuit-switched network. With an ISDN switch, you have access to *both* the circuit-switched and packet-switched networks through a single 2-wire line, a 4-wire line, or a DS1 trunk (used with, Primary Rate Interface [PRI]).

This lesson concentrates on packet switching, its architecture, and its unique set of identifiers. If you work with packet switching, this information will help you on your job.

Lesson Objectives

After completing this lesson, you will be able to answer the following questions:

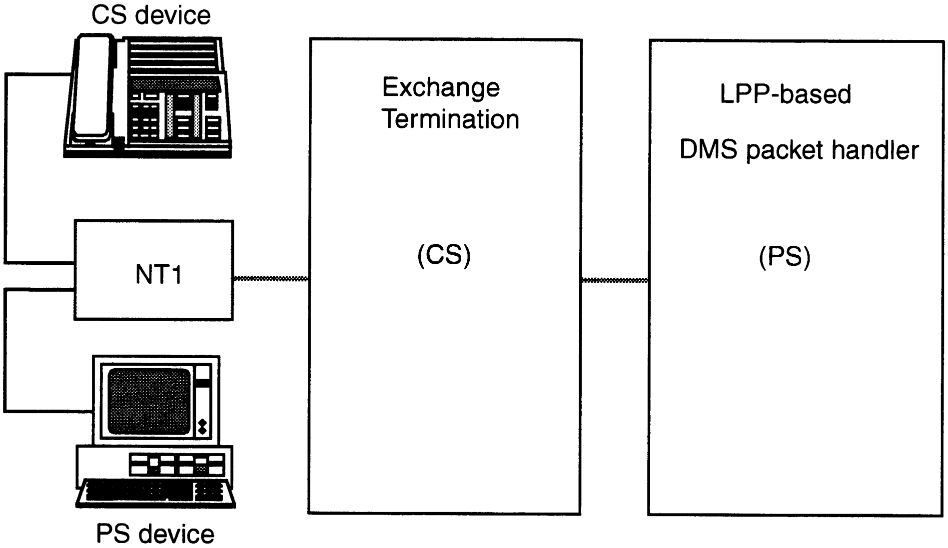
- What is packet switching?
- What are the components of the packet switching architecture?
- What is virtual switching?
- What are the functions of the packet handler identifiers?

What is Packet Switching?

Packet switching (PS) is a data transmission technology that breaks information into smaller, more manageable groups called **packets**.

- During packet switching, packet data calls are routed through a digital switch.
- As you can see in Figure 6, the packet-switched (PS) network exists separately from the circuit-switched (CS) network.
- The network handles both high-speed and low-speed data.

Figure 6 ISDN Switching



Legend

LPP Link Peripheral Processor

How Does Packet Switching Work?

Packet switching works in a way very similar to your regular mail or postal system.

1. First, information is broken up into packets.

2. The packets are like an electronic version of an envelope that you put a letter in and mail.

   — As the information is being broken up into packets, overhead bits are added to the packet.

   — The overhead bits include the address along with sequencing bits.

   — So, now you have an electronic envelope with an address on it, ready to tell the switching equipment where the envelope is from and where it is going to.

3. Before the first packet is sent through the network, the packet arrives at the switching equipment, which reads the address on the packet and determines the route the packet will take.

   — The switching equipment creates a virtual circuit over which all packets will travel. The virtual circuit expires once the information has been sent.

4. On the receiving end of the transmission, the packet is re-assembled by using those sequencing bits to place the information in the proper order.

Example of Packet Switching

An example of how packet switching works is an Automated Teller Machine (ATM). The ATM terminal contacts the network and information is sent. When the terminal is done sending or receiving information, the terminal disconnects from the network.

Transmission Protocols

Packet switching could not take place without the help of transmission protocols. **Transmission protocols** are the communication languages between various types of terminals and computers on the packet-switched data network.

The packet-switched data network uses two different transmission protocols to route and transfer data—**X.25** and **X.75**.

X.25 and X.75 not only **specify the characteristics of the physical link**, but also **specify the format** that the information packets must be in before the packets can be sent through the network.

Table 7 provides you with a quick summary of the functions for the two protocols.

Table 7 Functions of X.25 and X.75 Protocols

X.25	X.75
• Used for **intra**-office communication (within one office) • States communication protocols between Data Terminal Equipment (DTEs) within one network	• Used for **inter**-office communication (between offices) • Provides a gateway for data transmission through multiple networks • Specifically used for operating international packet-switching services

Packet Switching Architecture

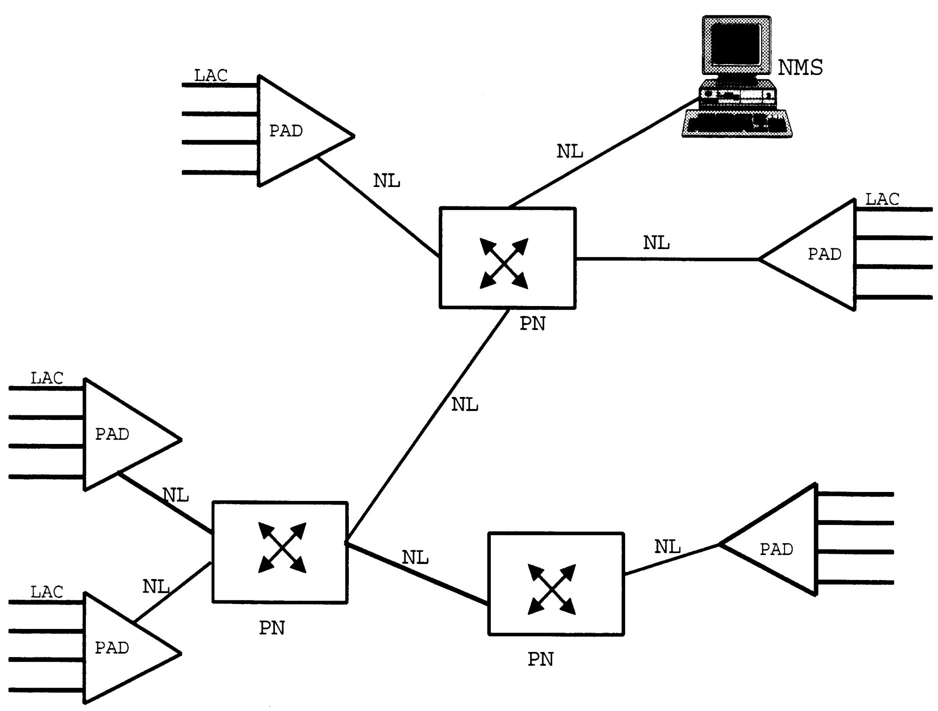
Five major components make up a Packet-Switched Data Network (PSDN):

