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PREFACE

The past years have seen an explosion in the use of digital media. Industry is making significant investments to deliver digital audio, image and video information to consumers and customers. A new infrastructure of digital audio, image and video recorders and players; online services and electronic commerce is rapidly being deployed. At the same time, major corporations are converting their audio, image and video archives to an electronic form. Digital media offer several distinct advantages over analog media. The quality of digital audio, image and video signals is higher than that of their analog counterparts. Editing is easy because one can access the exact discrete locations that need to be changed. Copying is simple with no loss of fidelity. A copy of digital media is identical to the original. Digital audio, image and video are easily transmitted across networked information systems. These advantages have opened up many new possibilities.

Multimedia consists of Multimedia data + Set of interactions. Multimedia data is informally considered as the collection of three Ms: multisource, multitype and multiformat data. The interactions among the multimedia components consist of complex relationships without which multimedia would be a simple set of visual, audio and other data.

Multimedia and multimedia communication can be globally viewed as a hierarchical system. The multimedia software and applications provide a direct interactive environment for users. When a computer requires information from remote computers or servers, multimedia information must travel through computer networks. Because the amount of information involved in the transmission of video and audio can be substantial, the multimedia information must be compressed before it can be sent through the network in order to reduce the communication delay. Constraints, such as limited delay and jitter, are used to ensure a reasonable video and audio effect at the receiving end. Therefore, communication networks are undergoing constant improvements in order to provide for multimedia communication capabilities. LANs are

used to connect local computers and other equipment, and Wide Area Networks (WANs) and the Internet connect the LANs together. Better standards are constantly being developed, in order to provide a global information superhighway across which multimedia information will travel.

Organization of the Book

The book is organized into six chapters:

Chapter 1 describes the concept of multimedia communication modeling. It presents a brief description of elements for multimedia systems. After that, we discuss user and network requirements together with the packet transfer concept. An overview of multimedia terminals is also given.

Chapter 2 explains that multimedia communication is more than simply putting together text, audio, images and video. It reviews a recent trend in multimedia research to exploit the audio-visual interaction and to build the link between audio and video processing. The emphasis is on lip reading, synchronization and tracing audio-to-visual mapping as well as the bimodal person verification.

Chapter 3 is devoted to multimedia processing in communication. We present and analyze digital media and signal processing elements. Next, we describe a general framework for image copyright protection through digital watermarking. We then review the key attributes of neural processing essential to intelligent multimedia processing. Finally, this chapter concludes with recent large-scale-integration programmable processors designed for multimedia processing such as real-time compression and decompression of audio and video as well as the next generation of computer graphics.

Chapter 4 deals with the issues concerning distributed multimedia systems. We give an overview: main features, resource management, networking and multimedia operating systems. Next, we identify the applications like interactive television, telecooperation and hypermedia, and we survey the important enabling technologies.

Chapter 5 focuses on multimedia communication standards. We discuss Moving Pictures Experts Group (MPEG)-1, MPEG-2, MPEG-4, MPEG-4 Visual Texture Coding (VTC), Joint Photographic Experts Group (JPEG)-2000, MPEG-7, MPEG-21, International Telecommunications Union-Telecommunication Sector (ITU-T) and Internet standards. We discuss the ITU-T standardization process in multimedia communications from the video and speech coding, as well as from multimedia, multiplex and synchronization points of view (H.320, H.321, H.322, H.323, H.262, H.263, H.26L, H.221, H.222, H.223 and H.225).

Chapter 6 concentrates on multimedia communication across networks. After an introduction about packet audio-video in the network environment, we discuss the concept of video transport across generic networks. Multimedia transport over ATM networks is described, too. We then move to multimedia across IP networks, including video transmission, traffic specification for MPEG video transmission on the Internet and bandwidth allocation mechanism. We present and illustrate the concepts of Internet access networks. In addition, we discuss special issues relating to multimedia across wireless networks such as wireless broadband communica-

tion for multimedia audiovisual solutions, mobile and broadcasting networks and digital TV infrastructure for interactive multimedia services.

