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Digital Audio Broadcasting (DAB); Guidelines and rules for implementation and operation; Part 2: System features

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Contents

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Foreword

This Technical Report (TR) has been produced by Joint Technical Committee (JTC) Broadcast of the European Broadcasting Union (EBU), Comité Européen de Normalisation ELECtrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI).

NOTE 1: The EBU/ETSI JTC Broadcast was established in 1990 to co-ordinate the drafting of standards in the specific field of broadcasting and related fields. Since 1995 the JTC Broadcast became a tripartite body by including in the Memorandum of Understanding also CENELEC, which is responsible for the standardization of radio and television receivers. The EBU is a professional association of broadcasting organizations whose work includes the co-ordination of its members' activities in the technical, legal, programme-making and programme-exchange domains. The EBU has active members in about 60 countries in the European broadcasting area; its headquarters is in Geneva.

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The Eureka Project 147 was established in 1987, with funding from the European Commission, to develop a system for the broadcasting of audio and data to fixed, portable or mobile receivers. Their work resulted in the publication of European Standard, EN 300 401 [1], for DAB (see note 2) which now has worldwide acceptance. The members of the Eureka Project 147 are drawn from broadcasting organizations and telecommunication providers together with companies from the professional and consumer electronics industry.

NOTE 2: DAB is a registered trademark owned by one of the Eureka Project 147 partners.

The present document is part 2 of a multi-part deliverable covering Guidelines and rules for implementation and operation for Digital Audio Broadcasting (DAB), as identified below:

Part 1: "System outline";

Part 2: "System features";

Part 3: "Broadcast network".

1 Scope

The present document is Part 2 of the Guidelines and Rules of Implementation and Operation for the Digital Audio Broadcasting (DAB) system. It gives a detailed description of the system features which have been introduced in TR 101 496-1 [13]. The guidelines have been developed by the Eureka Project 147 as the major companion document to the DAB system specification given in EN 300 401 [1]. They are intended to provide additional information to aid interpretation of the on-air signal and to assist broadcasters and manufacturers to implement systems using the specification features as intended. TR 101 496-3 [17] focuses on the DAB broadcast network.

2 References

For the purposes of this Technical Report (TR), the following references apply:

[1] ETSI EN 300 401 (V1.3.2): "Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers".

[2] ITU-R Recommendation BS.774-2: "Service requirements for digital sound broadcasting to vehicular, portable and fixed receivers using terrestrial transmitters in the VHF/UHF bands".

[3] ITU-R Recommendation BO.789-2: "Service for digital sound broadcasting to vehicular, portable and fixed receivers for broadcasting-satellite service (sound) in the frequency range 1 4000 - 2 700 MHz".

[4] ITU-R Recommendation BS.1114-1: "System for terrestrial digital sound broadcasting to vehicular, portable and fixed receivers in the frequency range 30-3 000 MHz".

[5] ITU-R Recommendation BO.1130-2: "System selection for digital sound broadcasting to vehicular, portable and fixed receivers for broadcasting-service satellite (sound) bands in the frequency range 1 400 - 2 700 MHz".

[6] ISO/IEC 11172-3 (1993): "Coding of moving pictures and associated audio for digital storage media at up to about 1,5 Mbit/s - Part 3: Audio".

[7] ISO/IEC JTC-1-SC29-WG11 MPEG 91-101 (1991): "The SR Report on The MPEG/Audio Listening Tests" - Stockholm.

[8] EN ISO 14819-1: "Traffic and Traveller Information (TTI) – TTI messages via Traffic Message Coding – Part 1: Coding protocol for Radio Data System – Traffic Message Channel (RDS-TMC) using ALERT-C".

[9] ETSI ETS 300 174 (1992): "Network Aspects (NA); Digital coding of component television signals for contribution quality applications in the range 34 - 45 Mbit/s".

[10] EN 50094 (1992): "Access control system for the MAC/packet family: EUROCRYPT".

[11] Norwegian Telecom, Issue 2 (20th July 1989): "NR-MSK Access Control System".

[12] ISO/IEC 13818-3 (1998): "Information technology - Generic coding of moving pictures and associated audio information - Part 3: Audio".

[13] ETSI TR 101 496-1: "Digital Audio Broadcasting (DAB); Guidelines and rules for implementation and operation; Part 1: System outline".

[14] ETSI EN 301 234 (V1.2.1):"Digital Audio Broadcasting (DAB); Multimedia Object Transfer (MOT) protocol".

[15] prENV ISO 18234-3: "Traffic and Traveller Information (TTI) - TTI via Transport Protocol Experts Group (TPEG) data streams - Part 3: Service and Network Information (SNI) Application".