- Local Access Components (LACs)
- Packet Assemblers/Disassemblers (PADs)
- Packet Switching Nodes (PNs)
- Network Links (NLs)
- Network Management System (NMS)

You will have a better understanding of how data is transferred over the packet-switched data network if you learn the functions of the five major components that make up the packet-switching architecture.

Figure 7 gives you an overview of a packet switching architecture.

Figure 7 Packet Switching Architecture



Local Access Component (LAC)

These components are responsible for conveying information from the end user to the Packet Assembler/Disassembler (PAD) so that the information can be "packetized" and sent on its way. Three devices make up the LAC:

- The end user terminal
- A modem
- The physical link that connects the terminal to the modem to the PAD

Packet Assemblers/Disassemblers (PADs)

A PAD is the component responsible for chopping messages into more manageable blocks or (packets). A PAD can be implemented as software or hardware. Table 8 provides a quick summary of PAD functions.

Table 8 Functions Performed by the PAD

Packet Architecture Component	Function
PAD	• As information is "packetized" the PAD adds the overhead bits (such as call control, address information, and sequence number) • On the receiving end of transmission, the PAD removes overhead bits and re-assembles packets in proper order • Performs localized switching • Provides protocol emulation and conversion • Provides call recording for billing purposes • Provides call setup

Packet Switching Node (PN)

A crucial part of PSDN, the packet switching node is responsible for routing information through the network. As a high-throughput device, the PN has the capacity to handle large amounts of packet traffic. The PN also handles network diagnostics and records information for billing purposes.

The LPP-based DMS Packet Handler

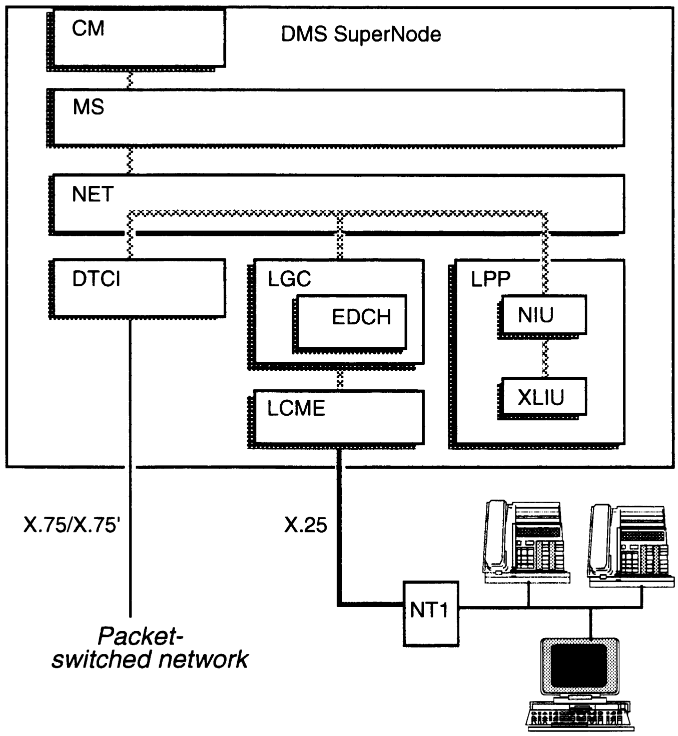
The DMS packet handler (PH) is an important sub-part of the overall packet switching node. Recall, the DMS packet handler is located within the Link Peripheral Processor (LPP) frame and consists of a set of circuit packs. The circuit packs make up the Network Interface Unit (NIU) and the X.25/X.75 Link Interface Unit or (XLIU).

The DMS packet handler performs the following functions:

- Provides full NI-1 compliance including simplified billing and maintenance of ISDN packet-switched services.
- Provides physical, data link and network protocol services.

Figure 8 illustrates the key components of the DMS packet handler.

Figure 8 DMS LPP-based Packet Handler



Network Links (NL)

Network Links (NL) form the backbone of the PSDN. NLs are responsible for interconnecting multiple PNs. The connections can be in various forms including analog, digital, microwave, satellite, and fiber-optic links.

Network Management System (NMS)

The Network Management System (NMS) is management software responsible for the control and monitoring of the network. NMS is present with all packet switching nodes.

What is Virtual Switching?

Within a packet-switching network, no actual route is specified to transmit information from one point to another. When a request for transmission is made, a path is dynamically selected through the network, forming a virtual connection between the sender and the receiver of the information. All the packets take this route to reach their destination. The connection is called "virtual" because it lasts only as long as the two parties are sending and receiving information.

There are three stages to the virtual connection:

1. **Call Setup**—Here the user connects to a local PAD and enters the address of the desired receiver. The PAD establishes a circuit to the other party.