Appendix/Web Site

Appendix A contains useful information available on the Internet: standardization organizations, associations, alliances, fora and consortia; documents, software and hardware reference, and a products and services list. No software is provided. The appendix can be downloaded at the following Web site: www.phptr.com/rao.

References

The references are grouped according to the various chapters. Special efforts have been taken to make this list as up to date and exhaustive as possible.

A number of forces are driving communications, such as the following:

- The evolution of communications and data networks in today's modern Plain Old Telephone Service (POTS) network and packet (including the Internet) networks, with major forces driving these networks into an integrated structure
- The increasing availability of almost unlimited bandwidth demand in the office, the home and eventually on the road, based on high-speed data modems, cable modems, hybrid fiber-mix systems, and, recently, a number of fixed wireless access systems
- The availability of ubiquitous access to the network through Local Area Networks (LANs), wireline and wireless networks providing the promise of anywhere, anytime access
- The ever-increasing amount of memory and computation that can be brought to bear on virtually any communications or computing system
- The terminals, including sophisticated screen phones; digital telephones; multimedia personal computers (PCs) that handle a wide range of text, image, audio and video signals; network computers and other low-cost Internet-access terminals and Personal Digital Assistants (PDAs) of all types that can access and interact with the network using wired and wireless connections
- The digitalization of virtually all devices, including cameras, video capture devices, video playback devices, handwriting terminals, sound capture devices and so forth

Multimedia Communication Systems provides a comprehensive coverage of various surveys of the current issues relating to multimedia communications. This book addresses the fundamentals of the major topics of the multimedia communication systems: audio-visual integration, multimedia processing in communications, distributed multimedia systems, multimedia communication standards and multimedia communications across networks.

We have focused our attention on these topics with the hope that the level of discussion provided will enable an engineer or a scientist to design multimedia communication systems or

to conduct research on advanced and newly emerging topics. The objective of this book is not only to familiarize the reader with multimedia communication systems, but also to provide the underlying theory, concepts and principles related to these disciplines, including the power and the practical utility of the topics.

A major challenge during the preparation of this book was the rapid pace of development, both in software and hardware related to multimedia communication systems. We have tried to keep pace by including many of the latest developments. In this way, it is hoped that the book is timely and appeals to a wide audience in the engineering, scientific and technical communities. In addition, we have included more than 270 figures and more than 800 references. Although this book is primarily for graduate students, it can be also very useful for academia, researchers, scientists and engineers dealing with multimedia communication systems.

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LIST OF ACRONYMS

1D.....	One-dimensional	ASIC.....	Application-Specific Integrated Circuit
2D.....	Two-dimensional	ASPEC.....	Adaptive Spectral Entropy Coding
3D.....	Three-dimensional	ASR.....	Automatic Speech Recognition
8D.....	Eight-dimensional	ATC.....	Adaptive Transform Coding
3G.....	Third Generation	ATDM.....	Asynchronous Time Division Multiplex
3GPP.....	Third Generation Partnership Project	ATM.....	Asynchronous Transfer Mode
4G.....	Fourth Generation	ATSC.....	Advanced Television System Committee
AAC.....	Advanced Audio Coding	AU.....	Access Unit
AAL.....	ATM Adaptation Layer	B.....	Blue
AAP.....	ATM Access Point	BAM.....	Bandwidth Allocation Mechanisms
ABR.....	Available Bit Rate	BAP.....	Body Animation Parameter
ACE.....	Advanced Coding Efficiency	BB.....	Band-by-Band
ACELP.....	Algebraic Code-Excited Linear Prediction	BDP.....	Body Definition Parameter
ACR.....	Absolute Category Rating	BER.....	Bit Error Rate
AD.....	Adaptive Differential	BGP.....	Border Gateway Protocol
AD.....	Area Directors	BIFS.....	Binary Format for Scene Description
ADPCM.....	Adaptive DPCM	BISDN.....	Broadband ISDN
ADSL.....	Asymmetric Digital Subscriber Line	BoD.....	Bandwidth on Demand
AH.....	Authentication Header	BQ.....	Bilevel Quantization
AL.....	Adaptation Layer	BRAS.....	Broadband Remote Access Servers
ALF.....	Application Level Framing	BSAC.....	Bit-Sliced Arithmetic Coding
ALU.....	Arithmetic and Logic Unit	BTS.....	Base Transceiver Stations
AMR.....	Adaptive Multirate	B-VOP.....	Bidirectional Interpolated VOP
AP.....	Access Point	CAI BIOS... Common Air Interface Basic Input Output System	
API.....	Application Programming Interface	CAP.....	Carrierless Amplitude Phase
ARPANET ..	Advanced Research Agency Network	CATV.....	Cable Television
ARQ.....	Automatic Repeat Request	CBR.....	Constant Bit Rate
ARTS.....	Advanced Real-Time Simple (Profile)	CBT.....	Core-Based Tree

