



Telecommunications Essentials

The Complete Global Source
for Communications Fundamentals,
Data Networking and the Internet,
and Next-Generation Networks

Lillian Goleniewski

Telecommunications Essentials

The Complete Global Source
for Communications Fundamentals,
Data Networking and the Internet,
and Next-Generation Networks

Lillian Goleniewski

◆◆Addison-Wesley

Boston • San Francisco • New York • Toronto • Montreal
London • Munich • Paris • Madrid
Capetown • Sydney • Tokyo • Singapore • Mexico City

Many of the designations used by manufacturers and sellers to distinguish their products are claimed as trademarks. Where those designations appear in this book, and Addison-Wesley was aware of a trademark claim, the designations have been printed with initial capital letters or in all capitals.

Lido Telecommunications Essentials® is the registered trademark of The Lido Organization, Inc.

The author and publisher have taken care in the preparation of this book, but make no expressed or implied warranty of any kind and assume no responsibility for errors or omissions. No liability is assumed for incidental or consequential damages in connection with or arising out of the use of the information or programs contained herein.

The publisher offers discounts on this book when ordered in quantity for bulk purchases and special sales. For more information, please contact:

U.S. Corporate and Government Sales
(800) 382-3419
corpsales@pearsontechgroup.com

For sales outside of the U.S., please contact:

International Sales
(317) 581-3793
international@pearsontechgroup.com

Visit Addison-Wesley on the Web: www.awprofessional.com

Library of Congress Cataloging-in-Publication Data

Goleniewski, Lillian.

Telecommunications essentials : the complete global source for communications fundamentals, data networking and the Internet, and next-generation networks / Lillian Goleniewski.
p. cm.

Includes bibliographical references and index.

ISBN 0-201-76032-0

1. Telecommunication. I. Title.

TK5101 G598 2002

621.382—dc21

2001053752

Copyright © 2003 by Pearson Education, Inc.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form, or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior consent of the publisher. Printed in the United States of America. Published simultaneously in Canada.

For information on obtaining permission for use of material from this work, please submit a written request to:

Pearson Education, Inc.
Rights and Contracts Department
75 Arlington Street, Suite 300
Boston, MA 02116
Fax: (617) 848-7047

Text printed on recycled and acid-free paper.

ISBN 0201760320

9 101121314 CRS 07 06 05

9th Printing August 2005

Contents

	Introduction	xv
	About the Author	xix
	Acknowledgments	xxi
Part I	Telecommunications Fundamentals	1
Chapter 1	Understanding the Telecommunications Revolution	3
	Changes in Telecommunications	4
	Incorporating Human Senses in Telecommunications	5
	The Emergence of Wearables	6
	Moving Toward Pervasive Computing	8
	Moving Toward Machine-to-Machine Communications	8
	Adapting to New Traffic Patterns	9
	Handling New Types of Applications	10
	Increasing Backbone Bandwidth	11
	Responding to Political and Regulatory Forces	11
	The New Public Network	16
	Convergence	18
Chapter 2	Telecommunications Technology Fundamentals	21
	Transmission Lines	21
	Circuits	22
	Channels	24

Lines and Trunks	25
Virtual Circuits	26
Types of Network Connections	28
The Electromagnetic Spectrum and Bandwidth	28
The Electromagnetic Spectrum	28
Bandwidth	32
Analog and Digital Transmission	34
Analog Transmission	35
Digital Transmission	36
Analog Versus Digital Transmission	37
Conversion: Codecs and Modems	38
Multiplexing	39
FDM	41
TDM	43
STDM	43
Intelligent Multiplexing	44
Inverse Multiplexing	46
WDM/DWDM	47
Standards Organizations	49
 Chapter 3	
Transmission Media: Characteristics and Applications	53
Twisted-pair	56
Categories of Twisted-pair	57
Applications of Twisted-pair	58
Analog and Digital Twisted-pair	58
Advantages and Disadvantages of Twisted-pair	61
Coaxial Cable	62
Characteristics of Coaxial	63
Applications of Coaxial	64
Advantages and Disadvantages of Coaxial	64
Microwave	66
Characteristics of Microwave	66
Applications of Microwave	67
Advantages and Disadvantages of Microwave	70
Emerging Applications and Developments in Microwave	71
Satellite	72
Frequency Allocations of Satellite	74
Satellite Network Segments	76
Satellite Orbits	76
Applications of Satellite	81
Advantages and Disadvantages of Satellite	82
Emerging Applications and Innovations in Satellite	82
Fiber Optics	84
Characteristics of Fiber Optics	84

