Appendixes

Appendix A. Basic Parameters of the DAB+ System

The carrier frequency of the transmitter is in Europe within technically reasonable ranges

$$\mathbf{174} - \mathbf{240\ MHz}(\text{III VHF band})$$

with possibility of tuning every 16 kHz.

In the digital DAB or DAB+ system, the basic frequency units are blocks of size 1,536 MHz. The gross bit throughput of each block is 2309 kbit/s.

The main carrier of programs and information is the main service channel, MSC. The information in the Fast Information Channel (FIC), introduced in the transmitter simultaneously with the main channel programs, at the receiver are decoded about 384 milliseconds in advance. This is due to omission in the FIC channel of the frame time interleaving, which delays the transmission process. Adoption of constant efficiency 1/3 of convolutional encoder in this channel also accelerates the decoding. Faster transmission in FIC channel is required to forward parameters of the frame structure to the receiver to determine options of its operating system responsible for signal deconvolution and frame subchannel reconstruction.

Basic parameters of the output frame are presented in Table A.1.

M. Oziewicz, *Digital Radio DAB+*, https://doi.org/10.1007/978-3-030-66478-7

Table A.1 Mode of the DAB transmitter

Parameter	Mode I
Sampling frequency	48 kHz
Frame TF	96 ms
OFDM frame gross capacity	236 544 bits
The number of symbols in OFDM frame	77
Null symbol T_0	1.297 ms
Useful symbol T_U	1 ms
Guard interval T_g	0.246 ms
Full symbol T_s	1.246 ms
Number of subcarriers	1536
Intercarrier frequency	1 kHz

Appendix B. Grouping of Convolutional Code in Channels FIC and MSC

General convolutional encoding scheme in DAB system in the individual channels is used with different perforations indices (PI).

In the audio frames, systems of codes with different perforation indices in individual fields of frames are applied.

A. Encoding Words in the Fast Information Channel (FIC)

The words outgoing the energy dispersion scrambler – prior to OFDM encoder – have a length of 768 bits (mode I). After convolutional encoder with fourfold longer mother code, the words are converted to the corresponding scheme:

$$(768 + 768 + 768 + 768 + 24 \text{ bits of the tail}),$$

and then divided into blocks:

$$(6 \cdot 128 + 6 \cdot 128 + 6 \cdot 128 + 6 \cdot 128 + 24 \text{ bits of the tail}),$$

and the sub-blocks (puncturing vectors) of 32 bits:

$$(24 \cdot 32 + 24 \cdot 32 + 24 \cdot 32 + 24 \cdot 32 + 24 \text{ bits of the tail})$$

In the Fast Information Channel (FIC), the puncturing indexes scheme in the blocks is constant with puncturing indexes PI=16, PI=15, and PI=8 for 24 bits of the tail.

The puncturing index PI = 16 is applied to first 84 puncturing vectors and index PI = 15 to the remaining 12. To the tail, the index PI = 8 is applied. This gives the total output codeword of length

$$84 \cdot 32 \cdot [(8 + 16)/32] + 12 \cdot 32 \cdot [(8 + 15)/32] + 24 \cdot [(8 + 8)/32] = 2304 \text{ bity} = 3 \cdot 768 \text{ bits}$$

The code rate is therefore

$$768/(3 \cdot 768) = 1/3$$

This gives a constant code rate of third. Each frame with capacity of 256 bits because of convolutional coding is increased to 768 bits.

B. **Encoding of the Applications in the Main Service Channel**

In the MSC channel, where the encoder efficiency for different applications may be different, the flexibility of the encoder is increased by introducing the systems of puncturing indices.

The throughput of services in subchannels of main service channel is a multiple of 8 kbit/s (corresponding to multiple of 3 units CU per logical DAB frame).

In the subchannel of throughput n·(8 kbit/s), the services are transmitted in 24-milisecond logical fields in DAB frames, each of capacity n·3CU. These fields are elements of the encoder input.

At the output of the mother encoder, one respectively gets fields of capacity 4n·3CU, next divided in 6n blocks of 128 bits and 24 bits of tail.