CD	Committee Draft	DBA	Dynamic Bandwidth Allocation
CD	Compact Disc	DBNN	Decision-Based Neural Network
CDMA	Code Division Multiple Access	DBS	Direct Broadcast Satellite
CDPD	Cellular Digital Packet Data	DCA	Dynamic Channel Allocation
CDV	Cell Delay Variation	DCR	Degradation Category Rating
CELP	Code-Excited Linear Prediction	DCT	Discrete Cosine Transform
CGI	Common Gateway Interface	DDL	Description Definition Language
CIF	Common Intermediate Format	DDM	Dense Division Multiplexing
CISC	Complex Instruction Set Computer	DFT	Discrete Fourier Transform
CLEC	Competitive Local Exchange Carriers	DIS	Draft International Standard
CLP	Cell Loss Priority	DLC	Digital Link Control
CN	Corresponding Node	DLC	Digital Loop Carriers
CN	Canonical Name	DMA	Division Multiple Access
CNG	Comfort Noise Generation	DMIF	Delivery Multimedia Integration Framework
COFDM	Coded Orthogonal Frequency Division Multiplex	DMS	Distributed Multimedia System
CPE	Customer Premises Equipment	DMT	Discrete Multitone
CPS	Constrained Parameter Set	DNI	DMIF Network Interface
CPU	Central Processing Unit	DNS	Domain Name System
CRC	Cyclic Redundancy Check	DPAC	Differential Perceptual Audio Coder
CREW	Compression with Reversible Embedded Wavelets	DPCM	Differential Pulse Code Modulation
CSCW	Computer-Supported Cooperative Work	DRC	Dynamic Resolution Conversion
CSP	Content Service Provider	DS	Description Scheme
CS-VQ	Constrained-Storage Vector Quantization	DSL	Digital Subscriber Line
CTI	Complete Timing Information	DSLAM	DSL Access Multiplexer
CTI	Computer Tomography Information	DSM	Digital Storage Media
CVC	Consonant-Vowel-Consonant	DSM-CC	DSM-Command and Control
D	Data or Descriptor	DSPs	Digital Signal Processors
D/A	Digital-to-Analog	DSVD	Digital Simultaneous Voice and Data
DAB	Digital Audio Broadcast	DTH	Direct-to-Home
DAI	DMIF Application Interface	DTS	Decoding Time Stamp
DAT	Digital Audio Type	DTV	Digital TV
DAVIC	Digital Audio Visual Council	DVB	Digital Video Broadcasting
		DVB-C	DVB Cable
		DVB-RCS	DBV Return Channel System by Satellite
		DVB-S	DVB via Satellite
		DVB-T	DVB Terrestrial

