

DSPedia

Standards

DSP Short Course Notes written and developed by:

**Bob Stewart
Daniel García-Alís, Garrey Rice, Iain Stirling,
Graham Freeland, Jamie Bowman**

**E-mail: info@steepestascent.com
<http://www.steepestascent.com>**

**Steepest Ascent Ltd.
Ladywell
94 Duke Street
Glasgow
G4 0UW**

telephone: 0141 552 8855

Contents:

1. GSM Mobile Communications

GSM Cellular System	1.1
GSM Network Overview	1.2
GSM: Frequency Allocation	1.3
GSM Channels	1.4
Traffic and Control Channels	1.5
TCH/FACCH vs SACCH	1.6
GSM Access	1.7
Timeslot Structure	1.8
GSM Physical Layer Principle	1.9
GSM Vocoders	1.10
Full Rate GSM Encoder	1.11
Full Rate GSM Decoder	1.12
Half Rate and Enhanced Full Rate	1.13
Parameter Formatting and re-ordering	1.14
Channel Coding	1.15
Cyclic Coder	1.16
Convolutional Encoder Principle	1.17
Convolutional Encoder (CE) (cont'd)	1.18
CE: Polynomial representation	1.19
CE: State Diagram Representation	1.20
CE: Trellis Diagram	1.21
CE (cont'd)	1.22
Convolutional Encoder (cont'd)	1.23
Interleaving	1.24
Interleaving (cont'd)	1.25
Ciphering	1.26
GSM Bursts:	1.27
Modulation Scheme	1.28
Equaliser	1.29
Equaliser Overview	1.30
Convolutional Decoder	1.31
Viterbi Decoder	1.32
Viterbi Decoding: Hard Decision	1.33
Towards the Next Generation	1.34

2. GSM Speech Coding

Basic Principle	2.1
Basic Principle (2)	2.2
Basic Block Diagram	2.3
Input Speech Signal	2.4
Encoded Bitstream	2.5
Preprocessing	2.6
LPC Analysis	2.7
Quantization of Reflection Coefficients	2.8
Quantization of Reflection Coefficients (2)	2.9
Log Area Ratios (LARs)	2.10

Quantization of the LARs	2.11
Short-Term Analysis Filtering	2.12
Long-Term Prediction (LTP)	2.13
RPE (Regular Pulse Excitation) Encoding	2.14
APCM Quantization of RPE Sequence	2.15
Summary of Transmitted Parameters	2.16
GSM-FR Decoder	2.17
Short-Term Synthesis Filtering	2.18
Post processing	2.19
GSM Enhanced Full Rate Speech Coding	2.20
Basic Principle	2.21
Input Speech Signal	2.22
Encoded Bitstream	2.23
Preprocessing	2.24
LP Analysis	2.25
LP Analysis (Cont'd)	2.26
LP Analysis (Cont'd)	2.27
LP Analysis – Speech Windowing	2.28
LP Analysis – Autocorrelation	2.29
LP Analysis – Lag Windowing	2.30
LP Analysis – Levinson-Durbin	2.31
Line Spectral Frequencies (LSFs)	2.32
LSF Fundamentals	2.33
LSF Fundamentals (Cont'd)	2.34
Calculating the LSFs	2.35
Calculating the LSFs (Cont'd)	2.36
Quantising the LSPs	2.37
LSF Prediction Residuals	2.38
Split Matrix Quantization	2.39
Open-Loop Pitch Analysis	2.40
Open-Loop Pitch Analysis (Cont'd)	2.41
Adaptive Codebook	2.42
Adaptive Codebook (Cont'd)	2.43
Adaptive Codebook (Cont'd)	2.44
Adaptive Codebook (Cont'd)	2.45
Adaptive Codebook Bit Allocation	2.46
Algebraic Codebook	2.47
Algebraic Codebook (Cont'd)	2.48
Algebraic Codebook Search	2.49
Algebraic Codebook Search (Cont'd)	2.50
Algebraic Codebook Search (Cont'd)	2.51
Algebraic Codebook Search (Cont'd)	2.52
Algebraic Codebook Search (Cont'd)	2.53
Algebraic Codebook Search (Cont'd)	2.54
Algebraic Codebook Gain	2.55
Algebraic Codebook Gain – Quantization	2.56
Algebraic Codebook – Bit Allocation	2.57
GSM-EFR Decoder	2.58
GSM-EFR Decoder – Postfilter	2.59
GSM Adaptive Multi Rate Speech Coding	2.60