2. **Data Transfer**—Once the connection is made, the data is sent over the network in the pre-determined path.

3. **Call Clearing**—Once the transfer is completed, both parties are disconnected from the network.

Packet Handler Identifiers

As you can see, the packet-switched data network uses a different type of switching architecture than the circuit-switched network. Like the circuit-switched network, the packet switch network also uses a series of identifiers to work in conjunction with the packet handler (PH). The packet handler uses two identifiers:

X.121 and E.164 are communication protocols.

- **Data Network Address (DNA)**—A unique ten-digit number used to identify a subscriber's data call origination or termination point to the PH. The DNA is used to give a packet-switched device (low or high speed) an address that acts similar to a DN's function in the Exchange Termination (ET).

  The DNA can be in one of two formats:

  — X.121 is the format of most packet-switched addressing

  — E.164 has been implemented specifically for ISDN packet-switching that is NI-1 compliant

- **Data Network Identification Code**—A unique number from one to four digits **used to identify a subscriber's packet network.**

  — This code gives a packet switch network an identifier, which acts similar to the area code function in the circuit-switched network.

Summary

Packet switching (PS) is a data transmission technology that breaks information into smaller, more manageable groups called **packets**.

- Packet data calls are routed through a digital switch.
- The packet-switched network exists separately from the circuit-switched network.
- The network handles both high-speed and low-speed data.

Five components make up the Packet Switched Data Network (PSDN):

- Local Access Components (LACs)
- Packet Assemblers/Disassemblers (PADs)
- Packet Switching Nodes (PNs)
- Network Links (NLs)
- Network Management System (NMS)

Finally, the packet handler uses two types of identifiers:

- Data Network Address (DNA)
- Data Network Identification Code (DNIC)

Check Your Learning

1. Match the packet-switched data network (PSDN) term with its function.

PSDN Terms	Functions
_____ X.25 Protocol	a. Adds overhead bits as information is packetized
_____ X.75 Protocol	b. Provides physical, data link and network protocol services
_____ Local Access Components (LACs)	c. Type of connection that lasts only as long as the two parties are sending and receiving information
_____ Packet Assemblers/ Dissassembers (PADs)	d. Used to give a packet-switched device (low or high speed) an address that acts similar to a DN's function
_____ LPP-Based Packet Handler (PH)	e. Used for **inter**-office communication (between offices)
_____ Network Management System (NMS)	f. Responsible for conveying information from the end user to the PAD so that it can be "packetized" and sent on its way
_____ Virtual Switching	g. Management software responsible for the control and monitoring of the network
_____ Data Network Address (DNA)	h. States communication protocols between Data Terminal Equipment (DTEs) within one network

Answers

1. Match the packet switched data network (PSDN) term with its function.

Answer	PSDN Terms	Functions
h	_____ X.25 Protocol	a. Adds overhead bits as information is packetized
e	_____ X.75 Protocol	b. Provides physical, data link and network protocol services
f	_____ Local Access Components (LACs)	c. Type of connection that lasts only as long as the two parties are sending and receiving information
a	_____ Packet Assembers/ Dissassembers (PADs)	d. Used to give a packet-switched device (low or high speed) an address that acts similar to a DN's function
b	_____ LPP-Based Packet Handler (PH)	e. Used for **inter**-office communication (between offices)
g	_____ Network Management System (NMS)	f. Responsible for conveying information from the end user to the PAD so that it can be "packetized" and sent on its way
c	_____ Virtual Switching	g. Management software responsible for the control and monitoring of the network
d	_____ Data Network Address (DNA)	h. States communication protocols between Data Terminal Equipment (DTEs) within one network

If you had trouble answering the questions or you missed questions—review this lesson before you proceed.

Lesson 5

Primary Rate Interface (PRI)

You have already been introduced to Primary Rate Interface or (PRI). Recall that PRI is one of two ISDN interfaces (the other interface is Basic Rate Interface [BRI]). PRI is a larger interface than BRI.

PRI is the ISDN trunking technology that enables multiple locations to network together. PRI also allows access to a hybrid network of both public and private facilities.

Internet service providers and larger businesses use PRI service to handle incoming BRI connections. If you are or will be working with PRI, this lesson provides you with a brief description of the functions and services offered by PRI.

Lesson Objectives

After completing this lesson, you will be able to answer the following questions:

- What is PRI?
- What is the purpose of PRI?
- What types of services does PRI offer?
- What is the advantage of a PRI network?
- What is a PRI trunk group? What trunking features does PRI offer?
- What is Bearer Capability? How does Bearer Capability relate to PRI?
- What are some differences between BRI and PRI?

What is PRI?

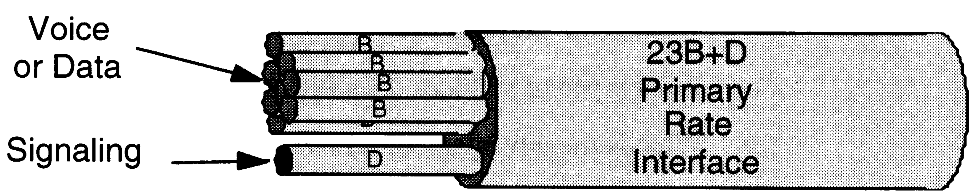
PRI is associated with trunks.

You have already been introduced to Primary Rate Interface (PRI), but remember that PRI is intended for ISDN trunking facilities over standard 4-wire, DS1 trunks. PRI trunks connect an ISDN host office to other ISDN offices, Private Branch Exchanges (PBXs), or remotes.