DVD	Digital Versatile Disk	FF/FR.....	Fast Forward/Fast Reverse
DVD	Digital Video Disk	FFT	Fast Fourier Transform
DWT.....	Discrete Wavelet Transform	FGS.....	Fine Granularity Scalability
EBCOT.....	Embedded Block Coding with Optimized Truncation	FIR.....	Finite Impulse Response
EBU.....	European Broadcasting Union	FIT	FAP Interpolation Table
EDF	Earliest Deadline First	FLC	Fixed Length Code
EEG	Electroencephalogram	FPGA.....	Field Programmable Array
EFR	Enhanced Full Rate	fps	frames per second
EKG.....	Electrocardiogram	FR	Full Rate
EM.....	Expectation Maximization	FS.....	Frame Store
EP	Error Protection	FTP	File Transfer Protocol
EPG	Electronic Program Guide	G	Green
ER.....	Error-Resilient	GA	General Audio
EREC.....	Error-Resilient Entropy Code	GDDS	Group-Decision Support System
ES	Elementary Stream	GFA	Gateway Foreign Agent
ESA	European Space Agency	GII	Global Information Infrastructure
ESM.....	Elementary Stream Management	GMC.....	Global Motion Compensation
ESP.....	Encapsulating Security Payload	GOB.....	Group of Blocks
ETSI	European Telecommunication Standards Institute	GOP	Group of Pictures
EZW	Embedded Zero-Tree Wavelet	GOV	Group of Video Planes
FAB	Face and Body	GSM	Global System for Mobile
FACS.....	Facial Action Coding System	GSTN.....	General Switched Telephone Network
FAP	Facial Animation Parameter	GW	Gateway
FAPU.....	Facial Animation Parameter Unit	HDTV.....	High Definition Television
FAT	Facial Animation Table	HFC	Hybrid Fiber Coax
FCA	Fixed Channel Allocation	HILN	Harmonic and Individual Lines plus Noise
FCPAS.....	Fault, Configuration, Accounting Performance and Security Management Areas	HL.....	High Level
FCC	Federal Communication Commission	HMIHY	How May I Help You
FDDI	Fiber Distributed Data Interface	HMM.....	Hidden Markov Model
FDDS.....	Fiber Distributed Data Service	HP	High Profile
FDIS	Final Draft International Standard	HP.....	High Pass
FDMA	Frequency Division Multiple Access	HPNA	Home Phonenumber Network Alliance
FDP	Facial Definition Parameter	HR	Half-Rate
FEC	Forward Error Correction	HSCSD	High-speed Circuit-Switched Data
		HSV	Hue Saturation Value
		HTML.....	Hypertext Markup Language

HTTP.....Hypertext Transport Protocol	Standardization
HVS.....Human Visual System	ISOC.....Internet Society
HVXC.....Harmonic Vector Excitation Coding	ISP.....Internet Service Provider
IAB.....Internet Architecture Board	ISP POP.....Internet Service Provider's Point of Presence
IAD.....Integrated Access Device	ISWG.....IETF Integrated Services WG
IANA.....Internet Assigned Number Authority	ITU.....International Telecommunications Union
ICMP.....Internet Control Message Protocol	ITU-T.....ITU-Telecommunication sector
ICT.....Irreversible Component Transformation	ITV.....Interactive Television
IDB.....Interactive Data Broadcast	IVB.....Interactive Video Broadcast
IDCT.....Inverse DCT	I-VOP.....Intra VOP
IEC.....International Electrotechnical Commission	IZT.....Isolated Zero Tree
IEEE.....Institute of Electrical and Electronics Engineers	JND.....Just Noticeable Distortion
IESG.....Internet Engineering Steering Group	JPEG.....Joint Photographic Experts Group
IETF.....Internet Engineering Task Force	JSC.....Joint Source Channel Coding
ILP.....Integrated Level Processing	JTC.....Joint ISO/IEC Technical Committee
IMP.....Intelligent Multimedia Processing	KBD.....Kaiser-Bessel Derived
IMT.....International Mobile Telecommunication	KLT.....Karhunen-Loeve Transform
IN.....Intelligent Network	LAN.....Local Area Network
I/O.....Input/Output	LC.....Low Complexity
IP.....Internet Protocol	LD-CELP.....Low Delay CELP
IPA.....International Phonetic Alphabet	LFE.....Low Frequency Enhancement
IP-H.....IP-based header plus Extensions headers	LL.....Low Level
IPI.....Intellectual Property Identification	LLC.....Logical Link Control
IPMP.....Intellectual Property Management and Protection	LMDS.....Local Multipoint Distribution Service
IPN.....Integrated Packet Network	LMS.....Least Mean Square
IPPV.....Impulse Pay-Per-View	LNB.....Low Noise Block
IPR.....Intellectual Property Rights	LOAS.....Low Overhead Audio Stream
IROS.....Internet Radio Operating System	LOD.....Level of Detail
ISD.....Independent Segment Decoding	LOT.....Lapped Orthogonal Transform
ISDN.....Integrated Services Digital Network	LPAS.....Linear Prediction Analysis by Synthesis
ISI.....Intersymbol Interference	LP.....Linear Prediction
ISM.....Industrial, Scientific, Medical	LP.....Lowpass
ISO.....International Organization for	LPC.....Linear Predictive Coding
	LSP.....Line Spectral Pair
	LTP.....Long-Term Prediction

