

Contents

	About the Author	xix
	About LIDO	xxi
	Acknowledgments	xxiii
	Introduction: Understanding the Broadband Evolution	xxvii
Part I	Communications Fundamentals	1
Chapter 1	Telecommunications Technology Fundamentals	3
	Transmission Lines	3
	Circuits	4
	Channels	6
	Lines and Trunks	6
	Virtual Circuits	9
	Types of Network Connections	11
	The Electromagnetic Spectrum and Bandwidth	11
	The Electromagnetic Spectrum	11
	Bandwidth	15
	Analog and Digital Transmission	18
	Analog Transmission	18
	Digital Transmission	19

Analog Versus Digital Transmission	20
Conversion: Codecs and Modems	20
Multiplexing	23
FDM	26
TDM	26
STDM	27
Intelligent Multiplexing	28
Inverse Multiplexing	30
WDM, DWDM, and CWDM	30
Political and Regulatory Forces in Telecommunications	33
Regulatory Background	34
The Policy and Regulatory Players	34
The Main Regulatory Issues	35
Internet Governance	36
Standards Organizations	37
Chapter 2 Traditional Transmission Media	41
Twisted-Pair	44
Characteristics of Twisted-Pair	44
Categories of Twisted-Pair	45
Applications of Twisted-Pair	47
Analog and Digital Twisted-Pair	47
Advantages and Disadvantages of Twisted-Pair	50
Coaxial Cable	51
Characteristics of Coaxial Cable	52
Applications of Coaxial Cable	53
Advantages and Disadvantages of Coaxial Cable	53
Microwave	54
Characteristics of Microwave	55
Traditional Applications of Microwave	56
Advantages and Disadvantages of Microwave	60
The New Era of Microwave: Wireless Broadband	60
Satellite	61
Frequency Allocations of Satellite	63
Satellite Network Segments	65
Satellite Orbits	66
Applications of Satellite	70
Advantages and Disadvantages of Satellite	72
Fiber Optics	73
Characteristics of Fiber Optics	73
Components of Fiber Optics	74
How Fiber-Optic Transmission Works	76
Innovations in Fiber Optics: EDFAs and WDM	77
Applications of Fiber Optics	78
Advantages and Disadvantages of Fiber Optics	79

Chapter 3	Establishing Communications Channels	83
	Establishing Connections: Networking Modes and Switching Modes	83
	Networking Modes	84
	Switching Modes	86
	The PSTN Versus the Internet	100
	PSTN Characteristics	100
	Internet Characteristics	101
	Converging Networks: Next-Generation Networks	101
Chapter 4	The PSTN	103
	The PSTN Infrastructure	103
	Service Providers	105
	Network Access	106
	Access Services	107
	Transport Services	109
	PSTN Architecture	111
	The Transport Network Infrastructure	114
	The PDH Infrastructure	114
	The SDH/SONET Infrastructure	123
	Signaling Systems	129
	SS7 Architecture	132
	Intelligent Networks	135
	AINs	136
	SS7 and Next-Generation Networks	138
	Next-Generation Networks and the PSTN	140
Part II	Data Networking and the Internet	143
Chapter 5	Data Communications Basics	145
	The Evolution of Data Communications	145
	Data Communications Architectures	145
	Data Communications Traffic	150
	Data Flow	152
	The DTE, the DCE, the Transmission Channel, and the Physical Interface	152
	Modems and Modulation	154
	Simplex, Half-Duplex, and Full-Duplex Data Transmission	159
	Coding Schemes: ASCII, EBCDIC, Unicode, and Beyond	160
	Transmission Modes: Asynchronous and Synchronous Transmission	162
	Error Control	164
	The OSI Reference Model and the TCP/IP Reference Model	165
	The OSI Seven-Layer Reference Model	166
	The TCP/IP Four-Layer Reference Model	168
	The TCP Stack Versus the OSI Model	170

Chapter 6	Local Area Networking	173
	LAN Basics	173
	LAN Concepts and Benefits	174
	LAN Components	175
	LAN Characteristics	176
	LAN Transmission Media	176
	LAN Transport Techniques and Standards	177
	LAN Access Methods	182
	LAN Topologies	185
	LAN Interconnection and Internetworking	187
	Hubs	187
	LAN Switches	189
	VLANs	191
	Bridges	192
	Routers	194
	IP Switches	198
Chapter 7	Wide Area Networking	201
	Circuit-Switched Networks	203
	Networks Based on Leased Lines	203
	Networks Based on ISDN	212
	Packet-Switched Networks	215
	X.25	219
	Frame Relay	221
	ATM	229
	IP and ATM	238
Chapter 8	The Internet and IP Infrastructures	245
	Internet Basics	245
	A Brief History of the Internet	247
	What the Internet Is and How It Works	251
	Internet Protocols	254
	Internet Network Architectures	264
	Internet Addressing and Address Resolution	268
	Addressing and Routing Schemes	269
	IPv4 Addressing	271
	IPv6 Addressing	275
	DNS	280
	The Organization of the Internet	284
	The Evolution of the POP Architecture	285
	Internet Challenges and Changes	289
	Service Providers and Interconnection	291