Division of 6n blocks of 128 bits into groups of L_i sub-blocks with fixed puncturing indices means that

$$\sum\nolimits_i L_i = 6n \qquad (/a/)$$

Choosing in each group L_i puncturing index PI_i ($0 < PI_i < 25$) constant in the four 32-bit puncturing vectors, and in the 'tail' taking PI = 8, one can set up a condition that the encoder output frames have capacity equal to multiple of the units CU (64 bits):

$$\sum 4 \cdot 32 \cdot L_i \cdot [(8 + PI_i)/32] + 12 = 64\ K \qquad (/b'/)$$

Each input frame of encoder has 3n·CU bits, so for the output frame we have

$$K \cdot (CU) = n \cdot (3CU) + k \cdot (CU),$$

where k is the number of redundant 64-bit units CU. Hence from (b')

$$\sum L_i(8 + PI_i) + 3 = 16 \cdot (3n + k)$$

or

$$\sum L_i \, PI_i + 3 = 16 \cdot k \qquad (/b/)$$

and code rate

$$C = 3n/K = 3n/(3n + k) \qquad (/c/)$$

Assuming in /b/ maximum value of the puncturing index PI = 24 for all "i", we obtain for the range of k the value

$$1 <= k <= 9n \qquad (/c1/)$$

Since the numbers "n" and "k" are integers, condition /c1/ limits acceptable efficiency of C code to the ¾, 3/5, ½, 3/7, 3/8, 1/3, 3/10, 3/11, and ¼.

For a fixed subchannel throughput, several divisions for blocks of puncturing indices satisfying the conditions /a/ and /b'/ can be selected. They will ensure the code rates of the formula /c/. In order to parameterize selected divisions of blocks and puncturing indexes, the concepts of the protection profile and the protection level were introduced:

Protection profile: a fixed set of puncturing indexes $\mathbf{PI_1,...,PI_k}$ for division $\mathbf{L_1,...,L_k}$
Protection level: equivalent of code rate defined for a given throughput by selection of the protection profile

Suitable relations represent a chain:

signal throughput → frame capacity → number of sub-blocks of mother code →
→ division (L_1, ..., L_4) →protection profile (PI_1, ..., PI_4) →protection level

Protection levels from 1 (most secure) to 5 (least protection) correspond approximately to the code rates of 1/3, 3/7, ½, 3/5, and ¾. For different bit rates, these values may vary slightly.

Information about current coding parameters $\{L_i, Pi_{pi}\}$ of application are transmitted to the decoder in the receiver in a parameterized form of the protection level. For a given throughput of a subchannel, a protection level uniquely determines the puncturing parameters through specified Table [1].

For services transmitted in stream or packet mode in order to fulfill the conditions /a–c/, it is enough to split mother code into two groups of blocks (to take k = 2). For applications with a throughput of 8n kbit/s and protection profile $\{PI_1, PI_2\}$, the conditions on parameters take the form

$$L_1 + L_2 = 6n \qquad (/a1/)$$

$$L_1 PI_1 + L_{2\,PI2} + 3 = 16k \qquad (/b1/)$$

$$C = 3n/(3n + k) \qquad (/c1/)$$

As mentioned above – not for each C – the condition /c1/can be satisfied.

Table B.3 Protection levels (type A) of multimedia services of bitrate 8n kbit/sec

Protection level	**1A**	**2A**	**3A**	**4A**
Code rate C	**1/4**	**3/8**	**1/2**	**¾**
Division $\{L_1, L_2\}$	**{6n-3,3}**	**{2n-3,4n+3}**	**{6n-3,3}**	**{4n-3,2n+3}**
Protection profile $\{PI_1, PI_2\}$	**{24, 23}**	**{14, 13}**	**{8, 7}**	**{3, 2}**
Inner frame capacity of audio encoder	**3nCU**	**3nCU**	**3nCU**	**3nCU**
Outer frame capacity of audio encoder	**12nCU**	**8nCU**	**6nCU**	**4nCU**

Table B.4 Protection levels (type B) of multimedia services of bitrate 8n kbit/sec

Protection level	**1B**	**2B**	**3B**	**4B**
Code rate C	**4/9**	**4/7**	**4/6**	**4/5**
Division $\{L_1, L_2\}$	**{24n-3,3}**	**{24n-3,3}**	**{24n-3,3}**	**{24n-3,3}**
Protection profile $\{PI_1, PI_2\}$	**{10, 9}**	**{6, 5}**	**{4, 3}**	**{2, 1}**
Inner frame capacity of audio encoder	**12nCU**	**12nCU**	**12nCU**	**12nCU**
Outer frame capacity of audio encoder	**27nCU**	**21nCU**	**18nCU**	**15nCU**

Assuming four protection levels for equivalent code rate C equal to ¼, 3/8, ½, and ¾, one selects appropriate protection profiles from /a1 to c1/. This task is ambiguous. The standard of the system adopted the values referred to as Type A [1] (Table B.3).