LZW	Lempel-Ziv-Welch	MOT	Multimedia Object Transfer
MA	Multiple Access	MOTIVATE	Mobile Television and Innovative Receivers
MAC	Media Access Control	MP	Main Profile
MAD	Mean Absolute Difference	MPE	Multipulse Excitation or Multi-Protocol Encapsulation
MAN	Metropolitan Area Network	MPEG	Moving Pictures Experts Group
MB	Macroblock	MPEG-J	MPEG-Java
MBS	Mobile Broadband System	MPLS	Multiprotocol Label Switching
MC	Motion Compensation	MPTS	Multiprogram TS
MCP	Multimedia Car Platform	MPU	Multimedia Processor Unit
MCU	Multipoint Control Unit	MQ	Multiple Quantization
MD	Multidimensional	MRI	Magnetic Resonance Imaging
MDC	Multiple Description Coding	MRC	Mixed Raster Content
MDCT	Modified Discrete Cosine Transform	MSB	Most Significant Bit
MDS	Multipoint Distribution Service	MSE	Mean Square Error
MDS	Multimedia Description Schemes	MSS	Mobile Support Station
ME	Motion Estimation	MSTVQ	Multistage Tree-Structured Vector Quantization
MEMO	Multimedia Environment for Mobiles	MTU	Maximum Transmission Unit
MF-TDMA	Multifrequency Time Division Multiple Access	MV	Motion Vector
MH	Multihypothesis	MVPD	Multichannel Video Program Distribution
MHBP	Multihypothesis Block Pattern	NADIB	Narrow Band Audio Digital Broadcasting
MHP	Multimedia Home Platform	NAPT	Network Address and Port Translation
MIDI	Musical Instrument Digital Interface	NAT	Network Address Translation
MIME	Multipurpose Internet Mail Extension	NBC	Nonbackward Compatible
MIPS	Millions of Instructions per Second	NC	Noiseless Coding
M-JPEG	Motion-JPEG	NGN	Next Generation Network
ML	Main Level	NISDN	Narrow-band ISDN
MLP	Multilayer Perceptron	NLIVQ	Nonlinear Interpolative Vector Quantization
MM	Multimedia	NM	Nuclear Medicine
MMDS	Multichannel MDS	NMR	Noise-to-Mask Ratio
MMDS	Multimedia Description Scheme	NN	Neural Network
MMSP	Multimedia Signal Processing	NNTP	Network News Transfer Protocol
MMX	Multimedia Extension	NTI	Null Timing Information
MOP	Mesh Object Plane		
MOPS	Mega Operations Per Second		
MOS	Mean Opinion Score		