IP QoS	295	
QoS Mechanisms	295	
Queuing Mechanisms	296	
The IP QoS Continuum	299	
What's Next on the Internet	303	
The Next-Generation Internet	303	
The Interplanetary Internet	304	
Internet-Enabled Devices	305	
RFID Applications	305	
SIP Telephony	306	
Digital Objects and Libraries	306	
The Semantic Web	306	
Part III	The New Generation of Networks	309
Chapter 9	IP Services	311
The Evolution to IP Services	311	
IPT	313	
The IPT Evolution	314	
The IPT Network	318	
Standards for IP Voice	324	
VoIP Call-Signaling Protocols	330	
ENUM: Telephone Number Mapping	339	
IPTV	342	
IPTV Versus Streaming Media	343	
The IPTV Architecture	344	
VPNs	345	
Key VPN Concepts	347	
Types of IP VPNs	359	
VPN Security	374	
Chapter 10	Next-Generation Networks	383
The Broadband Evolution	384	
Communications Traffic Trends	384	
Communications Backbone Trends	385	
Communications Bandwidth Trends	386	
Communications Application Trends	387	
Broadband Applications	388	
Multimedia Networking Requirements	389	
Digital Video	390	
Television Standards	396	

The Broadband Infrastructure	409
Converging Public Infrastructures	410
Broadband Service Requirements	410
Next-Generation Networks and Convergence	411
Convergence in Different Industry Segments	412
Arguments for Convergence	414
Regulatory Effects on Convergence	414
Converging Public Infrastructures	415
Convergence in the Service Environment	416
The Next-Generation Network Infrastructure	418
The IP Multimedia Subsystem	420
The Next-Generation Network Architecture	425
The Multiservice Intelligent Edge	432
Quality of Service	437
The MPLS Architecture	445
Chapter 11 Optical Networking	451
Optical Networking Today and Tomorrow	451
Drivers of Optical Networking	452
Network Reality Today	453
Bandwidth Abundance	456
End-to-End Optical Networking	456
Optical Line Amplifiers: EDFAs, Raman Amplifiers, and SOAs	457
WDM Equipment	458
OADMs	463
Optical Switches	464
Integrated Photonic Circuits	469
Optical Network Management	470
The Optical Edge	471
Next-Generation Digital Loop Carriers	471
PONs	472
MSPPs	472
The Optical Core: Overlay Versus Peer-to-Peer Networking Models	473
The Overlay Model	476
The Peer-to-Peer Model	478
The Overlay and Peer-to-Peer Models Compared	483
The IP+Optical Control Plane	483
GMPLS	485
UNI	487
ASON	487
The Migration to Optical Networking	488

Chapter 12	Broadband Access Alternatives	489
	Drivers of Broadband Access	489
	DSL Technology	492
	How DSL Works	493
	Characteristics and Properties of DSL	494
	HDSL	499
	SDSL	500
	G.SHDSL	501
	ADSL	503
	ADSL2	505
	ADSL2+	506
	ADSL2-RE	507
	RADSL	507
	VDSL	508
	VDSL2	508
	Cable TV Networks	509
	HFC Architecture	510
	Cable Modems and CMTSs	512
	Cable Modem Standards	513
	The Future of Cable TV Networks	521
	Fiber Solutions	522
	FTTx	523
	PONs	525
	Wireless Broadband	529
	Broadband PLT	530
	PLT Architecture	530
	The Future of PLT	532
	HANs	534
	The HAN Market, Applications, and Elements	535
	Types of HANs	536
	HAN Gateways and Servers	544
	Planning for the Future of HANs	544
Part IV	Wireless Communications	547
Chapter 13	Wireless Communications Basics	549
	A Brief History of Wireless Telecommunications	550
	Wireless Communications Regulations Issues	553
	Wireless Impairments	554

Antennas	556
Phased-Array Antennas	557
Magnetic Polarization Antennas	558
MIMO Antennas	558
Wireless Bandwidth	560
Wireless Signal Modulation	560
Single-Carrier Modulation Techniques	561
Multicarrier Modulation Techniques	562
Spectrum Utilization	563
Using the Available Radio Spectrum	563
Duplexing Techniques	575
Compression Techniques	576
Chapter 14 Wireless WANs	579
1G: Analog Transmission	581
1G Analog Cellular Networks	581
1G Wireless Data Networks	583
2G: Digital Cellular Radio	586
GSM	588
UWC	590
cdmaOne	590
PDC	592
2.5G: Enhanced Data Services	592
HSCSD	593
GPRS	593
EDGE	595
GERAN	596
Messaging Services Standards	596
3G: Moving Toward Broadband Wireless	597
3G Standards	599
3G Deployment Issues	609
Beyond 3G	611
4G: Wireless Broadband	612
5G: Intelligent Technologies	614
Chapter 15 WMANs, WLANs, and WPANs	617
WMANs	618
BFWA	619
IEEE 802.16 (WiMax)	621
WiBro	626
IEEE 802.20 (Mobile-Fi)	627
ETSI BRAN	628
iBurst	630

Flash-OFDM	632
DMB	634
VF	636
WLANs	638
Wi-Fi	640
IEEE 802.11x Standards	642
WLAN Security	646
VoWLAN	648
The Integration of WLANs and Cellular Networks	651
Mesh Networks	654
WPANs	660
IEEE 802.15.1 (Bluetooth)	661
IEEE 802.15.3 (WPAN-HR and WPAN-AHR)	664
UWB	665
IEEE 802.15.4 (ZigBee)	670
RFID	674
NFC	683
Chapter 16 Emerging Wireless Applications	687
The Handset Revolution	688
From Mobile Phones to Multimedia Handsets	689
Software-Defined Radio	691
Cognitive Radio	692
Mobile IP	693
The IP Multimedia Subsystem	696
Push-to-Talk	700
Presence-Based Services	701
Mobile Gaming	702
Mobile Game Categories	703
Mobile Game Platforms	704
Mobile Video	706
Mobile TV	707
DMB	708
DVB-H	709
ISDB	710
MediaFLO	710
Mobile Content	712
Glossary	715
Index	819