For multimedia services of bit rate equal to multiple of 32 kbit/s, or n = 4n', conditions /a–c/ can be solved for code rate 4/9, 4/7, 2/3, and 4/5. Thus, obtained additional levels of protection are referred to as type B [1] (Table B.4).

The protection level is presented in the form of a 2-bit number:

00 – level 1A (1B) (top)
01 – level 2A (2B)
10 – level 3A (3B)
11 – level 4A (4B) (lowest)

Selection of convolutional encoder parameters is the result of a compromise between:

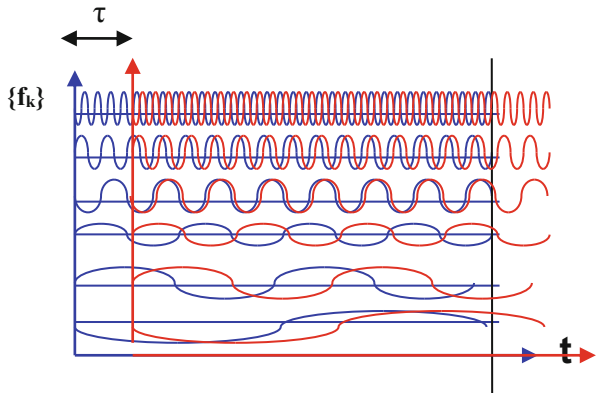
- Encoder efficiency determined by the expected maximum error rate of transmission
- Increase of channel throughput because of redundant bits of code
- Range of time delay fluctuations contributed by the encoder

Encoding and puncturing parameters of the signal are determined by the multiplexer operator. The multiplexer operator sets the protection level for individual programs and services based on the requirements of the services operator and information on propagation conditions from the DAB network operator. Initially established average values can be assumed for the program of encoding.

Convolutional encoding increases the demanded bit rate of application. The usable throughput of the DAB system is thus limited.

Appendix C. Preliminaries on the Phasor Model of the Multipath OFDM Signal

Information carried in the OFDM signal is included in phasors of subcarriers of the OFDM symbols. Signal path delayed by τ deforms the phasors of the first path – adopted as reference – and the information transmitted by the system. This modification of information following the estimated parameters of phasors can be obtained from the phasor model.



In order to pass from sinusoidal to phasor model, the phase differences between the first and delayed by τ paths on different subcarriers are calculated:

(a) The phase difference between the first and delayed paths on subcarrier of frequency $f_k = k/T_U$

$$2\pi \cdot f_k \cdot \tau = k \cdot 2\pi \cdot (\tau/Tu)$$

(b) The phase difference between *subsequent subcarriers* of delayed path: k and (k - 1). In OFDM, the intertone frequency separation is equal 1/Tu, so

$$\Delta\varphi_k = 2\pi \cdot f_k \cdot \tau - 2\pi \cdot f_{(k-1)} \cdot \tau = 2\pi \cdot (\tau/Tu) = \Delta\varphi$$

This phase difference does not depend on subcarrier number.

(c) Number $k_{2\pi}$ of subchannels within full 2π turn of phasors in delayed path

$$k_{2\pi} = 2\pi/\Delta\varphi = Tu/\tau$$

(d) Frequency separation between points of full turn (in OFDM the intertone frequency separation is equal 1/Tu)

$$\Delta f = k_{2\pi} \cdot (1/Tu) = 1/\tau$$

(e) Number of full phasor turns within frequency block B

$$n = B/\Delta f = \tau \cdot B$$

The graphical presentation of phasor model is presented in Figs. 3.2, 3.3, and 3.4.

1. M. Oziewicz, 'Phasor Description of the COFDM Signal in a Multipath Channel; 6th International OFDM-Workshop (InOWo'01), Hamburg, 2001
2. M. Oziewicz, 'Phasor Description of the OFDM Signal in the SFN Network', IEEE Transactions on Broadcasting, vol. 50, no 1, pp. 63-70, March 2004

Appendix D. Transport of the Conditional Access Parameters in the DAB System

The access control is based on the following conditional statements:

- Is the program component or service a subject to limited access?
- What entitlements are necessary to gain access to its reception?
- Where are the control word parameters placed to run the PRBS generator in order to descramble data?

Since the initialization modifier IM in the control word depends on the current parameters of transmission, it is different for different types of transmission and hence different locations for the various components of audio and services in the stream transport mode, packet mode in MSC channel, and packet transport in FIC channel.