	Components of Fiber Optics	85
	How Fiber-Optic Transmission Works	87
	Innovations in Fiber Optics: EDFAs, WDM, and DWDM	88
	Applications of Fiber Optics	89
	Advantages and Disadvantages of Fiber Optics	90
	Wiring for Tomorrow: Undersea Fiber Cables	92
Chapter 4	Establishing Communications Channels	95
	Establishing Connections: Switching Modes and Networking Modes	95
	Networking Modes	96
	Switching Modes	97
	The PSTN Versus the Internet	111
	PSTN Characteristics	111
	Internet Characteristics	111
	Converging Networks: The Next Generation	112
Chapter 5	The PSTN	113
	The PSTN Infrastructure	113
	Service Providers	114
	Network Access	116
	Access Services	117
	Transport Services	118
	PSTN Architecture	121
	The Transport Network Infrastructure	123
	The PDH Infrastructure	123
	The SDH/SONET Infrastructure	132
	Signaling Systems	138
	SS7 Architecture	140
	SS7 and the Internet	143
	Intelligent Networks	144
	AINs	145
	Next-Generation Networks	146
Part II	Data Networking Basics	151
Chapter 6	Data Communications Basics	153
	The Evolution of Data Communication	153
	Data Communication Architectures	153
	Data Communication Traffic	157
	Data Flow	159
	The DTE, the DCE, the Transmission Channel, and the Physical Interface	159
	Modems and Modulation	160
	Simplex, Half-Duplex, and Full-Duplex Data Transmission	165

	Coding Schemes: ASCII, EBCDIC, Unicode, and Beyond	166
	Transmission Modes: Asynchronous and Synchronous Transmission	167
	Error Control	169
	The OSI Reference Model and Protocols	170
	The OSI Reference Model	171
	Protocols and Protocol Stacks	173
Chapter 7	Wide Area Networking	175
	Circuit-Switched Networks	176
	Leased Lines	177
	ISDN	186
	Packet-Switched Networks	189
	X.25	193
	Frame Relay	197
	ATM	205
Chapter 8	Local Area Networking	215
	LAN Basics	215
	LAN Concepts and Benefits	216
	LAN Components	217
	LAN Characteristics	217
	LAN Transmission Media	218
	LAN Transport Techniques	219
	LAN Access Methods	221
	LAN Topologies	225
	LAN Interconnection and Internetworking	227
	Hubs	227
	LAN Switches	228
	VLANs	230
	Bridges	231
	Routers	234
	IP Switches	237
	Enterprise Network Trends	238
Chapter 9	The Internet: Infrastructure and Service Providers	241
	Internet Basics	241
	A Brief History of the Internet	242
	What the Internet Is and How It Works	244
	Internet Protocols	247
	Internet Addressing	252
	The Domain Name System	256
	The Organization of the Internet	259
	The Evolution of the POP Architecture	259
	Internet Challenges and Changes	263

Service Providers	265
Evaluating Service Providers	267
The Service Provider Value Chain	274
Internet Interconnection and Exchange	276
NAPs	276
Peering Agreements	278
Private NAPs	278
 Part III	 281
Next-Generation Networks	281
 Chapter 10	 283
Next-Generation Networks	283
The Broadband Evolution	283
Communications Traffic Trends	284
Communications Backbone Trends	285
Communications Bandwidth Trends	285
Communications Application Trends	286
Multimedia Networking Requirements	287
Digital Video	288
Television Standards	292
The Broadband Infrastructure	295
Converging Public Infrastructures	295
Broadband Service Requirements	296
Characteristics of Next-Generation Networks	297
IP and ATM	300
The Broadband Architecture: Multiservice Networks	304
The Three-Tiered Architecture	306
The Next-Generation Switching Architecture	311
QoS	316
 Chapter 11	 329
Next-Generation Network Services	329
Traditional Internet Applications	329
VPNs	331
VPN Frameworks	333
VPN Applications	336
VPN Gateway Functions	340
Benefits and Evolution of VPNs	342
Security	342
Firewalls	342
Authentication	343
Encryption	344
Digital Certificates	348
VoIP	348
VoIP Trends and Economics	348
Advantages of VoIP	349

VoIP Applications	350
VoIP Service Categories	354
VoIP Network Elements	355
Next-Generation Standards and Interoperability	361
IP PBXs	362
The Future of VoIP	363
Multimedia on the Internet: Streaming Media	364
Streaming Media Trends	364
Streaming Media Applications	365
Streaming Media on the Internet	365
Chapter 12 Optical Networking	369
Optical Networking Drivers	369
Components of an End-to-End Optical Network	371
EDFAs	372
WDM and DWDM	373
OADMs	377
Optical Switches	378
Other Optical Components	384
IP over Optical Standards	385
Managing Optical Networks	385
Chapter 13 Broadband Access Solutions	389
xDSL	391
HDSL	393
IDSL	395
SDSL	395
M/SDSL	396
ADSL	396
RADSL	399
VDSL	399
HFC	401
HFC Architectures	402
Cable Modems	403
Digital Cable TV Devices	405
Fiber	407
FTTC	408
FTTH	410
PONs	411
Wireless Broadband Access Media	413
DBS	415
MMDS	416
LMDS	418
Free Space Optics	419
Unlicensed Bands	420