Contents:

Access slots and PRACH access codes	5.27	Fast User Scheduling	6.4
PRACH: Preamble	5.28	User/Code Scheduling	6.5
PRACH: Message	5.29	Fast Hybrid-ARQ	6.6
Physical Random Access Ch (PRACH)	5.30	N-Channel Stop and Wait	6.7
Acquisition Indicator Channel (AICH)	5.31	HS TrCH/PhyCH Channels	6.8
Paging Procedure	5.32	HS-DSCH Transport Processing	6.9
Paging a Mobile Station	5.33	HS-DSCH Transport Processing	6.10
Paging a Mobile Station (cont.)	5.34	HARQ Processing	6.11
Paging Indicator Channel (PICH)	5.35	HS-SCCH	6.12
Secondary CCPCH (S-CCPCH)	5.36	HS-SCCH Timing and Structure	6.13
Phy. Common Packet Chan (PCPCH)	5.37	HS-DPCCH	6.14
PCPCH Procedure, preamble	5.38	Terminal Categories	6.15
PCPCH Preamble, collision detection	5.39	LTE: Long Term Evolution	6.16
PCPCH message	5.40	LTE peak data rate and latency	6.17
Physical Downlink Shared Ch. (PDSCH)	5.41	LTE throughput and spectral efficiency	6.18
Uplink (UL) Dedicated Physical Channels	5.42	LTE mobility and coverage	6.19
Uplink Spreading	5.43	LTE spectrum flexibility	6.20
Uplink Spreading: One DPDCH	5.44		
Uplink Spreading: Multiple DPDCHs	5.45		
UL Multiple DPDCHs: Code Allocation	5.46		
Downlink Dedicated Physical Channel	5.47		
Downlink DPCH Spreading	5.48		
DL BS Example: no. of Channels	5.49		
DL BS Test Model Example: Spreading	5.50		
Downlink Spreading	5.51		
DL Scrambling Code Generation	5.52		
DL Scrambling Code Organisation	5.53		
DL Scrambling Code Numbering	5.54		
DL Scrambling Code Numbering (cont'd)	5.55		
DL Scrambling Code Numbering (cont'd)	5.56		
DL Channelisation Codes	5.57		
UL Scrambling Code Generation	5.58		
UL Spreading: HPSK Modulation	5.59		
HPSK: Increasing Battery Life	5.60		
HPSK: Desired Signal Attributes	5.61		
HPSK: PAR and QPSK Constellation	5.62		
HPSK: Reducing the PAR	5.63		
HPSK Modulation Structure	5.64		
Real vs. Complex Scrambling	5.65		
HPSK: Codes	5.66		
HPSK: Resulting Constellation	5.67		
HPSK Modulator	5.68		
HPSK and Multiple DPDCHs	5.69		

6. 3G Evolution

UMTS Release 5: HSDPA	6.1
HSDPA Architecture	6.2
Efficiency through Adaptation	6.3

7. Digital Audio Broadcasting (DAB)

Introduction	7.1
Features	7.2
Multiplexes	7.3
Multiplex Capacity	7.4
Multiplex Re-Configuration	7.5
Single Frequency Networks	7.6
Encoding Mechanisms	7.7
Convolutional Coding	7.8
Transmission Modes	7.9
Transmission Frame	7.10
DAB Transmission Signal	7.11
Synchronisation Channel	7.12
Block Partitioner I	7.13
Block Partitioner II	7.14
QPSK Symbol Mapper	7.15
Frequency Interleaving	7.16
Differential Modulation	7.17
Multiplexor	7.18
OFDM Symbol Generator	7.19
Spectrum Mask	7.20
DAB-2	7.21

8. Digital Video Broadcasting (DVB)

Introduction	8.1
DVB Standards	8.2

Contents:

Standards I	8.3	Data Frames	9.32
Standards II	8.4	Data frame addressing example	9.33
Standards III	8.5	Data Frame Body: MPDU	9.34
Multiplexes	8.6	The Physical Layer	9.35
UK Multiplexes	8.7	PHY protocols	9.36
UK Multiplexes	8.8	Service Access Points (SAPs)	9.37
Frequency Planning	8.9	Management Entities	9.38
UK Digital Switch Over	8.10	The IR PHY	9.39
Digital Switch Over	8.11	Frequency Hopped SS PHY	9.40
DVB-H	8.12	Direct Sequence SS PHY	9.41
PHY and DLL	8.13	The FHSS PLCP	9.42
DVB-H Time Slicing	8.14	PSDU Structure	9.43
DVB-H Data Burst	8.15	PSDU Structure II	9.44
DVB-H Transmission	8.16	The DSSS PPDU	9.45
Mobile Video on Demand	8.17	The DSSS PPDU II	9.46
		Modulation Format	9.47
		DSSS Spectrum	9.48
		Transmitter structure	9.49
		Differential Phase Shift Keying	9.50
		Spreading	9.51
		Spreading II	9.52
		Modulation	9.53
		Spectral Mask	9.54
		IEEE Std. 802.11a	9.55
		Subcarrier Arrangement	9.56
		Modulation formats	9.57
		OFDM PHY	9.58
		Training Sequences	9.59
		further PPDU fields	9.60
		further PPDU fields II	9.61
		DATA field processing	9.62
		Convolutional Encoder	9.63
		Interleaving	9.64
		Symbol Mapping	9.65
		OFDM Modulation	9.66
		Frequency allocations	9.67
		Spectral Mask	9.68
		IEEE Std. 802.11b	9.69
		CCK Modulation	9.70
		CCK Modulation II	9.71
		CCK Modulation III	9.72
		CCK Modulation IV	9.73
		CCK Modulation V	9.74
		The HR/DSSS/short PHY	9.75
		PBCC Modulation	9.76
		PBCC Convolutional Encoder	9.77
		PBCC Cover Code	9.78
		PBCC Constellations	9.79
		IEEE Std. 802.11g	9.80
		ERP-DSSS/CCK PHY	9.81
9. 802.11			
Contents	9.1		
What is 802.11?	9.2		
IEEE 802.11 Working Group	9.3		
802.11 Working Group structure	9.4		
802.11 Working Group structure II	9.5		
Other Task Groups: The Amendments	9.6		
Amendments and standard releases	9.7		
Amendments	9.8		
Amendments II	9.9		
Amendments III	9.10		
Future Amendments	9.11		
Future Amendments II	9.12		
The 802.11 Standard - Clauses	9.13		
Wireless networks	9.14		
The IEEE 802.11 Architecture	9.15		
Independent BSSs	9.16		
The Distribution System (DS)	9.17		
The Extended Service Set (ESS)	9.18		
Logical Services	9.19		
Distribution	9.20		
The MSDU	9.21		
The MPDU	9.22		
MPDU Structure	9.23		
MPDU Structure in Detail	9.24		
Frame Control Field	9.25		
Frame Control Field II	9.26		
Other Frame Header fields	9.27		
Control Frames	9.28		
Control Frames II	9.29		
Management Frames	9.30		
Management Frame Control field	9.31		

Contents:

The ERP-OFDM PHY	9.82	Permutation modes	10.41
Channel Overlap	9.83	PUSC OFDMA symbol	10.42
The ERP-PBCC PHY	9.84	PUSC subcarrier allocation	10.43
ERP-PBCC 22Mbit/s	9.85	PUSC group allocation	10.44
ERP-PBCC 33Mbit/s	9.86	Subchannel subcarrier allocation	10.45
The DSSS-OFDM PHY	9.87	Example subchannelisation for a group	10.46