A. **Signal Audio in the Main Service Channel (MSC)**

Initialization modifier (IM) consists of three parts:

(a) The identifier of the MSC subchannel (Subsid), wherein the audio signal is transmitted. Subchannel identifier of the service is in the group FIG(0/4).
(b) Two complementary zero bits.
(c) The Logical Frame Counter (LFC) modulo 250 frames of FIG(0/0).

Other information of a CA system parameters is included in the Service Component Conditional Access frame (SCCA), which is also located in the FIG(0/4).

The SCCA frame contains the following information:

- What type of control word is used (CW fixed or variable)
- Whether the entitlement to conditional access has been changed (information every 32 frames)
- Whether the transmission mode of the Entitlement Control Message frame (ECM) has been changed
- The following scrambling mode
- Identifier of the frame with Entitlement Control Message (ECM) and Entitlement Management Message (EMM)
- Transport flags with information about the mode of transmission of entitlement frames of the service or its changes

Transport flags and ECM/EMM frame identifier allow for the unequivocal identification of ECM or EMM frame positioning for each component of the program or services.

ECM frame in the field of message identifier contains a 6-bit type of crypto algorithm used to encrypt the control word CW and phase of the word (bit switched along with the change of CW). Cryptogram of CW and entitlement parameters for service reception are loaded in the data field of ECM frame. The detailed organization of this field depends on the conditional access system. It is specified by the identifier CAId of the conditional access in FIG(0/2).

The EMM frame contains a flag of address type (individual or group and which), specific individual or group address of eligible customers, the type of crypto algorithm applied for the data field encryption, and in the data field the parameters of introduced or amended entitlements to receive certain services. The organization of this field is defined by the conditional access system described by the CAId.

B. **Services in Stream Mode in the Main Service Channel (MSC)**

The Initialization Word (IW) is built like in a point A. Information about the service subchannel and a SCCA frame of conditional access of component service is in FIG(0/4).

Acceptable transport flags of ECM/EMM frames determine their respective location.

Transport flags and identifier allow for the unequivocal positioning of ECM or EMM frames.

C. **Services in the Fast Information Channel (FIC)**

C1. Services scrambled before the division on the FIG 5 frames

Initialization modifier (IM) creates a 6-bit field filled with zeros and the 10-bit word of initialization modifier (IMW). The IMW word is transported in conditional access parameter FIDCCA or its extension FIDCCA_Ext (extension contains field of additional flags of transport and identification of frames ECM or EMM) of services in Fast Information Channel.

FIDCCA parameter is transported in a FIG 5 frame.

Acceptable flag transport frames ECM/EMM, respectively, define the position of its frames.

C2. Scrambling the FIG 5 frames, onto which the service is divided

Acceptable transport flags of ECM/EMM frames define respectively its positions

D. **Services in Packet Mode in MSC**

D1. Services scrambled after division onto Data Groups (DG)
The flags of transport of ECM/EMM frames define the specific variants
D2. Scrambling the packets, onto which the service is divided
Additional information about the service components transmitted in a packet mode are in the FIG (0/3), in the field of Service Component Conditional Access (SCCA).
Acceptable flags of transport of ECM/EMM frames define the specific variants.

Appendix E. DAB Carrier Frequencies in Blocks in the VHF Band III

Block DAB	Carrier frequency MHz
5A	174.928
5B	176.640
5C	178.352
5D	180.064
6A	181.936
6B	183.648
6C	185.360
6D	187.072
7A	188.928
7B	190.640
7C	192.352
7D	194.064
8A	195.936
8B	197.648
8C	199.360
8D	201.072
9A	202.928
9B	204.640
9C	206.352
9D	208.064
10A	209.936
10B	211.648
10C	213.360
10D	215.072
11A	216.928
11B	218.640
11C	220.352
11D	222.064
12A	223.936
12B	225.648

(continued)

Block DAB	Carrier frequency MHz
12C	227.360
12D	229.072
13A	230.748
13B	232.496
13C	234.208
13D	235.776
13A	237.448
13B	239.200

Norms and Specifications

DAB in the light of international standards and technical projects of JTC, EBU, ETSI, CENELEC, ACTS, and MEMO and specifications used in those acts.

Below the dates of publication and versions are omitted because actual are the last versions.