[16] ETSI TS 101 498 (V1.1.1): "Digital Audio Broadcasting (DAB), Broadcast Web Site Application".

[17] ETSI TR 101 496-3: "Digital Audio Broadcasting (DAB); Guidelines and rules for implementation and operation; Part 3: Broadcast network".

[18] ETSI TS 101 757 (V1.1.1): "Digital Audio Broadcasting (DAB) Conformance testing for DAB Audio".

[19] ETSI EN 301 700: (V1.1.1): "Digital Audio Broadcasting (DAB); VHF/FM Broadcasting: cross-referencing to simulcast DAB services by RDS-ODA 147".

[20] ETSI TS 101 756: (V1.1.1): "Digital Audio Broadcasting (DAB); Registered tables".

[21] J. Hallier, T. Lauterbach & M. Unbehaun, 1994: "Multimedia Broadcasting to mobile, portable and fixed receivers using the EUREKA 147 Digital Broadcasting System, Proceedings ICCC Regional Meeting on Wireless Computer Networks (WCN)", Den Haag, 23rd September 1994, p 794.

[22] CENELEC EN 50067 (1998): "Specification of the radio data system (RDS) for VHF/FM sound broadcasting in the frequency range from 87,5 to 108,0 MHz".

[23] ISO 3901 (1986): "International Standard Recording Code (ISRC)".

[24] CEN EN 797: "Bar coding - Symbology specifications Universal Product Code / European Article Number (UPC/EAN)".

[25] IEC 61866 (1997): "Audiovisual systems- Interactive text transmission system (ITTS)".

[26] IEC 60958-3 (2000): "Digital audio interface - Part 3: Consumer applications".

[27] EBU document Tech. 3258 (2nd edition, 1991): "Specifications of the systems of the MAC/packet family".

[28] ITU-R Recommendation TF.457-1 (1990): "Use of the modified Julian date by the standard-frequency and time-signal services".

[29] ITU-R Recommendation TF.460-4 (1990): "Standard-frequency and time-signal emissions".

[30] ISO/IEC 10646-1: "Information technology - Universal Multiple-Octet Coded Character Set (UCS) - Part 1: Architecture and Basic Multilingual Plane".

2a Definitions, symbols and abbreviations

2a.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

Access Control System (ACS): particular set of rules for managing entitlement checking and conditional access messages

audio bit stream: sequence of consecutive audio frames

audio frame: frame of a duration of 24 ms (at 48 kHz sampling frequency) or of 48 ms (at 24 kHz sampling frequency) which contains a Layer II encoded audio signal ISO/IEC 11172-3 [6], ISO/IEC 13818-3 [12], corresponding to 1 152 consecutive audio samples; the smallest part of the audio bit stream which is decodable on its own

audio mode: audio coding system provides single channel, dual channel, stereo and joint stereo audio modes
In each mode, the complete audio signal is encoded as one audio bit stream.

Auxiliary Information Channel (AIC): all or part of sub-channel 63, used to carry information redirected from the Fast Information Channel

Capacity Unit (CU): smallest addressable unit (64 bits) of the Common Interleaved Frame (CIF)

change event indication (CEI): set of FIG fields with particular values to indicate a change of database content for certain service information features

Common Interleaved Frame (CIF): serial digital output from the main service multiplexer which is contained in the Main Service Channel part of the transmission frame
It is common to all transmission modes and contains 55 296 bits (i.e. 864 CUs).

Conditional Access (CA): mechanism by which the user access to service components can be restricted

convolutional coding: coding procedure which generates redundancy in the transmitted data stream in order to provide ruggedness against transmission distortions

DAB audio frame: The same as audio frame, but includes all specific DAB audio-related information.

DAB transmission signal: transmitted radio frequency signal

data service: service which comprises a non-audio primary service component and optionally additional secondary service components

ensemble: transmitted signal, comprising a set of regularly and closely-spaced orthogonal carriers
The ensemble is the entity which is received and processed. In general, it contains programme and data services.

Entitlement Checking Messages (ECM): messages containing information about the conditions required for accessing service components, which are intended for restricted access, and for descrambling the data

Entitlement Management Messages (EMM): messages containing information about the conditions required for accessing service components which are intended for restricted access and for descrambling the data

Equal Error Protection (EEP): error protection procedure which ensure a constant protection of the bit stream

Extended Programme Associated Data (X-PAD): extended part of the PAD carried towards the end of the DAB audio frame, immediately before the Scale Factor Cyclic Redundancy Check (CRC)
Its length is variable.