Emerging Media	421
HomePNA	421
Ethernet-in-the-Loop	422
PLT	422
Chapter 14 Wireless Communications	425
Spectrum Reuse	427
Space Division	427
Multiple Access Techniques	430
Spread Spectrum Techniques	434
Duplexing Techniques	436
Compression Techniques	436
Wireless WANs: Cellular Radio and PCS Networks	437
Analog Cellular Networks	438
Digital Cellular Networks	440
Wireless Data Networks	442
Cellular and PCS Standards	444
3G Mobile Systems and Beyond	449
Mobile Internet	455
Wireless MANs	459
Wireless Local Loop Applications	460
Wireless Local Loop Options	461
Wireless LANs	463
Wireless PANs	465
IrDA	465
Bluetooth	465
HomeRF	466
Chapter 15 The Broadband Home and HANs	467
The Broadband Home	467
The Smart House	468
Intelligent Appliances	469
HANs	472
The HAN Market, Applications, and Elements	474
Types of HANs	476
HAN Gateways and Servers	480
Planning for the Future	480
Glossary	483
Index	561

■ Intelligent Networks

The ITU's standardization of SS7, in 1980, began the evolution toward the concept of intelligent networking. An IN includes a set of nodes that rely on widespread distribution of call-handling functions and capabilities (see Figure 5.14). Before the advent of INs, customers could have only the services and features available from their local exchanges. Their ability to demand and achieve new services from the operator was very much tied to the generation of software in the local exchange and whether it had yet incorporated the feature of interest. With INs, you can centrally place this type of service and feature logic on a node (such as an SCP), and then any switch can reach it and make use of that feature. The objective of the IN initially was to ease the introduction of new services into the network. It also provided a foundation for complex services that would be required and desirable on a networkwide basis, such as the automation of the operator-assistance function. Because of the IN and specialized peripherals—again, computing systems loaded with specific software—we no longer have to use operators to place a credit card call or a collect call.

Intelligent networking gives carriers the capability to directly develop network functionality on outboard processors connected to the switches, instead of having to be tied to their switch manufacturer and having to rely on the internal software. A main feature developed for the IN during the early and mid-1980s was *digit translation*, which was applied to toll-free number translation and VPNs. Customers could develop a unique calling plan that identified their location. They could invent their own numbering plan so that they could dial numbers that were easy

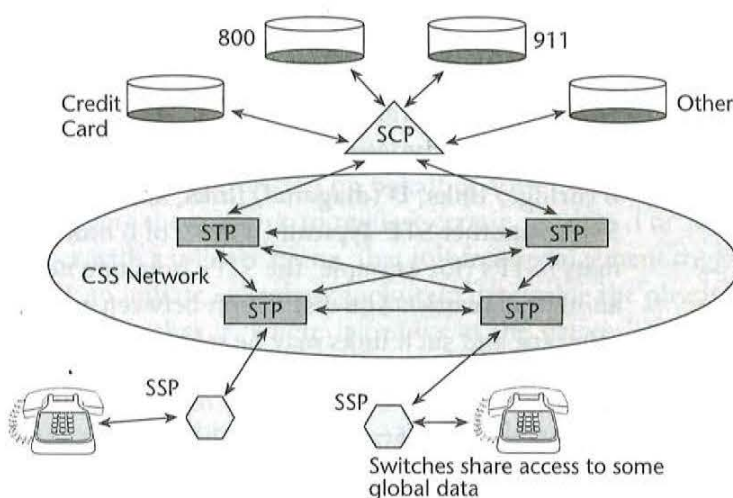


Figure 5.14 An IN

for them to remember, and in the network, the IN infrastructure would translate these private numbers into network physical addresses (for example, country code, city code, area code).

The IN also enables operator-assistance features such as eliminating credit card calling and collect calling as manual fulfillment processes. The IN also enables the identification of primary carriers (where competition exists), so that customers can select their primary carriers. *Local number portability*—which allows you to keep your own telephone number when you move to a new location—is a rather new concept that can be delivered thanks to the sophistication of this IN infrastructure. With local number portability, although your physical address will be different at your new location, you may want to keep your old phone number so your friends and colleagues can easily recall it. But for calls made with your old number to reach your new physical address, there must be translation tables in the network that can identify your correct physical address and properly route incoming calls to you.

AINs

Around the mid-1980s, Bellcore (which is now Telcordia) pioneered the second generation of INs, which we call AINs (see Figure 5.15). AINs move the service logic outside the switch and onto an independent SCP. An AIN is a service-independent network architecture that allows carriers to create and uniformly support telecom services and features via a common architectural platform, with the objective of allowing for rapid creation of customizable telecommunication services.