1. ETSI EN 300 401 “Radio broadcast systems: Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers”
2. ETSI EN 300 751 “Radio Broadcasting System; Data Radio Channel (DARC); System for Wireless Infotainment Forwarding and Teledistribution”
3. ETSI EN 300 797 “Digital Audio Broadcasting (DAB); Distribution interfaces; Service Transport Interface (STI)”
4. ETSI EN 300 798 “Digital Audio Broadcasting (DAB); Distribution interfaces; Digital baseband In-phase and Quadrature (DIQ) interface”
5. ETSI TS 300 799 “Digital Audio Broadcasting (DAB); Distribution interfaces; Ensemble Transport Interface (ETI)”
6. ETSI EN 301 234 "Digital Audio Broadcasting (DAB); Multimedia Object Transfer (MOT) protocol”
7. ETSI EN 301 700 “VHF/ FM Broadcasting; cross-referencing to simulcast DAB services by RDS-ODA 147”
8. EN 50 094 “Access control system for the MAC/packet family: EUROCRYPT”
9. EN 50 255 “Digital Audio Broadcasting system – preliminary specification of the receiver data interface (RDI)”
10. ITU-R Recommendation BS 1194 “Data Radio Channel (DARC)”
11. ITU-T Recommendation X.24 “List of definitions for interchange circuits between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) on public data networks”
12. ITU-T Recommendation G.703 “Physical/electrical characteristics of hierarchical digital interfaces: Section 6. Interface at 2 048 kbit/sec”

M. Oziewicz, *Digital Radio DAB+*, https://doi.org/10.1007/978-3-030-66478-7

13. ITU-T Recommendation G.704 “Synchronous frame structures used at primary and secondary hierarchical levels: Section 2.3. Basic frame structure at 2 048 kbit/sec”
14. ITU-T Recommendation G.706 “Frame alignment and cyclic redundancy check (CRC) procedures relating to basic frame structures in Recommendation G.704”
15. ITU-T Recommendation H.221 “Frame structure for a 64 to 1920 kbit/sec channel in audiovisual teleservices”
16. ITU-T Recommendation H.242 “System for establishing communication between audiovisual terminals using digital channels up to 2 Mbit/s”
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21. EBU B/TPEG Project: BPN 027-1 “TPEG specification – Part 1: Introduction, Numbering and Versions TPEG-INV/004”
22. EBU B/TPEG Project BPN 027-2 “TPEG specifications – Part 2: Syntax, Semantics and Framing Structure TPEG-SSF_1.2/002”
23. ETSI ES 201 735 “Digital Audio Broadcasting (DAB); Internet Protocol (IP) datagram tunnelling”
24. ETSI ES 201 736 “Digital Audio Broadcasting (DAB); Network Independent Protocols for Interactive Services”
25. ETSI ES 201 737 “Interaction channel through Global System for Mobile communications (GSM), the Public Switched Telecommunications System (PSTN), Integrated Services Digital Network (ISDN) and Digital Enhanced Cordless Telecommunications (DECT)”
26. ETSI TS 101 428 v1.2.1 “Digital Audio Broadcasting (DAB); DMB video service; User Application Specification”
27. ETSI TR 101 495 “Digital Audio Broadcasting (DAB); Guide to DAB standards; Guidelines and Bibliography”
28. ETSI TR 101 496-1 “Digital Audio Broadcasting (DAB); Guides and rules for implementation and operation; Part 1: System outline”
29. ETSI TR 101 496-2 “Digital Audio Broadcasting (DAB); Guides and rules for implementation and operation; Part 2: System features”
30. ETSI TR 101 496-3 “Digital Audio Broadcasting (DAB); Guides and rules for implementation and operation; Part 3: Broadcast network”
31. ETSI TR 101 497 “Digital Audio Broadcasting (DAB); Rules of Operation for the Multimedia Object Transfer Protocol”
32. ETSI TS 101 498-1 “Digital Audio Broadcasting (DAB); Broadcast website; Part 1: User application specification”
33. ETSI TS 101 498-2 “Digital Audio Broadcasting (DAB); Broadcast website; Part 2: Basic profile specification”