Fast Information Block (FIB): data burst of 256 bits
The sequence of FIBs is carried by the Fast Information Channel. The structure of the FIB is common to all transmission modes

Fast Information Channel (FIC): part of the transmission frame, comprising the Fast Information Blocks, which contains the multiplex configuration information together with optional service Information and data service components

Fast Information Data Channel (FIDC): dedicated part of the Fast Information Channel which is available for non-audio related data services, such as paging

Fast Information Group (FIG): package of data used for one application in the Fast Information Channel
Eight different types are available to provide a classification of the applications.

Fixed Programme Associated Data (F-PAD): fixed part of the PAD contained in the last two bytes of the DAB audio frame

joint stereo mode: audio mode in which two channels forming a stereo pair (left and right) are encoded within one bit stream and for which stereophonic irrelevance or redundancy is exploited for further bit reduction
The method used in the DAB system is Intensity stereo coding.

logical frame: data burst, contributing to the contents of a sub-channel, during a time interval of 24 ms
For example, data bursts at the output of an audio encoder, a Conditional Access scrambler and a convolutional encoder are referred to as logical frames. The number of bits contained in a specific logical frame depends on the stage in the encoding process and the bit rate associated with the sub-channel

Main Service Channel (MSC): channel which occupies the major part of the transmission frame and which carries all the digital audio service components, together with possible supporting and additional data service components

Multiplex Configuration Information (MCI): information defining the configuration of the multiplex
It contains the current (and in the case of an imminent re-configuration, the forthcoming) details about the services, service components and sub-channels and the linking between these objects. It is carried in the FIC in order that a receiver can interpret this information in advance of the service components carried in the Main Service Channel. It also includes identification of the ensemble itself and a date and time marker.

null symbol: first Orthogonal Frequency Division Multiplex (OFDM) symbol of the transmission frame

OFDM symbol: transmitted signal for that portion of time when the modulating phase state is held constant on each of the equi-spaced, equal amplitude carriers in the ensemble
Each carrier is four-phase differentially modulated from one symbol to another, giving a gross bit rate of two bits per carrier per symbol.

packet mode: mode of data transmission in which data are carried in addressable blocks called packets
Packets are used to convey MSC data groups within a sub-channel.

primary service component: first and mandatory component of a service
It can be used as a default selection in the receiver.

Programme Associated Data (PAD): information which is related to the audio data in terms of contents and synchronization
The PAD field is located at the end of the DAB audio frame.

programme item: time-slice of a programme, for example, a piece of music or a news report

programme service: service which comprises an audio Primary service component and optionally additional Secondary service components

protection level: level specifying the degree of protection, provided by the convolutional coding, against transmission errors

protection profile: Defines the scheme of convolutional coding applied.

secondary service component: In case a service contains more than the primary service component, the additional service components are secondary service components.

service: user-selectable output which can be either a programme service or a data service

service component: part of a service which carries either audio (including PAD) or data
The service components of a given service are linked together by the Multiplex Configuration Information. Each service component is carried either in a sub-channel or in the Fast Information Data Channel.

Service Identifier (SId): 16- or 32-bit code used to identify a particular service

Service Information (SI): auxiliary information about services, such as service labels and programme type codes

service label: alphanumeric characters associated with a particular service and intended for display in a receiver

single channel mode: audio mode, in which a monophonic audio programme is encoded within one bit stream

Single Frequency Network (SFN): network of DAB transmitters sharing the same radio frequency to achieve a large area coverage

stereo mode: audio mode in which two channels forming a stereo pair (left and right) are encoded within one bit stream and for which the coding process is the same as for the Dual channel mode

stream mode: mode of data transmission within the Main Service Channel in which data are carried transparently from source to destination
Data are carried in logical frames.

sub-channel: A part of the Main Service Channel which is individually convolutionally encoded and comprises an integral number of Capacity Units per Common Interleaved Frame.

synchronization channel: part of the transmission frame providing a phase reference

transmission frame: actual transmitted frame, specific to the four transmission modes, conveying the Synchronization channel, the Fast Information Channel and the Main Service Channel

transmission mode: specific set of transmission parameters (e.g. number of carriers, OFDM symbol duration)
Four transmission modes (i.e. I, II, III and IV) are defined to allow the system to be used for different network configurations and a range of operating frequencies.