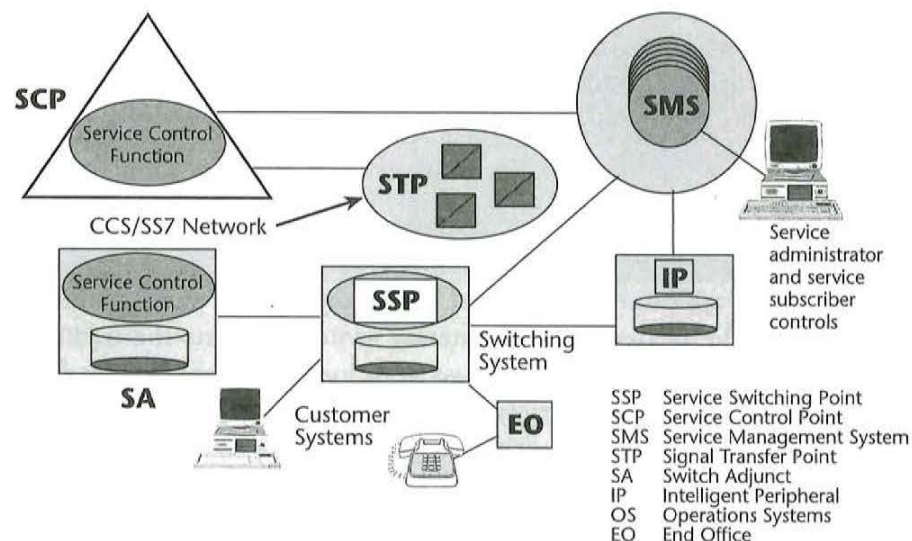


Figure 5.15 AIN architecture

An AIN is composed of intelligent nodes that are linked via SS7 to support a variety of services and advanced call-handling features across multiple vendor domains. With the introduction of the AIN architecture, a few additional components were needed. First, the service management system is a service-creation environment that facilitates the technical and customer service representatives' interface with the provisioning and network management systems. Second, intelligent peripherals are computing platforms that serve a very specific purpose but have a very widespread demand across the network (for example, voice recognition and voice synthesis capabilities to process third-party-assisted calls).

AINs can be used for a number of applications, including intelligent call routing, visitor location registration, virtual number service, voice-activated dialing, voice response, speech recognition, and text-to-speech conversion. The AIN infrastructure is critical in mobile communications. The reason you can roam across cellular networks is that IN databases are able to log whether you are present in your home network or in a visitor network, and they can identify whether you're authenticated to use the network. If you are authenticated to use the network, IN databases can identify which services should be made available to you. Virtual number services are also an important application of AINs; for example, a 700 number can identify and locate you within a footprint, rather than requiring you to be at a specific telephone to receive a call.

Next-Generation Networks

The SS7 network acts as the backbone for the AIN—it provides access to the AIN features, allows for efficient call setup and teardown, and interconnects thousands of service providers under one common signaling network. The capability to communicate with SS7 networks is essential for all service providers because SS7 networks give next-generation local exchange carriers access to an existing base of service features.

Next-Generation Network Equipment

SS7 uses new genres of equipment to ensure that packet-based telephony switching gateways can in fact support key legacy services and signaling features. For example, the next-generation gateway switch supports the traditional Class 4, or toll switch, services and the Class 5, or local exchange switch, services. It is designed to support a wide variety of traffic—data, voice, fax, multimedia, and other emerging sensory forms—over a data backbone. The next-generation gateway switch provides seamless interoperability between the circuits that network the PSTN and packet-switching networks, such as IP backbones, ATM networks, Frame Relay networks, and emerging MPLS networks. We can use these gateway switches to connect with the SS7 network and to handle the IP services that are so popular

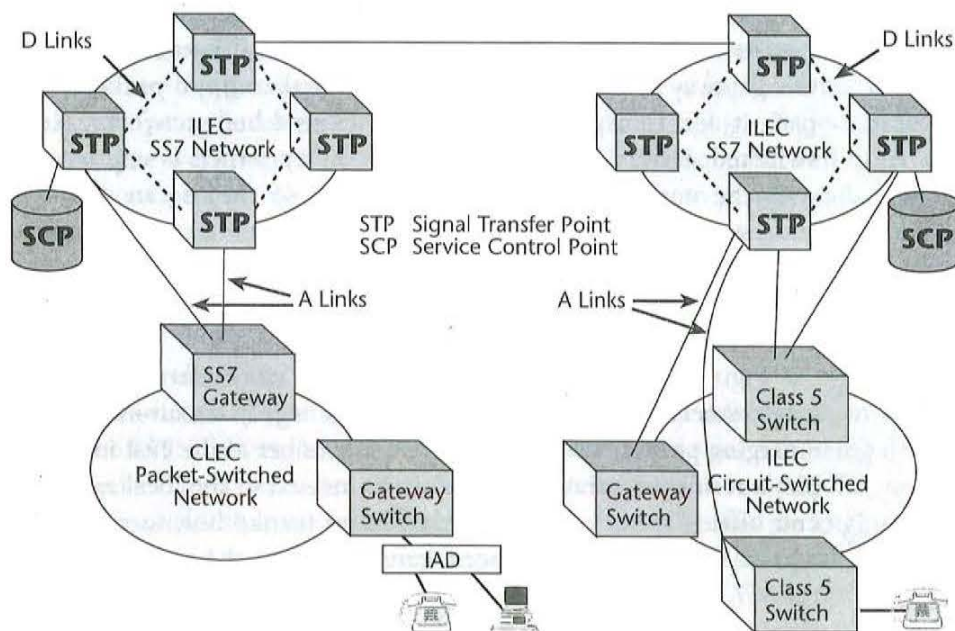


Figure 5.16 Next-generation gateway switches

Telephony Signaling Protocols and SS7

A number of telephony signaling protocols are currently used, and we don't know yet which will become the standard. Today, H.323 is found most frequently and offers the greatest range of vendor interoperability. Session Initiation Protocol (SIP), which is an Internet Engineering Task Force (IETF) standard, has a lot of support from the Internet community, and it is being included on more devices all the time. Over the next few years, we will be better able to determine which will be the dominant protocols, although IETF's SIP protocol is gaining popularity and supplanting H.323. (Signaling protocols are discussed in detail in Chapter 11, "Next-Generation Network Services.")

today. These gateway switches support a variety of telephony signaling protocols (for example, H.323, Session Initiation Protocol [SIP], Media Gateway Control Protocol [MGCP]) for communicating with the underlying SS7 architecture.