34. ETSI TS 101 498-3 “Digital Audio Broadcasting (DAB); Broadcast website; Part 3: TopNews basic profile specification”
35. ETSI TS 101 499 “Digital Audio Broadcasting (DAB); MOT Slide Show; User Application Specification”
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42. ETSI TS 101 759 “Digital Audio Broadcasting (DAB); Data Broadcasting – Transpa-rent Data Channel”
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44. ETSI TS 101 993 “Digital Audio Broadcasting (DAB); A Virtual Machine for DAB; DAB Java Specification”
45. ETSI TS 102 182 “Emergency Communications (EMTEL); Requirements for communications from authorities/organizations to individuals, groups or the general public during emergencies”
46. ETSI TS 102 367 "Digital Audio Broadcasting (DAB); Conditional access”
47. ETSI TS 102 368 “Digital Audio Broadcasting (DAB); DAB-TMC (Traffic Message Channel”
48. ETSI TS 102 371 V1.3.1,"Digital Audio Broadcasting (DAB); Digital Radio Mondiale (DRM); Transportation and Binary Encoding Specification for Electronic Programme Guide (EPG)”
49. ETSI TS 102 427 “Digital Audio Broadcasting (DAB); Data Broadcasting – MPEG-2 TS streaming”
50. ETSI TS 102 428 “Digital Audio Broadcasting (DAB); DMB video service; User application specification”
51. ETSI TS 102 563” Digital Audio Broadcasting (DAB); Transport of Advanced Audio Coding (AAC) audio”
52. ETSI TS 102 632 “Digital Audio Broadcasting (DAB); Voice Applications"
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54. ETSI TS 102 693 “Digital Audio Broadcasting (DAB); Encapsulation of DAB Interfaces”, (EDI)

55. ETSI TS 102 818,"Digital Audio Broadcasting (DAB); Digital Radio Mondiale (DRM); XML Specification for DAB Electronic Programme Guide (EPG)"
56. ETSI TS 102 978 "Digital Audio Broadcasting (DAB); IPDC Services; Transport specification"
57. ETSI TS 102 979 "Digital Audio Broadcasting (DAB); Journaline; User application specification"
58. ETSI TS 102 980 "Digital Audio Broadcasting (DAB); Dynamic Label Plus (DL Plus); Application specification"
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60. ETSI TS 103 461 "Digital Audio Broadcasting (DAB); Domestic and in-vehicle digital radio receivers; Minimum requirements and Test specifications for technologies and products"
61. ETSI TS 103 466 "Digital Audio Broadcasting (DAB); DAB audio coding (MPEG LAYER II)"
62. IETF RFC 1945 "Hypertext Transfer Protocol – HTTP/1.0"
63. IETF RFC 2068 "Hypertext Transfer Protocol – HTTP/1.1"
64. IETF RFC 1738 "Uniform Resource Locator (URL)"
65. IETF RFC 2045 "Multipurpose Internet Mail Extensions (MIME) – Part 1"
66. IETF RFC 2046 "Multipurpose Internet Mail Extensions (MIME) – Part 2"
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83. AC034 and AC054 OnTheMove and MEMO “Using DAB as a Testbed for a Mobile Middleware System”
84. AC054 MEMO Multimedia for Mobiles “Implementation Guidelines for Multimedia Broadcast”
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93. MEMO Specifications Version 1.1.

    Protocol Specifications:
    PS1. Broadcast Network Submission Protocol
    PS2. Mobility Management Protocol
    PS3. Extended TCP
    PS4. Access Control Protocol
    System Function Specifications:
    SFS1. Personal Service Routing
    SFS2. Personal Service Transport
    SFS3. Interactive Broadcast
    SFS4. Mobility Management
    SFS5. Security
    API Specifications
    AS1. Mobile Terminal API
    AS2-1. Correspondent Node API (Low Level)
    AS2-2. Correspondent Node API (High Level)
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    SRD1. MEMO System Reference Model
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95. ERTICO Committee on DAB-based Multimedia ITS Applications “DAB-based Multimedia ITS Applications. ERTICO strategy for implementation”
96. European Commission Brussels, COM (97)623 “Green Paper on the Convergence of the Telecommunications, Media and Information Technology Sectors, and the Implications for Regulation. Towards an Information Society Approach”
97. Federal Ministry of Economics and Technology ‘Introduction of digital broadcasting in Germany: “Launch Scenario 2000”. Status report and recommendations by the “Digital Broadcasting” Initiative on the digitisation of radio and television taking account of the cable, satellite, and terrestrial paths
98. ETSI ES 201 980 "Digital Radio Mondiale (DRM); System specification"

ETSI 300 744 "Digital Video Broadcasting (DVB): Framing structure, channel coding and modulation for digital terrestrial television"

Index

M. Oziewicz, *Digital Radio DAB+*, https://doi.org/10.1007/978-3-030-66478-7