NTP	Network Time Protocol	PSTN.....	Public Switched Telephone Network
NVoD.....	Near Video on Demand	PVC.....	Permanent Virtual Connection
OBMC.....	Overlapped Block Motion Compensation	P-VOP.....	Predicted-VOP
OCFD.....	Optimum Coding in the Frequency Domain	PVR	Packet Voice Receiver
OCI.....	Object Content Information	PVT.....	Packet Voice Transmitter
OCR.....	Object Clock Reference	PW	Perceptual Weighted
OD.....	Object Descriptor	Q	Quantization
OS.....	Operating System	QCIF	Quarter CIF
OSI.....	Open System Interconnection	QMF.....	Quadrature Mirror Filter
OSPF.....	Open Shortest Path First	QoS.....	Quality of Service
PAR.....	Pixel Aspect Ratio	QP	Quantization Parameter
PC.....	Personal Computer	QPSK.....	Quadrature Phase-Shift Keying
PCA.....	Principal Component Analysis	R.....	Red
PCF.....	Picture Clock Frequency	RAM.....	Random Access Memory
PCM.....	Pulse Code Modulation	RAS.....	Registration, Admission, and Status
PCR.....	Program Clock Reference	RCPC.....	Rate-Compatible Punctured Convolution
PCS.....	Personal Communication System	RCST.....	Return Channel Satellite Terminal
PCU.....	Processor Complexity Units	RCT.....	Reversible Component Transformation
PDA.....	Personal Digital Assistant	RCU.....	RAM Complexity Units
PDC.....	Personal Digital Cellular	R-D.....	Rate-Distortion
PDF.....	Probability Density Function	R&D.....	Research and Development
PDM.....	Packet Division Multiple	RFC.....	Request for Comments
PDU.....	Protocol Data Unit	RGB.....	Red, Green and Blue
PE.....	Perceptual Entropy	RIP.....	Routing Information Protocol
PES.....	Packetized Elementary Stream	RISC.....	Reduced Instruction Set Computer
PFGS.....	Progressive FGS	RL.....	Run-Length
PID.....	Packet Identifier	RMOA.....	Real-Time Multimedia over ATM
PLL.....	Phase-Locked Loop	RMSE.....	Root MSE
PNG.....	Portable Network Graphics	ROI.....	Region of Interest
PNS.....	Perceptual Noise Substitution	ROM.....	Read-Only Memory
POCS.....	Projection onto Convex Sets	RPE.....	Regular Pulse Excitation
POP.....	Point of Presence	RPM.....	Return Path Multiplexer
POTS.....	Plain Old Telephone Service	RS.....	Read-Solomon
PPD.....	Proposed Package Description	RSVP.....	Resource Reservation Protocol
PPP.....	Point-to-point Protocol	RTCP.....	Real Time Control Protocol
PSI.....	Program-Specific Information	RTE.....	Run Time Engine
PSNR.....	Peak Signal-to-noise Ratio	RTFD.....	Recommended Technical Framework

Document	SMIL Synchronized Multimedia Integration Language
RTI Real Time Interface	SMM Streaming Multimedia
RTP Real-Time Transport Protocol	SMPTE Society of Motion Picture and Television Engineers
RTSP Real-Time Streaming Protocol	SMR Signal-to-Mask Ratio
RTT Round-Trip Time	SMTP Simple Mail Transfer Protocol
RVLC Reversible Variable Length Coding	SNHC Synthetic and Natural Hybrid Coding
SA Structured Audio	SNMP Simple Network Management Protocol
SA-DCT Shape Adaptive – DCT	SNR Signal-to-Noise Ratio
SAM Split-and-Merge	SONET Synchronous Optical Network
SAOL Structured Audio Orchestra Language	SP Signal Processing
SAP Session Announcement Protocol	SP Simple Profile
SAR Segmentation and Reassembly	SPIE Society of Photo-optical and Instrumentation Engineers
SBBP Switched-Batch Bernoulli Process	SPIHT Set Partitioning in Hierarchical Trees
SBC Subband coding	SPL Sound Pressure Level
SCN Switched Circuit Network	SPS SL-Packetized Streams
SDC Single Description Coding	SPTS Single Program TS
SDH Synchronous Digital Hierarchy	SQ Scalar Quantization
SDL Specification and Description Language	SRC Scalable Rate Control
SDM System Decoder Model	SRM Session and Resource Manager
SDP Session Description Protocol	SSR Scalable Sampling Rate
SDRAM Synchronous Dynamic Random Access Memory	SSRC Synchronization Source RC
SDTV Standard Definition Television	STB Set-Top Box
SER Symbol Error Rate	STM Synchronous Transfer Mode
SFM Spectral Flatness Measure	STU Subscriber Terminal Unit
SG Study Groups	SVC Switched Virtual Connection (Circuit)
SH Supervisor Host	SZ Step Size
SHDSL Single Pair High-Speed DSL	Tabs Absolute threshold
SI Service Information	TAM Technical Issues Associated with MHP
SIF Source Input Format	TC Technical Committee, or Transform Coding
SIMD Single Instruction Multiple Data	TCP Transmission Control Protocol
SIP Session Initiation Protocol	TCQ Trellis Coded Quantization
SIT Satellite Interactive Terminal	TD Tree-Depth
SL Synchronization Layer	
SLI Spoken Language Interface	
SM Simulation Model	
SMG Statistical Multiplexing Gain	