10. 802.16

Contents	10.1	FUSC OFDMA symbol	10.47
What is 802.16?	10.2	FUSC pilot allocation	10.48
IEEE 802.16 Structure	10.3	FUSC subchannelisation	10.49
IEEE 802.16 Task Groups	10.4	Adjacent subcarrier permutation	10.50
IEEE 802.16 Air Interface Task Groups	10.5	Adjacent subcarrier subchannels	10.51
IEEE 802.16 Conformance Task Group	10.6	A quick recap	10.52
IEEE 802.16 Coexistence Task Group	10.7	OFDMA frame structure	10.53
IEEE Std. 802.16-2001 overview	10.8	Downlink bursts	10.54
IEEE Std. 802.16a overview	10.9	OFDMA frame detail	10.55
IEEE Std. 802.16c overview	10.10	PUSC segmentation	10.56
IEEE Std. 802.16-2004 overview	10.11	Subchannel renumbering	10.57
Further 802.16 Task Groups	10.12	Downlink preamble	10.58
Further 802.16 Task Groups II	10.13	Frame Control Header (FCH)	10.59
What is WiMAX?	10.14	Downlink map information	10.60
IEEE Std. 802.16-2004	10.15	Uplink map information	10.61
WirelessHUMAN	10.16	802.16e	10.62
WirelessHUMAN spectrum	10.17	the 802.16e standard	10.63
The WirelessMAN-SC PHY	10.18	Mobile WiMAX	10.64
WirelessMAN-SC Framing	10.19	802.16 technology overview	10.65
WirelessMAN-SC Multiple Access	10.20	802.16e PHY changes: SC and SCa	10.66
WirelessMAN-SC MAP messages	10.21	802.16e PHY changes: OFDM	10.67
WirelessMAN-SC Downlink	10.22	802.16e PHY changes: OFDMA	10.68
WirelessMAN-SC Preambles	10.23	more 802.16e PHY changes: OFDMA	10.69
WirelessMAN-SC PHY processing	10.24	802.16e summary	10.70
WirelessMAN-SC rates	10.25	802.16e summary continued	10.71
WirelessMAN-SCa	10.26		
WirelessMAN-SCa rates	10.27		
WirelessMAN-OFDM	10.28		
WirelessMAN-OFDM rates	10.29		
WirelessMAN-OFDMA	10.30		
WirelessMAN-OFDMA features	10.31		
OFDMA symbol construction	10.32		
OFDMA subcarriers	10.33		
Subchannel and symbol numbers	10.34		
Subchannel physical mapping	10.35		
OFDMA Slots	10.36		
OFDMA slot examples	10.37		
Data Regions	10.38		
Segments	10.39		
Permutation zone	10.40		

11. 802.20: MBWA

Introduction	11.1
Existing IEEE 802 Wireless Groups	11.2
802.20 PAR Scope	11.3
802.20 (MBWA) I	11.4
802.20 (MBWA) II	11.5
802.20: Five Criteria	11.6
802.20 Uniqueness?	11.7
Comments from 802.16 Group on 802.20	11.8
802.20 Response: 802.20 vs. 3G I	11.9
802.20 Response: 802.20 vs. 3G II	11.10
802.20 Response: Beyond IMT-2000	11.11
802.20 Response: 802.20 vs. HSDPA	11.12
802.20 Response: 802.20 vs 802.16e	11.13
802.20, 802.16 & 3G: Summary I	11.14
802.20, 802.16 & 3G: Summary II	11.15

Contents:

802.20 DRAFT standard	11.16
802.20: Modes of Operation	11.17
802.20 Encoding & Modulation	11.18
FL FDD Frames and Superframes	11.19
FL TDD Frames and Superframes	11.20
RL FDD Frames and Superframes	11.21
FL TDD Frames and Superframes	11.22
OFDM Symbols	11.23
Guard subcarriers	11.24
OFDM symbol duration	11.25
Time Domain Processing	11.26
Windowing	11.27
Overlapping	11.28

12. 802.21

Introduction	12.1
802.21: Scope	12.2
802.21: Purpose	12.3
802.21: Areas Covered	12.4
802.21 Architecture	12.5
MIH Function I	12.6
MIH Function II	12.7
MIH Function: Design Principles	12.8
MIH Function: Location & Services	12.9
Media Independent Services I	12.10
Media Independent Services II	12.11
Media Independent Services III	12.12
802.21: Assumptions	12.13
General Design Principles	12.14