Contents

Pr	ix	
1	Digital Video Transport System	1
	1.1 Introduction	1
	1.2 Functions of Video Transport Systems	3
	1.3 Fixed Length Packet vs. Variable Length Packet	8
	1.4 The Packetization Approach and Functionality	11
	The Link Layer Header	12
	The Adaptation Layer	14
	1.5 Buffer, Timing and Synchronization	16
	1.6 Multiplexing Functionality	20
	1.7 Inter-operability, Transcoding and Re-multiplexing	23
	Bibliography	26
2	Digital Video Compression Schemes	29
	2.1 Video Compression Technology	29
	2.2 Basic Terminology and Methods for Data Coding	30
	2.3 Fundamental Compression Algorithms	35
	Run-Length Coding	38
	Huffman Coding	38
	Arithmetic Coding	40
	Predictive Coding	42
	Transform Coding	43
	Subband Coding	48
	Vector Quantization	52
	2.4 Image and Video Compression Standards	55
	JPEG	55
	H.261 and H.263	56
	MPEG-1	57
	MPEG-2	62

	MPEG-4 Rate Control Bibliography	65 69 71
3	Buffer Constraints on Compressed Digital Video	75
	3.1 Video Compression Buffer	75
	3.2 Buffer Constraints for Variable-Rate Channels	77
	Buffer Dynamics Buffer Constraints	78 80
	3.3 Buffer Verification for Channels with Rate-Constraints	83
	Constant-Rate Channel	83
	Leaky-Bucket Channel	84
	3.4 Compression System with Joint Channel and Encoder Rate-Control	87
	System Description	87
	Joint Encoder and Channel Rate Control Operation	88
	Rate Control Algorithms	90
	Encoder Rate Control	90
	MPEG-2 Rate Control MPEG-4 Rate Control	90
	H.261 Rate Control	93 95
	Leaky-Bucket Channel Rate Control	97 97
	Bibliography	98
4	System Clock Recovery for Video Synchronization	101
	4.1 Video Synchronization Techniques	101
	4.2 System Clock Recovery	104
	Requirements on Video System Clock	104
	Analysis of the Decoder PLL	106
	Implementation of a 2 nd -order D-PLL	112
	4.3 Packetization Jitter and Its effect on Decoder Clock Recovery	116
	Time-stamping and Packetization Jitter	116
	Possible Input Process due to PCR Unaware Scheme Solutions for Providing Acceptable Clock Quality	118 126
	Bibliography	130
		130
5	Time-stamping for decoding and presentation	133
	5.1 Video Decoding and Presentation Timestamps	133
	5.2 Computation of MPEG-2 Video PTS and DTS	137
	B-picture Type Disabled, Non-film Mode	137
	B-picture Type Disabled, Film Mode	138
	Single B-picture, Non-Film Mode	141
	Single B-picture, Film Mode	144

Contents vii

	Double B-picture, Non-Film Mode	147		
	Double B-picture, Film Mode	149		
	Time Stamp Errors	151		
	Bibliography	152		
6	Video Buffer Management and MPEG Video Buffer Verifier			
		155		
	6.1. Video Buffer Management	155		
	6.2 Conditions for Preventing Decoder Buffer Underflow and Overflow	157		
	6.3 MPEG-2 Video Buffer Verifier	161		
	6.4. MPEG-4 Video Buffer Verifier	164		
	6.5 Comparison between MPEG-2 VBV and MPEG-4 VBV	169		
	Bibliography	170		
7	Transcoder Buffer Dynamics and Regenerating Timestamps			
		173		
	7.1 Video Transcoder	173		
	7.2 Buffer Analysis of Video Transcoder	177		
	Buffer dynamics of the encoder-decoder only system	178		
	Transcoder with a fixed compression ratio Transcoder with a Variable Compression Ratio	181 184		
	7.3 Regenerating Timestamps in Transcoder	188		
	Bibliography	190		
8	Transport Packet Scheduling and Multiplexing	193		
O	8.1 MPEG-2 Video Transport	193		
	Transport Stream coding structure	193		
	Transport Stream System Target Decoder (T-STD)	194		
	8.2 Synchronization in MPEG-2 by Using STD	197		
	Synchronization Using a Master Stream	198		
	Synchronization in Distributed Playback	199		
	8.3 Transport Packet Scheduling	199		
	8.4 Multiplexing of Compressed Video Streams	203		
	A Model of Multiplexing Systems	205		
	Statistical Multiplexing Algorithm	208		
	Bibliography	210		
9	Examples of Video Transport Multiplexer	213		
	9.1 An MPEG-2 Transport Stream Multiplexer	214		
	Overview of the Program Multiplexer	214		
	Software Process for Generating TS Packets	217		
	Implementation Architecture	221		
	9.2 An MPEG-2 Re-multiplexer	225		
	ReMux System Requirements	226		

Basic Functions of the ReMux	228
Buffer and Synchronization in ReMux	231
Bibliography	234
Appendix A Basics on Digital Video Transmission Systems	237
Index	257