- A PRI trunk consists of a total of 24 channels—23B+D
  - — 23 B-channels
  - — 1 D-channel
- With PRI, the D-channel operates at 64 kbps and is used for call control information **only**—not for packet calls.
  - — The D-channel carries out-of-band Q.931 signaling for one or more PRI links.
- The B-channels in PRI transport voice *or* data.

Figure 9 shows the 23 B+D-Channels used in PRI.

Figure 9 Primary Rate Interface (23 B+D)



1.544 Mbps is the rate used by the North American T1 carrier. A T1 is a digital transmission link (equivalent to a DS1).

The total digital data stream for a PRI trunk is 1.544 Mbps, which means:

— 23 64 kbps B-channels (B1–B23)

— One 64 kbps D-channel

— One 8 kbps channel for *framing* bits

Note: Framing is an error control procedure with multiplexed digital channels, such as T1, where bits are inserted so that the receiver can identify the time slots that are allocated to each sub-channel.

This lesson does not cover framing bits in great detail. If you need more information on this subject, reference NTP 297-2401-200, *ISDN PRI Implementation Guide.*

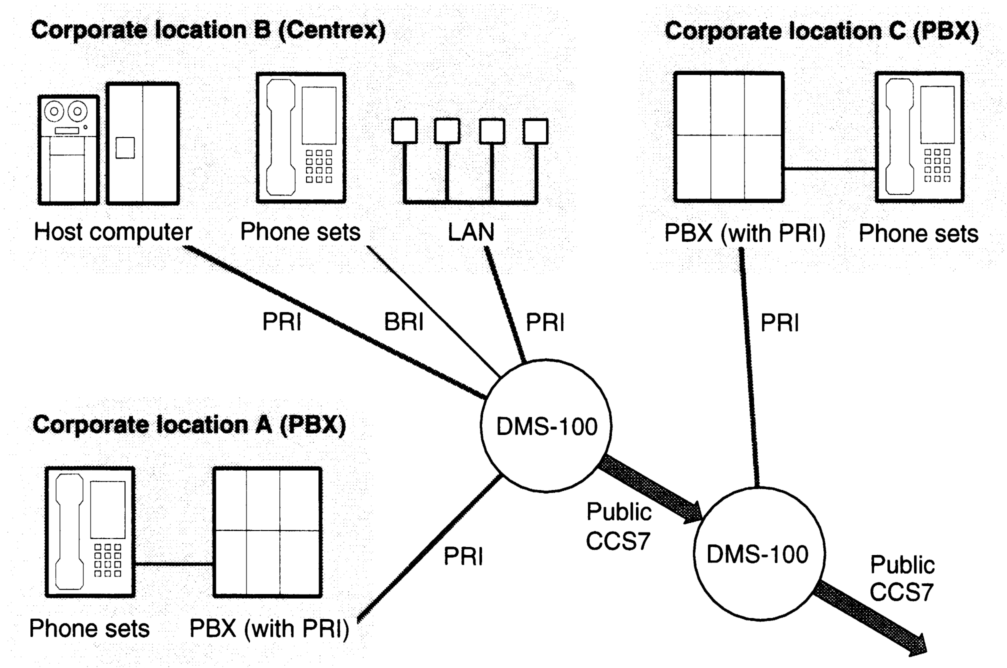
What is the Purpose of PRI?

Increasingly, businesses and Internet service providers are managing hybrid networks of public and private facilities. Implementation of PRI helps solve the connectivity and consistency problems inherent in these types of networks.

Figure 10 illustrates a typical corporate ISDN network. The figure shows PRI as

- An access connection between the DMS SuperNode and Customer Premise Equipment (CPE) (such as PBXs and LANs)
- As a a trunk interface between central offices

Figure 10 A Typical PRI Network



PBX = Private Branch Exchange
LAN = Local Area Network

PRI Services

You have probably heard about these services.

The following table provides a list of PRI services:

Table 9 ISDN PRI Services

PRI provides access to:	Services
	• Circuit-switched voice and data
Trunking features such as:	• Integrated Services Access (ISA), which allows call-by-call service selection of a trunk type to accommodate changes in trunk traffic throughout the day
Network-wide calling features such as:	• Network Ring Again (NRAG) • Calling-line ID (CLID) • Network Automatic Call Distribution (ACD) • Network Name Display • Call Forward with Reason

Advantages of a PRI Network

Two primary advantages of a PRI network include:

- PRI integrates a variety of services over a digital network using existing copper wiring (which reduces costs).
- PRI allows some or all of the B-channels to be bundled together to make one big transmission channel, which provides greater bandwidth to transmit data.
  - — As an example, videoconferencing systems use PRI.
  - — The D-channel sends the signaling information that sets up the B-channels to receive data simultaneously.

What is a PRI Trunk Group?

You already know from your telecommunications experience that a **trunk** is simply a communication line between two switching systems. A trunk usually handles many channels simultaneously.

In keeping with the above definition, a **PRI trunk group** can carry various types of traffic or calling types. This capability provides a more efficient use of trunk facilities than allocating one trunk group for each call type.

Each PRI trunk group requires one D-channel and can support multiple DS1s—up to a maximum of 479 B-channels distributed over 20 DS1 links.

> ***Note:*** A DS1 link is the 1.544 Mbps digital signaling format (the same as a T1) used in the DMS SuperNode family.

Trunking Features

The following table provides a quick look at some of the trunking features offered by PRI.