As shown in Figure 5.16, there are different forms of these next-generation gateway switches for different purposes. In the bottom right of Figure 5.16 is an ILEC and its resident circuit-switched network, which is a series of Class 5 offices at the perimeter. These Class 5 offices are connected to the SS7 network or the

STPs via A links. These Class 5 offices then connect into a CLEC's packet-switched network, and their first point of interface is a gateway switch. Among other things, this gateway switch is responsible for digitalizing and packetizing the voice to prepare it for transport over the packet-switched network. The CLEC's packet-switched network also has an SS7 gateway, which is capable of communicating with the underlying ILEC's SS7 network so that it can map the appropriate IP addresses associated with the destination telephone number, which is served by a given destination media gateway. The next-generation gateway switch, therefore, provides a means to seamlessly interoperate between two very important and existing infrastructures.

Figure 5.17 is an end-to-end view of a next-generation network. It shows an interconnected environment between the legacy circuit-switched network and the emerging packet-based networks. A subscriber at the customer premise (for example, a residence, a business site) is connected to the local exchange, known as the end office, by access lines. From there, trunks link to a media gateway switch, which, through SS7 interfaces, can reach into the underlying intelligence within the SS7 network and further add the necessary information to process the call as it's been requested. The call then goes out on a packet basis throughout a series of switches or routers (depending on what the provider is using as the backbone) and reaches a destination media gateway switch that unpackages the voice, undigitalizes it, and delivers it to the destination phone.

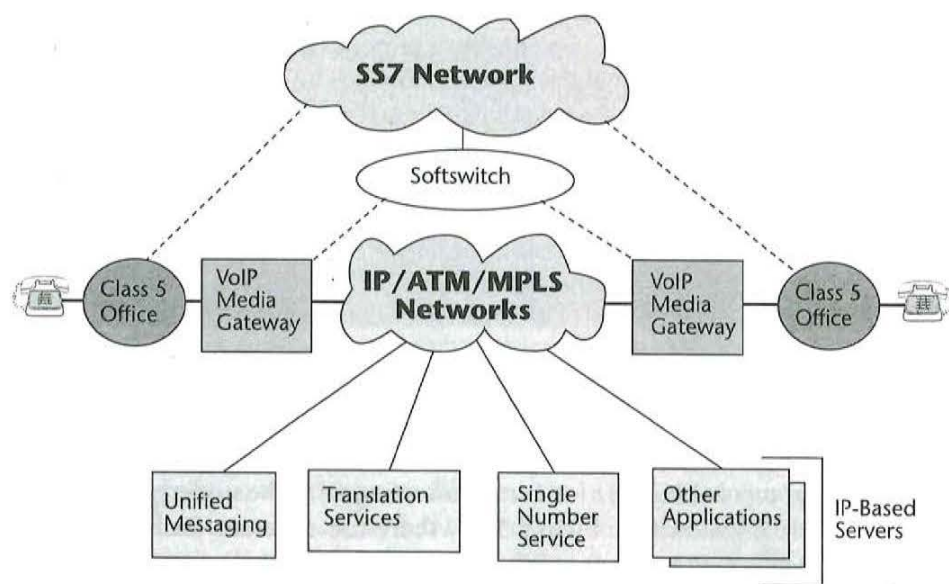


Figure 5.17 Next-generation networks

Although tremendous amounts of time and money have been spent in developing the intelligence that provides the telephony features we know today, there are still many new applications to be developed. These new applications, which are increasingly being developed for IP, include unified messaging, single-number service, and a network-type Rolodex that houses all kinds of contact and other information about people. We will be able to use databases to service calls when we have an integration or an interconnection between two networks. We will be able to provide traditional voice telephony features and introduce new generations of IP-based services.

Next-Generation Networks Versus the PSTN

The characteristics of next-generation networks are very different from what the traditional PSTN was aiming at. Next-generation networks are not being designed for just voice, data, or video. They're being designed for multimedia, and this requires capacities that are broadband in nature, networks that are engineered for extremely low and controllable latencies, and infrastructures that provide the ability to administer quality of service on a very granular level.

This book has talked about the explosion of bandwidth that's occurring because of developments in optics. As you have more and more bandwidth, it becomes cheaper and cheaper. When bandwidth becomes very inexpensive or free, a carrier needs to find other ways to generate revenue, such as by offering a large variety of value-added services (for example, reliability, priority, customer service, and encryption or security). But to administer all these services and to provide differentiated pricing, which can result in handsome revenue streams, there must be mechanisms for controlling, monitoring, and billing.