TDM.....	Time Division Multiplexing	VM.....	Verification Model
TDMA.....	Time Division Multiple Access	VO.....	Video Object
TDNN.....	Time-delayed Neural Network	VoATM.....	Voice over ATM
TMT.....	True Motion Technique	VoD.....	Video on demand
TNS.....	Temporal Noise Shaping	VoDSL.....	Voice over DSL
ToR.....	Terms of Reference	VoIP.....	Voice over IP
TR.....	Technical Report	VOL.....	Video Object Layer
TS.....	Transport Stream	VOP.....	Video Object Plane
TSP.....	Transport Stream Packet	VOP.....	Voice Over Packetts
TTS.....	Text-to-Speech	VP.....	Virtual Path
TTSI.....	Text-to-Speech Interface	VPI/VCI.....	Virtual Path Identifier/Virtual Connection Identifier
TWIN-VQ ...	Transform Domain-Weighted Interleave VQ	VPN.....	Virtual Private Network
UBR.....	Unspecified Bit Rate	VQ.....	Vector Quantization
UDP.....	User Datagram Protocol	VRML.....	Virtual Reality Modeling Language
UEP.....	Unequal Error Protection	VS.....	Video Session
UMTS.....	Universal Mobile Telecommunication System	VS.....	Visual Object Sequence
UNII.....	Unlicensed National Information Infrastructure	VSB.....	Vestigial Side Band
UPG.....	Usage Parameter Control	VTC.....	Visual Texture Coding
URL.....	Uniform Resource Locator	W3C.....	World Wide Web Consortium
US.....	Ultrasound, or United States	WAN.....	Wide Area Network
UTTCQ.....	Uniform Threshold TCQ	WATM.....	Wireless ATM
VAD.....	Voice Activity Detector	WBCS.....	Wireless Broadband Communication System
VB.....	Video Buffer	WD.....	Working Draft
VBR.....	Variable Bit Rate	WG.....	Working Group
VC.....	Virtual Connection, Virtual Circuit	WLAN.....	Wireless LAN
VCC.....	Virtual Circuit Connection	WMFTWG...	Wireless Multimedia Forum Technical Working Group
VCIP.....	Visual Communication and Image Processing	WTCQ.....	Wavelet/Trellis Coded Quantization
VCR.....	Video Cassette Recorder	WWW.....	World Wide Web
VCV.....	Vowel-Consonant-Vowel	X3D.....	Extensible 3D
VHS.....	Video Home System	XM.....	eXperimental Model
VLBR.....	Very Low Bit Rate	XML.....	Extensible Markup Language
VLC.....	Variable Length Coding	XMT.....	Extensible MPEG-4 Textual Format
VLD.....	Variable Length Decoder	YUV.....	Luminance Bandwidth-Chrominace
VLSI.....	Very Large-Scale Integration	ZTR.....	Zero Tree Root