Table 10 Summary of PRI Trunking Features

Trunking Feature	Description
Integrated Services Access (ISA)	• Allows call-by-call service selection of a trunk type to accommodate changes in trunk traffic throughout the day
Backup D-Channel	• Recommended when more than one DS1 span is used to interface a PRI trunk • Becomes active if the primary D-channel fails • Must be on a different span and different interface card than the primary D-channel

Table 10 Summary of PRI Trunking Features

Trunking Feature	Description
Enhanced Equal Access	• For outgoing PRI calls, has been enhanced by the creation of the *transit network selection information element*, which is part of the setup message.
Bearer Capability	• An information element that is carried in the setup message for functional signaling to indicate the type of call (voice or data) and the rate of transmission required for ISDN.

What is Bearer Capability?

Bearer Capability also applies to BRI.

As you saw in the previous table, Bearer Capability (BC) is a PRI trunking feature. In addition, BC is also a characteristic associated with a directory number (DN) to indicate the type of call (voice or data) and the rate of transmission that is allowed.

Q.931

In PRI, BC uses the powerful message-oriented signaling protocol known as **Q.931** to distinguish voice from data and to check for compatibility between terminals.

Specifically, Q.931 provides:

- Call setup and take-down
- Called party number, with type of number indication (private or public)
- Calling party number information (including privacy indicators)

Q.931 makes it possible to interwork PBX features with features in the public switched network. By offering end-users more access to a wider range of services, service providers are able to improve their revenue potential.

Differences Between BRI and PRI

Throughout this entire review, you have been given examples of BRI and PRI features and functions.

Table 11 provides you with a summary of differences between BRI and PRI that goes beyond the obvious difference of the number of B-channels and D-channels.

Table 11 BRI and PRI—Differences Between the Two

BRI	PRI
Associated with lines	Associated with trunks
Supports up to eight devices	Does not support individual devices Supports connection between ISDN switches, LANs, computers, and PBXs
Uses a network terminator	Terminates to a PBX or a router

Check Your Learning

Take a moment to review what you learned about PRI.

1. Which of the following is the transmission rate for PRI?

    a. 2B +D

    b. 24B+D

    c. 23db

    d. 23B +D

2. Which of the following is **not** a PRI trunking feature?

    a. Backup D-Channel

    b. Enhanced Equal Opportunity

    c. Bearer Capability

    d. Integrated Services Access

3. What is the primary advantage of a PRI network?

    a. Is a fast and inexpensive way to set up a network.

    b. Bundles some or all of the B-channels together to create one large transmission channel.

    c. Saves time and money because it does not use a network terminator.

    d. Uses two B-channels to route voice and data.

4. Of the items listed below, which is the **<u>only</u>** similarity between ISDN PRI and BRI?

   a. Both are DS1 links.

   b. Both can have at least 23 B-channels attached to it.

   c. Both use Bearer Capability.

   d. Both can only have a total of eight ISDN-compliant devices attached to it.

Answers

The correct answers are provided in **bold** text.

1. Which of the following is the transmission rate for PRI?

   a. 2B +D

   b. 24B+D

   c. 23db

   d. 23B +D

2. Which of the following is **not** a PRI trunking feature?

   a. Backup D-Channel

   b. Enhanced Equal Opportunity

   c. Bearer Capability

   d. Integrated Services Access

3. What is the primary advantage of a PRI network?

   a. Is a fast and inexpensive way to set up a network.

   b. Bundles some or all of the B-channels together to create one large transmission channel.

   c. Saves time and money because it does not use a network terminator.

   d. Uses two B-channels to route voice and data.

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   a. Both are DS1 links.

   b. Both can have at least 23 B-channels attached to it.

   c. Both use Bearer Capability.

   d. Both can only have a total of eight ISDN-compliant devices attached to it.

Appendix A

Related Information—How ISDN relates to the OSI Model

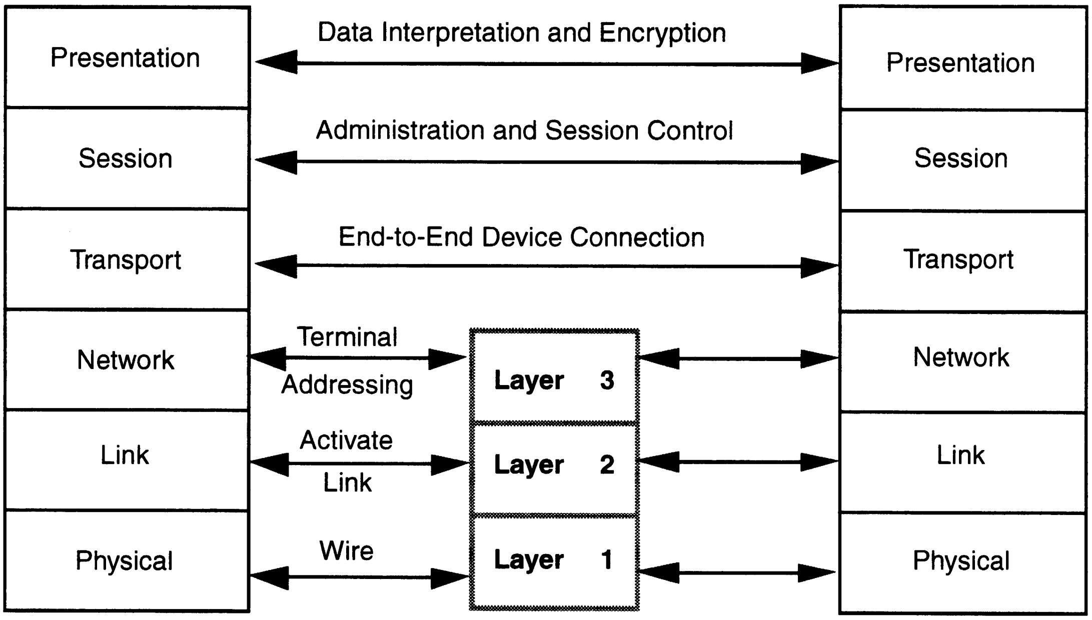
The Open Systems Interconnection (OSI) reference model was developed and agreed by international standards organizations. The OSI model provides the communications architecture and standards for ISDN services NI-1 and NI-2.