The following are important features of the next-generation network infrastructure that are covered in detail in later chapters:

- It has very fast packet switching, with capacities that we're beginning to need to measure in terabits per second (Tbps) and soon in petabits per second (1Pbps = 1,000Tbps), and on its heels, in exabits per second (1Ebps = 1 billion Gbps). (See Chapter 10.)
- It places great emphasis on optical networking elements, to take advantage of the abundant bandwidth that's inherent in the visible light spectrum. (See Chapter 12, "Optical Networking.")
- Multiservice access is being created, so we will not have separate devices for voice and data as we do today, but we'll have nodes that can accommodate any traffic type. We are also creating intelligent edges; we're displacing the smarts for processing service requests, delivering features, and accommodating advanced applications by deploying them at the edge. This allows for more rapid introduction, as well as more customization of the feature sets. The core

also has to be multiservice, but it also needs to be able to differentiate between the requirements of the different traffic streams. (See Chapter 10.)

- Next-generation telephony is very important for new entrants, particularly because of the costs of deploying normal local exchanges. A regular local exchange costs in the neighborhood of US\$3 million to US\$5 million, whereas a media gateway will be on the order of US\$100,000. For those seeking to become competitors in the local loop environment, next-generation telephony offers a very cost-effective means of gaining entry. (See Chapter 11.)
- Intelligent networking is being applied to the public data infrastructure as well as the Internet. (See Chapter 10.)
- Network operators are introducing video and multimedia elements, video servers, media farms, video compression, and decompression devices, all of which become part of what constitutes the entire communications network. (See Chapter 10.)
- Access is moving toward the broadband realm on both a wired and a wireless basis. (See Chapter 13, "Broadband Access Solutions.")

For more learning resources, quizzes, and discussion forums on concepts related to this chapter, see www.telecomessentials.com/learningcenter.

also need two types of cross-connects to build out a private SDH/SONET network: wideband cross-connects and broadband cross-connects. (Chapter 5 describes these muxes and cross-connects.)

Dark Fiber

With dark fiber, the customer leases the fiber itself and buys the necessary equipment to actually activate the fiber. The customer pays for the physical media, not for bandwidth, and as the customer adds equipment that can either pulse more bits per second or extract more wavelengths out of the underlying fiber, the bandwidth essentially becomes cheaper and cheaper.

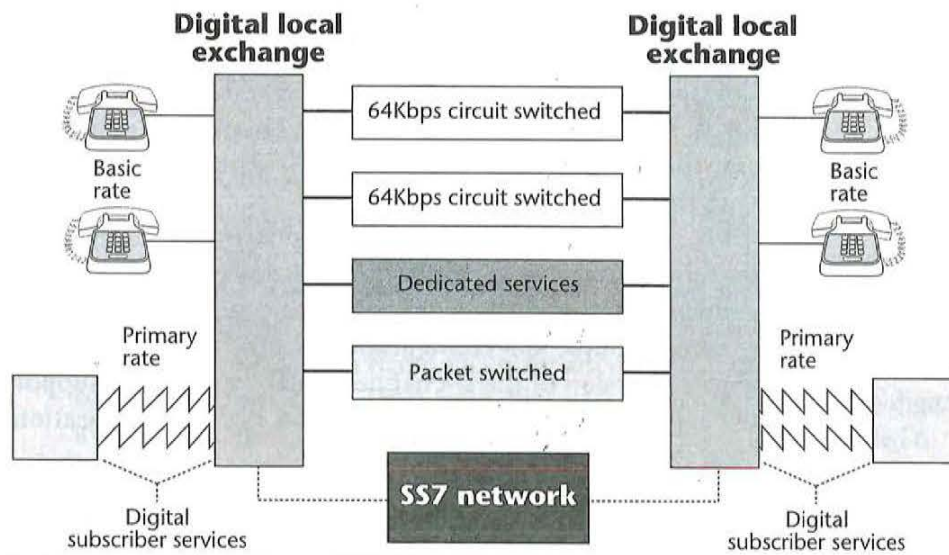
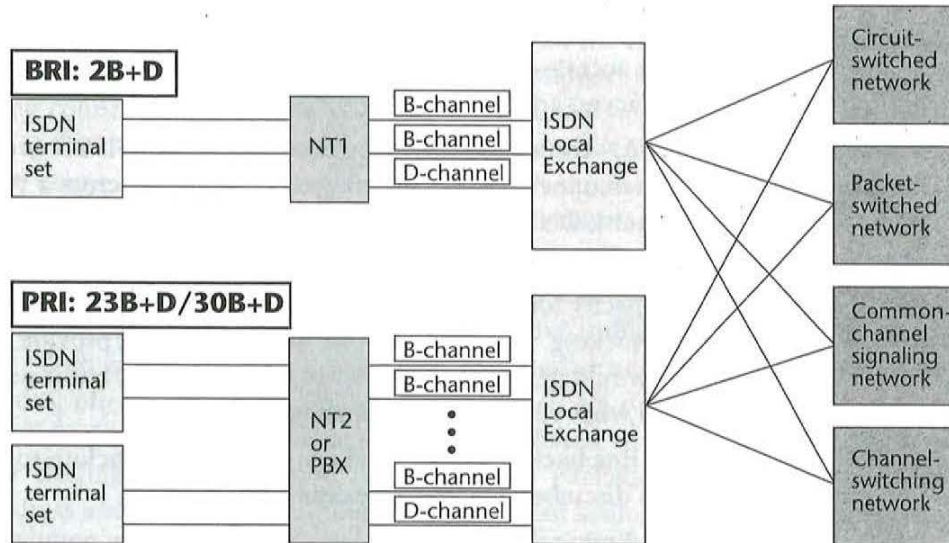
ISDN