Unequal Error Protection (UEP): error protection procedure which allows the bit error characteristics to be matched with the bit error sensitivity of the different parts of the bit stream

X-PAD data group: package of data used for one application in the Extended Programme Associated Data (X-PAD)

2a.2 Symbols

For the purposes of the present document, the following symbols apply:

N	number of carriers
p	padding
R_{ave}	mean code rate
Tf	Frame duration
T_{null}	null symbol duration
T_s	Total symbol duration
t_s	Useful symbol duration
t_Δ	Guard interval duration

2a.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AIC	Auxiliary Information Channel
AM	Amplitude Modulation
BER	Bit Error Ratio
C/N	Carrier to Noise ratio
CA	Conditional Access
CE	Current Ensemble
CEI	Change Event Indication
CIF	Common Interleaved Frame
COFDM	Coded Orthogonal Frequency Division Multiplex
CRC	Cyclic Redundance Check
CRC	Cyclic Redundancy Check
CU	Capacity Unit
CW	Control Word
DAB	Digital Audio Broadcasting
DFT	Discrete Fourier Transform
DG	Data Group
DGC	Data Group Continuity
DGH	Data Group Header
DGR	Data Group Repetition
DRC	Dynamic Range Control
EAN	European Article Number
EBU	European Broadcasting Union
ECC	Exgtended Country Code
ECM	Entitlement Checking Message
EEP	Equal Error Protection
EMM	Entitlement Management Message
EWS	Emergency Warning System
FFT	Fast Fourier Transform
FIB	Fast Information Block
FIC	Fast Information Channel
FIDC	Fast Information Data Channel
FM	Frequency Modulation

F-PAD	Fixed Programme Associated Data
GPS	Global Positioning System
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
ISRC	International Standard Recording Code
ITTS	Interactive Text Transmission System
ITU	International Telecommunications Union
LSN	Linkage Set Number
LTO	Lotal Time Offset
MCI	Multiplex Configuration Information
MFN	Multi-Frequency Network
MJD	Modified Julian Date
MOT	Multimedia Object Transfer
MPEG	Moving Picture Experts Groups
MSC	Main Service Channel
OE	Other Ensemble
OFDM	Orthogonal Frequency Division Multiplex
PAD	Programme Associated Data
PCM	Pulse Code Modulation
PI	Programme Identification
PRBS	Pseudo-Random Bit Sequence
PTy	Programme Type
QPSK	Quadrature Phase Shift Keying (4-PSK)
RCPC	Rate Compatible Punctured Convolutional
RDS	Radio Data System
RMS	Root Mean Square
SC	Service Component
SCCA	Service Component Conditional Access
SCF	Scale Factor
SFN	Single Frequency Network
SI	Service Information
SIV	Service Information Version
TII	Transmitter Identification Information
TMC	Traffic Message Channel
UEP	Unequal Error Protection
UHF	Ultra High Frequency
UPC	Universal Product Code
VHF	Very High Frequency
X-PAD	Extended Programme Associated Data

3 Implementation and operation of system features

3.1 Introduction

This clause considers in detail the implementation and operation of the system features which have been introduced in TR 101 496-1 [13], clause 5. The features are covered in the following order: data transport mechanisms, Multiplex Configuration Information (MCI), Audio, Programme Associated Data (PAD), Service Information (SI), the Fast Information Data Channel (FIDC), and Conditional Access. Guidance is given on recommended data repetition rates. Six different data repetition rates are recommended (and these are given together with code letters which are used throughout the text as appropriate, see also 5.10 in TR 101 496-1 [13]).

- every fourth logical frame (where a logical frame is 24 ms);
- 10 times per second (A);
- once per second (B);
- once every 10 seconds (C);
- less frequently than every 10 seconds (D);

- all information within 2 minutes (E).

These rates should be taken as minimum values to provide an acceptable performance. Whenever these minimum rates cannot be met for operational or some other reason, there can be a degradation in the overall system performance. Whenever data capacity allows (either because the FIC or MSC is not fully subscribed), the transmission rate of the data features can be increased to enhance their reception reliability.

3.2 Data transport mechanisms

Different data transport mechanisms are provided, within the Transmission frame, to suit specific needs (see 5.1 in [1]). The majority of data is carried in the Main Service Channel (MSC) which enjoys the best protection against errors by time-interleaving as well as convolutional encoding (see 5.3 in [1]). There is also a Fast Information Channel (FIC) which has a considerably reduced processing delay because there is no time-interleaving applied (see 5.2 in [1]).

The Fast Information Channel (FIC) allows a limited amount of information to be accessed quickly by a receiver - particularly the Multiplex Configuration Information (see 5.3 in TR 101 496-1 [13] and 5.2 in [1]). The lack of the advantages of time interleaving is compensated for by adopting a strategy of repeating the data carried in the FIC at regular intervals (i.e. at the recommended data repetition rates). To avoid the need for further signalling, the FIC has a fixed equal error protection (EEP) of approximately 1/3 code rate. Information, carried in the FIC, is encoded into special "packets" called Fast Information Groups (FIGs).