The set of ISDN interconnection standards provides these benefits:

- Vendors interfacing the ISDN must adhere to a set of defined protocols.
- Subscribers can purchase and use ISDN-compatible hardware and software.
- Communications and services share a common set of procedures.

The OSI model consists of various layers. Each layer inter-relates with adjacent layers to provide integrated voice and data services.

Figure 11 OSI Reference Model



Layer 1—Physical Layer

Layer 1 deals with low-level synchronization and timing. Layer 1 provides the physical electrical interface, the frame structure of the bit stream, and channel allocation. When a problem occurs at this layer, an error code that indicates Layer 1 trouble, or a numeric code beginning with the digit 1 can be displayed—for example, 10.

Layer 2—Data Link Layer

Layer 2 controls TEI initialization and supervision. Layer 2 creates logical data links that join terminals to points on the ISDN interface, which have access to packet-switched or circuit-switched services. ISDN dynamic terminals request and receive dynamic TEIs during Layer 2 signaling. When a problem occurs at this layer, an error code that indicates link trouble, or a numeric code beginning with the digit 2 can be displayed—for instance, 23.

Layer 3—Network Layer

Layer 3 is used to perform the following functions:

- Complete the initialization of a given dynamic service
- Obtain Protocol Version Control (PVC) information from the DMS SuperNode
- Obtain current Call Appearance (CAP) and Feature Appearance (FAP) information for the ISDN set
- Provide call control signaling for establishing, maintaining, and clearing calls for a given ISDN logical device (Q.931 signaling protocol)

When a problem occurs at this layer, an error code that indicates SPID trouble or SPID failure, or a numeric code beginning with the digit 3 (such as 31) can be displayed.

Glossary

2B1Q—Two Binary One Quaternary

Access Privilege B (B)—ISDN bearer service identifying the use of a 64 kbps B-channel for either circuit-switched voice or data.

Access Privilege BD (BD)—ISDN bearer service identifying the use of a 64 kbps B-channel for either circuit-switched voice or data, and the use of a 16 Kbps D-channel for low-speed packet-switched data by the same device.

Access Privilege D (D)—ISDN bearer service identifying the use of a 16-Kbps D-channel for packet-switched data.

Access Privilege PB (PB)—ISDN bearer service identifying the use of a 64-Kbps B-channel for transmission of high-speed packet-switched data.

AUD—Automatic Dial

AUL—Automatic Line

Automatic Dial (AUD)—Meridian Digital Centrex feature assignable to programmable keys of the Meridian Business Set or the Meridian ISDN M5317T digital telephone. The feature allows the user to dial a previously stored number by depressing one key only.

Automatic Line (AUL)—Meridian Digital Centrex feature assignable to a directory number of the Meridian Business Set or the Meridian ISDN M5317T Digital Telephone. It simulates a "ring-down" circuit by connecting to a predefined number in software.

B—Access Privilege B

B-Channel (Bch)— 64 kbps channels capable of carrying circuit-switched voice/data or packet-switched data found either on a Basic Rate Access or Primary Rate Access facility.

B Sub-b Channel (Bb)—DS0 channel that carries high speed packet-switched data from the Exchange Termination (ET) to the Packet Handler (PH). It is one of 24 channels on a DS1 facility between the ET and PH. It also refers to any DS0 channel of a Primary Rate Access facility carrying circuit-switched voice/data or high speed packet-switched data.

B Sub-d Channel (Bd)—DS0 channel that carries low-speed packet-switched data statistically multiplexed from up to 32 different sources. It is one of 24 channels on a DS1 facility between the ET and PH. It also refers to any DS0 channel of a Primary Rate Access facility carrying low-speed packet-switched data.

Basic Rate Access (BRA)—Standardized ISDN user-to-network interface comprised of two B-channels and one D-channel (2B+D) used for simultaneous transmission of voice and data on a single pair of wires.

Bb—B Sub-b Channel

BC—Bearer Capability

Bch—B Channel

BD—Access Privilege BD

Bd—B Sub-d Channel

Bearer Capability (BC)—Feature of ISDN that provides additional call screening to ensure that devices originate and terminate with devices of compatible communication capability.

BER—Bit Error Rate

BERT—Bit Error Rate Test

Bit Error Rate (BER)—Error in a digital transmission facility that occurs when pulses are lost or added to the digital signal during transmission. The bit error rate is the average rate at which errors occur.

Bit Error Rate Test (BERT)—Test performed on a digital facility to measure errors in data transmission.

BRA—Basic Rate Access

Call Appearance (CAP)—Directory number key on a Meridian ISDN M5317T Digital Telephone or any other ISDN terminal capable of transmitting circuit-switched voice.

CAP—Call Appearance

CCS—One Hundred Call Seconds

Circuit Switched Digital Data Service (CSDDS)—Service providing high-speed digital data communication capability on two pairs of wires through the telephony network.

Circuit Switching (CS)— Standard telephony switching wherein a nailed-up end-to-end circuit is established for the duration of a call.

CPE—Customer Premise Equipment

CS—Circuit Switching

CSDDS—Circuit Switched Digital Data Service

Customer Premise Equipment (CPE)—Any equipment at the customer's location (such as telephones, personal computers, modems, ISDN terminals) that connect to the central office.

D—Access Privilege D

D-Channel (Dch)—In Basic Rate Access, a 16-kbps channel used for ISDN call control or transmission of low-speed packet switched data. In Primary Rate Access, a 64-kbps channel used for ISDN call control only.