Another circuit-switched WAN option is ISDN. The International Telecommunication Union Telecommunications Standardization sector (ITU-T) formalized the ISDN standard in 1983. According to the ITU-T (www.itu.org), ISDN is “a network evolved from the telephony integrated digital network that provides end-to-end connectivity to support a wide range of services, including voice and nonvoice services, to which users have access by a limited set or standard multipurpose customer interfaces.” One of the ideas behind narrowband ISDN (N-ISDN), as the first generation of ISDN was called, was to give customers one access into the network, from which they could then engage in circuit-switched, leased-line, or packet-switched options. Although all these options were available before ISDN, each one generally required its own special access line and device, which meant extra costs and administrative responsibilities because of the large number of options. The goal of ISDN was to provide one plug into the network, from which you could then go out over multiple alternatives.

ISDN Networks

A couple of key elements are required to form an ISDN network (see Figure 7.10). First, you must have a digital local exchange, and that digital exchange must be loaded with ISDN software. This is not an inexpensive proposition. The ISDN software alone costs around US\$1 million, and each exchange costs in the neighborhood of US\$3 million to US\$5 million. Not all exchanges today are digital; a fairly significant number of exchanges—some 30% to 40% in the United States, for example—are analog, so not every locale can get ISDN services. But if you do have an exchange and the proper ISDN software, you also need a Signaling System 7 (SS7) network and a CPE that is compatible with the ISDN network. (SS7 is discussed in detail in Chapter 5.)

As discussed in Chapter 3, “Transmission Media: Characteristics and Applications,” N-ISDN has two interfaces (see Figure 7.11): BRI and PRI.

**Figure 7.10** ISDN components**Figure 7.11** N-ISDN network interfaces

BRI is primarily used for residential service, small businesses, and center environments. BRI is offered only by local telcos, and how they offer it varies greatly. It can be configured as either 1B, 2B, 1B+D, or the full 2B+D; 128Kbps transmission requires that two B-channels be used. One application for this is Internet access, so you might have a BRI device, such as an ISDN modem, that would bond together two B-channels to provide the 128Kbps access to the ISP.

PRI is primarily used for business applications, and both local and interexchange carriers offer it. In support of the voice environment, PRI applications would include access to PBX and call center networks, replacement of existing analog trunk groups, and configuration of PBX tie-lines. Q-Sig, a standard that's an enhanced version of the D-channel signaling protocol, supports feature transparency between different vendors' PBXs. A key data application of PRI is LAN/WAN integration.

ISDN Applications

The following are the main applications for N-ISDN:

- **Internet access**—You would use N-ISDN to increase the speeds otherwise supported by your analog voice-grade line, when you do not have available other broadband access options, such as DSL, cable modems, or broadband wireless, available.
- **Remote access**—You would use N-ISDN to give teleworkers or telecommuters access to corporate resources.
- **LAN/WAN connections**—As mentioned earlier, N-ISDN is a technique for LAN interconnection, so bridging multiple LANs across a WAN could be done over ISDN connections.
- **High-capacity access**—You could use N-ISDN if you needed to increase your capacity for things such as graphics, file transfer, video, and multimedia networking. Keep in mind that N-ISDN will not provide motion as good as you would get with the higher-capacity services, but it will be much better than what you get with an analog facility.
- **Private line backup**—You could use N-ISDN as a backup to the private line services discussed earlier (for example, DDS).
- **Dial-up Frame Relay access**—Frame Relay is a very popular data networking option, particularly for LAN-to-LAN interconnection. You can use ISDN to provide measured-use dialup access to Frame Relay services in which the user dials in to a remote access port on the carrier's Frame Relay switch at either 64Kbps or 128Kbps connections. This can be used at smaller sites and for remote access (for example, for telecommuters).

- **BRI 0B+D for packet data**—One 16Kbps D-channel can be shared by up to eight devices. BRI 0B+D makes use of 9.6Kbps of D-channel capacity to support low-speed data terminals. This requires a terminal adapter that encapsulates the user data in D-channel frames. Applications for BRI 0B+D include credit card terminals and automatic teller machines.
- **ISDN DSL (IDSL)**—IDSL delivers full-duplex, dedicated data services; it does not support voice services. It is provided either on a 1B or a 2B configuration (that is, 64Kbps or 128Kbps). IDSL is compatible with existing digital loop carrier systems, which, as mentioned previously, serve 30% to 40% of the U.S. population. Digital loop carriers are especially common in remote rural areas. Some of the new DSL services (which are discussed in Chapter 13, “Broadband Access Solutions”) are incompatible with these older-generation digital loop carriers. IDSL, however, is compatible with them, so it can be used to deliver digital private line service at speeds up to 128Kbps. In today’s environment, 128Kbps is not what we strive for, so even though IDSL can facilitate some speedier communications, it is not as fast as some other broadband access options, making its future rather short.