D-Channel Handler (DCH/EDCH)—Signaling terminal equipment within the Exchange Termination responsible for monitoring and processing D-channel information for routing purposes.

Data Network Address (DNA)—Series of digits required to designate an end user's data device in the packet-switching network. It is usually comprised of 10 digits that direct data to a specific switch, and then to a specific user's data terminal equipment (DTE).

Data Network Identification Code (DNIC)—Series of digits used in the packet-switching numbering scheme to identify a specific network, region, or country to which packets are DNC is analogous to the numbering plan used in the circuit switching environment and is used in conjunction with the Data Network Address to route packets.

Dch—D-Channel

DCH/EDCH—D-Channel Handler

Digital Signal 0 (DS0)—Channel carrying a bipolar pulse stream at a bit rate of 64 kbps. Twenty-four DS0 channels are multiplexed together to make a DS1.

Directory Number (DN)—Full complement of digits required to designate a subscriber's station in the circuit-switching network. It is usually comprised of a three-digit central office code, or exchange, followed by a four-digit station code.

DN—Directory Number

DNA—Data Network Address

DNIC—Data Network Identification Code

DS0—Digital Signal 0

EBS—Electronic Business Set

Electronic Business Set (EBS)—Meridian Digital Centrex specific key set, also known as the Meridian Business Set, Proprietary Phone, or P-Phone, that can support directory numbers or Centrex features on its programmable keys. It uses unique signaling techniques to and from the type “C” line card in the DMS SuperNode.

FAP—Feature Appearance

Feature Appearance (FAP)—Feature key on a Meridian ISDN M5317T Digital Telephone or any other ISDN terminal capable of transmitting circuit-switched voice. The key is used to activate the assigned feature.

FS—Functional Signaling

Functional Signaling (FS)—Signaling performed within an ISDN environment from an intelligent terminal which provides dial tone independent of the network when a user goes off-hook, collects digits and then reports to the network. Feature activation and transport throughout the network could also be accomplished through FS.

Integrated Services Digital Network (ISDN)—Fully digital, standardized technology allowing for simultaneous, integrated voice and data capability over 2-wire digital loops and 4-wire digital trunks to circuit-switched voice and data networks, packet-switched networks and network services databases.

ISDN—Integrated Services Digital Network

ISDN Line Concentrating Equipment Frame (LCEI)—DMS SuperNode/ Exchange Termination peripheral module bay housing two ISDN Line Concentrating Modules (LCMEs).

ISDN Line Concentrating Module (LCME)—DMS SuperNode/Exchange Termination peripheral module designed specifically for ISDN. It consists of eight line drawers capable of housing 480 "U" type ISDN line cards, or 240 "D" type Datapath line cards, or 480 "C" type MBS line cards. It takes up two shelves of an LCEI.

LCC—Line Class Code

LCE—Line Concentrating Equipment Frame

LCEI—ISDN Line Concentrating Equipment Frame

LCME—ISDN Line Concentrating Module

LD—Line Drawer

LEN—Line Equipment Number

Line Class Code (LCC)—Classification that defines customers to the DMS SuperNode. The LCC determines which features can be assigned to those customers' lines. Examples include 1FR, 1MR, COIN, IBN, and ISDNKSET.

Line Concentrating Equipment Frame (LCE)—DMS SuperNode peripheral module bay housing two Line Concentrating Modules (LCMs).

Line Drawer (LD)—Physical or logical compartment within a DMS SuperNode peripheral module housing line circuit cards.

Line Equipment Number (LEN)—Number assigned to a line circuit or line card to identify the physical location of the card within the central office. It is comprised of subfields: Site, Frame, Unit, Drawer (or Line Sub-group), and Circuit.

Logical Terminal Identifier (LTID)—Unique group name and number assigned in service data to an ISDN device in an ISDN node Basic Rate Access application. It is based on the mapping of a device's LEN and TEI, or a device's LEN and dedicated Bch.

LTID—Logical Terminal Identifier

M5317T/TD/TDX—Meridian M5317T Digital Telephone

Meridian M5317T Digital Telephone (M5317T/TD/TDX)—ISDN telephone that provides circuit-switched voice and data capabilities in an ISDN application. It has an RS232-C interface for data terminal connection.

Message Waiting (MWT)—Meridian Digital Centrex feature that provides an indicator or icon informing a called party that a message awaits at a predefined message center or that a call request has been activated against the called party.

MWT—Message Waiting

NCOS—Network Class of Service

Network Class of Service (NCOS)—Number assigned to Meridian Digital Centrex lines that defines a network dialing plan and available network features to those lines.

Network Termination 1 (NT1)—ISDN functionality as described by CCITT that performs layer 1 services as defined by the OSI seven-layer protocol reference model for ISDN Basic Rate and Primary Rate Access.

Northern Telecom Publication (NTP)—Sets of published documents that support the operation, administration and maintenance of various NTI products. NTPs are normally updated to coincide with a new Generic, BCS, or NSR, and are available to Nortel employees and customers.

NT1—Network Termination 1

NTP—Northern Telecom Publication

OA&M—Operations, Administration, and Maintenance

OM—Operational Measurement

One Hundred Call Seconds (CCS)—Unit of measurement which expresses the usage of a telephone line or B channel carrying either circuit-switched voice or data. If one party uses a line for a full hour (60 min. X 60 sec./hr = 3600 sec/hr = 36 CCS), line usage equals 36 CCS.

Operational Measurement (OM)—Engineering analysis tool used to filter network statistics selectively.

Operations, Administration, and Maintenance (OA&M)—Phrase describing the processes, systems, and tools that control the configuration, surveillance, diagnosis and repair of a software or hardware system.

Packet Assembler/Disassembler (PAD)—Part of a packet-switched network which performs the conversion between packets and a data stream suitable for a character-mode terminal.

Packet Handler (PH)—Portion of an ISDN node as defined per CCITT that serves as the interface to the Public Packet-Switching Network. It establishes virtual circuits in the switching of data packets.

Packet Handler Interface (PHI)—Signaling terminal card within the DMS SuperNode/Exchange Termination that statistically multiplexes X.25 LAPD data packets from up to 16 different D-channel low-speed terminals onto one Bd channel routed to the Packet Handler for packet-switching.

Packet Switching (PS)—Transfer of data using virtual circuits by means of addressed packets. Network bandwidth is occupied only for the duration of the packet transmission. The channel is then available for the transfer of other packets. In contrast with circuit switching, the data network may determine routing during, rather than prior to, the transfer of a packet.

PAD—Packet Assembler/Disassembler

PB—Access Privilege PB

PDN—Prime Directory Number

PH—Packet Handler

PHI—Packet Handler Interface

Prime Directory Number (PDN)—Directory number assigned to key number 1 of an MBS or Meridian ISDN M5317 digital telephone. It uniquely identifies that set from among many directory numbers that can be assigned to it.

PS—Packet Switching

Q.931—Q.931 Protocol

Q.931 Protocol (Q.931)—D-channel protocol of ISDN Basic Rate Access used for call control. It contains an information field comprised of the following: protocol discriminator, call reference, message type, and information elements.

QBB—Query Bb Channels

QDN—Query Directory Number

QLEN—Query Line Equipment Number

QLT—Query Logical Terminal

Query Bb Channels (QBB)—DMS SuperNode/Exchange Termination command that displays ISDN Bb channel connections from the ET to the PH on a per switch, per IAC, or per channel (of a DS1) basis.

Query Directory Number (QDN)—DMS SuperNode/Exchange Termination command that displays line service data for the directory number queried.

Query Line Equipment Number (QLEN)—DMS SuperNode/Exchange Termination command that displays service data for the line queried by way of its line equipment number.

Query Logical Terminal (QLT)—DMS SuperNode/Exchange Termination command used to display service data for an ISDN logical terminal (identified by its LTID; for example, ISDN 37).

Release (RLS)—Assignable feature of the Meridian ISDN M5317T Digital Telephone that terminates a circuit-switched connection.

Remote Switching Center (RSC)—High-capacity DMS SuperNode remote peripheral module that supports up to 5,760 lines. It is capable of intraswitching and stand-alone operation.

RLS—Release

RSC—Remote Switching Center

SAPI—Service Access Point Identifier

Service Access Point Identifier (SAPI)—CCITT-defined identifier for a point on either the network side or user side of the user-to-network interface at which data link services are provided by a layer 2 entity to a layer 3 entity. SAPIs define call control, packet communication, and management procedures. Other SAPIs have been reserved for national use or future standardization.

Service Order (SERVORD)—DMS SuperNode/Exchange Termination software subsystem that provides a series of commands that are used to add, delete, or modify service data within the DMS SuperNode. The subsystem collects information from users via a MAP and automatically datafills certain required DMS SuperNode tables.

SERVORD—Service Order

Set Logical Terminal (SLT)—DMS SuperNode/Exchange Termination service order command used to add or remove logical terminal service data, define access privileges, attach or detach a logical terminal to a LEN, and assign TEIs, PHIs and Bchs to those logical terminals.

SLT—Set Logical Terminal

SuperNode —Northern Telecom network resource comprised of a DMS-Core, DMS-Bus and DMS-Link, that can be configured as a high-capacity local or toll switch, a packet switch, a signaling transfer point, a service control point, a digital cross-connect point and/or a customer-programmable node.

TA—Terminal Adapter

Table Editor—Software subsystem of the DMS SuperNode/Exchange. Termination that provides commands that allow for the addition, deletion, and modification of table datafill.

Terminal Adapter (TA)—Device designed to allow non-ISDN terminals to interface the standardized ISDN S/T bus of a Basic Rate Access configuration. See also PCTA and UTA.

Terminating Resistor (TR)—Resistance circuit found on each end of an S/T loop used to provide bus termination. It can be an externally applied circuit or one applied to one end of the S/T loop by means of DIP switch settings on a NT1.

TR—Terminating Resistor

Two Binary One Quaternary (2B1Q)—Interface standard for ISDN BRA transmission between the network and the NT1 written by the T1D1 committee of the American National Standards Institute (ANSI). It allows two bits of information to be transmitted with each pulse. Bit values are determined by which of two positive and two negative (four total) voltage references are used to generate a pulse.

U—U Reference Point

U Reference Point (U)—CCITT-designated reference point in a Basic Rate or Primary Rate Access configuration identifying the location or interface between the NT1 (or any device performing NT1 functions) and the ISDN node. In BRA, the U refers to the two-wire subscriber loop. In PRA, the U refers to the T1 span connecting an ISDN PBX to the network.

Universal Terminal Adapter (UTA)—Adjunct device that provides ISDN compatibility to a non-ISDN terminal.

UTA—Universal Terminal Adapter

X.25—X.25 Protocol

X.25 Protocol (X.25)—CCITT-defined specification for interface between a user, terminal, or host (DTE) and a communication subsystem (DCE). It defines three protocol levels: the physical link (X.21), the logical link control (LAP, LAPD, LAPB), and the packet level. It is the recommended protocol for transmission of packets through the public network.

X.75 Protocol (X.75)—Terminal and transit call control procedures and data transfer system on international circuits between packet-switched data network. It is the CCITT-recommended protocol for data packet transfer between data networks.

X.75—X.75 Protocol

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