■ Packet-Switched Networks

Packet switching was developed as a solution for the communications implications of interactive processing—it was designed to support bursty data traffic, which has long connect times but low data volumes. Packet switching involves the application of statistical multiplexing, whereby numerous conversations can make use of one common communications channel, which significantly increases transmission efficiency. (Chapter 2, “Telecommunications Technology Fundamentals,” discusses statistical multiplexing in more detail.) However, sharing a communications link introduces latency. A key issue that we have to address in the future is how packet-switched networks can support latency-sensitive traffic such as real-time streams.

With packet switching, packets are routed through a series of intermediate nodes, often involving multiple networks; they are routed in a store-and-forward manner through a series of packet switches (that is, routers) that ultimately lead to the destination. Information is divided into packets that include a destination address and a sequence number. Let’s look at an analogy. Think about telecommunications as a transportation network in which the physical roadway is a gravelly, potholed, single-lane alley. This is the traditional voice channel—twisted-pair deployed in a limited spectrum to support voice. We can pave that alleyway and make it a slicker surface, which equates to DSL. The road can now accommodate some additional information and move traffic along at a faster rate. We could then build a street with four lanes, the equivalent of coaxial cable. We could even build

"Here is a book that demystifies a technical world. This book will be a permanent fixture on my 'go-to to find an answer' reference list."
—Kiron Chatterjee, CEO, Koshen Holdings, and former CEO of Asia Online

"Whether you are new to telecom or have years of experience, this well-organized and detailed reference will help you learn what you need to know, or remember what you have forgotten."
—David West, Executive Vice President, Equinox Information Systems

Telecommunications Essentials is an in-depth introduction to the rapidly growing world of telecommunications. This book provides a global perspective, ensuring a complete understanding of telecommunications technologies and standards worldwide. A comprehensive, one-stop reference for anyone needing to get up to speed on the \$2.5 trillion telecommunications industry, this book covers basic building blocks before moving on to explore the most current information on new technologies, including wireless, broadband, and optical networking. Coverage includes:

- ◆ Technology basics
- ◆ PSTN (Public Switched Telephone Networks)
- ◆ Switching and routing
- ◆ Data communications
- ◆ Frame relay and ATM
- ◆ Internet infrastructure
- ◆ VPNs, VoIP, and streaming media
- ◆ Broadband architectures
- ◆ Security
- ◆ Optical networking
- ◆ Cable
- ◆ Wireless
- ◆ Fiber
- ◆ xDSLs
- ◆ The broadband home

Goleniewski's clear approach to current and emerging technologies—starting with an introduction to important terms and definitions, and moving on to discussions about systems, networks, and the latest applications, products, and services—is based on

the successful LIDO Telecommunications Essentials® seminar and e-Learning series. The application of this proven teaching method helps make **Telecommunications Essentials** a must-have resource for any reader, whether they are new to the field of telecommunications or a seasoned professional.

As an additional bonus, **Telecommunications Essentials** is augmented by a dynamic online telecom learning center, www.telecomessentials.com/learningcenter, designed to enhance and further your learning experience. The *Telecom Essentials Learning Center* includes access to:

- ◆ Self-tests and quizzes that put your newfound knowledge to the test.
- ◆ Discussion forums for student interactions and Q&A.
- ◆ A list of recommended books and magazines that will help you build your telecommunications knowledge.
- ◆ Links to recommended Web sites, which supplement and enhance the content of each chapter.

The LIDO Organization, Inc.'s Telecommunications Essentials® educational products are further supported by a unique telecommunications knowledge portal, LIDO Telecom WebCentral®, www.telecomwebcentral.com, which provides you with access to:

- ◆ More than 6,000 learning resources and video tutorials featured on the site.
- ◆ Brand-new information on financial and legal news.
- ◆ Up-to-the-minute information on the latest applications.
- ◆ Connections to telecom career groups and newsgroups.



Lillian Goleniewski is founder and President of The LIDO Organization, Inc. (www.lidoorg.com). As an author and creator of the LIDO Telecommunications Essentials® seminar and e-Learning series, she lectures extensively throughout the world. Ms. Goleniewski is actively involved in several major industry conferences, including the Key3Media COMDEX® forums and conferences (she is an Industry Advisory Board member), and ComNet® Washington, D.C. She is also a judge for the Global Information Infrastructure Awards® (GII Awards) and a founding member of the Standard for Internet Commerce.

<http://www.aw.com/cseng/>
<http://www.telecomessentials.com/learningcenter>
<http://www.telecomwebcentral.com>



Lido Telecommunications Essentials® is the registered trademark of The Lido Organization, Inc.



Cover design by Melanie A. Buck
Cover illustration by Blake Webster, The Lido Organization, Inc.

♻ Text printed on recycled paper

▲ Addison-Wesley
Pearson Education



X001NVREKP

Telecommunications Essentials: The Complete G...

Used / Very Good



\$54.99 US
\$78.99 CANADA