Within the MSC there is a choice of two transport mechanisms and these are referred to as the "Stream" mode and the "Packet" mode. In the Stream mode, data is divided at source into regular 24 ms bursts which are called Logical frames. During the convolutional encoding and time-interleaving process, the data contents of a Logical frame become scattered but nevertheless can be associated with a Common Interleaved Frame (CIF) containing 55 296 bits. The smallest addressable unit of the CIF is the Capacity Unit (CU), comprising 64 bits. Therefore, the CIF contains 864 CUs, which are identified by the addresses 0 to 863. In the Packet mode, the total data capacity of a Sub-channel can be shared by several (up to 1 023) Service components (packet address 0 is reserved for padding packets), organized in addressable "packets". This can increase transport efficiency when several Service components have average data rates below the 8 kbit/s breakpoints. One particular Sub-channel operating in the Packet mode (Sub-channel Identifier "63" and Packet address "1 023") is reserved for the Auxiliary Information Channel (AIC). The AIC is used to re-direct information, encoded in FIGs, to the MSC (see 5.4 in [1]). This "overflow" mechanism can be used for certain non-critical information, such as some Service Information features (see 3.6.19).

For the basic audio application, additional non-audio information can be incorporated with the audio data. This additional information, referred to as Programme Associated Data (PAD), is carried at the end of each 24 ms audio frame in case of 48 kHz sampling frequency and at the end of each 48 ms audio frame in case of 24 kHz sampling frequency. Therefore, it is suited to information which requires to be synchronized to the audio programme, such as Dynamic Range Control (DRC) - see 5.5 in TR 101 496-1 [13]. PAD can be transported at a basic level only (667 bit/s for 48 kHz sampling frequency and 333 bit/s for 24 kHz sampling frequency) or at an extended level (whereby theoretically all of the audio frame can be occupied by PAD, with a maximum of about 65 kbit/s). In the first case, the PAD is termed "Fixed" (F-PAD) and this can always be used without prejudice to the audio data. However, the use of the "extended" form (X-PAD) has to be chosen carefully in conjunction with the audio application. These transport mechanisms are described in this clause.

3.2.1 Fast Information Channel (FIC)

3.2.1.1 Introduction

3.2.1.1.1 Purpose of the feature

The Fast Information Channel (FIC) is designed for rapid access of information by a receiver. It is used to send the Multiplex Configuration Information as described in clause 6 of [1] and optionally Service Information and Data services (see clause 8 in [1]). It can be used to carry Entitlement information (ECM, EMM) used by a Conditional Access System (see clause 9 in [1]).

3.2.1.1.2 End user

The receiver, the listener and other end-users via dedicated receivers.

3.2.1.1.3 Provider

The Service provider (Programme service provider and Data service provider), the Ensemble provider, the Network provider.

3.2.1.1.4 Other parties involved

Other Service providers, other Ensemble providers, other Network providers can participate to provide the Ensemble provider with optional information.

3.2.1.1.5 Description

The FIC is a non-time-interleaved data channel with fixed equal error protection (code rate of approximately 1/3). In each Transmission frame the FIC is adjacent to the Synchronization channel in the Transmission frame. The FIC carries Fast Information Blocks (FIBs). In Transmission mode I there are 12 FIBs per Transmission frame of 96 ms, in Transmission mode II there are 3 FIBs per Transmission frame of 24 ms, in Transmission mode III there are 4 FIBs per Transmission frame of 24 ms and in Transmission mode IV there are 6 FIBs per Transmission frame of 48 ms (see 5.1 in [1]). In Mode I, there are four CIFs in one Transmission frame. Therefore, the 12 FIBs of the three FIC symbols are divided into four groups that are each assigned to one CIF. This assignment is performed as shown in figure 3.2.1. The information contained in the first three FIBs in the frame refers to the first CIF, the information contained in the fourth, fifth and sixth FIB refers to the second CIF, etc. All FIBs contributing to a Transmission frame, in Transmission mode II and III, shall be assigned to one CIF associated with that Transmission frame as shown in figure 3.2.2 and figure 3.2.3. In Mode IV, there are two CIFs in one Transmission frame. Therefore the 6 FIBs of the three FIC symbols are divided into two groups that are each assigned to one CIF. This assignment is performed as shown in figure 3.2.4. The information contained in the first three FIBs in the frame refers to the first CIF, and the information contained in the fourth, fifth and sixth FIB refers to the second CIF. The transport mechanism is organized in consecutive blocks. That means even when there is no significant information to broadcast, it is mandatory to transmit block(s), padding blocks in that case.

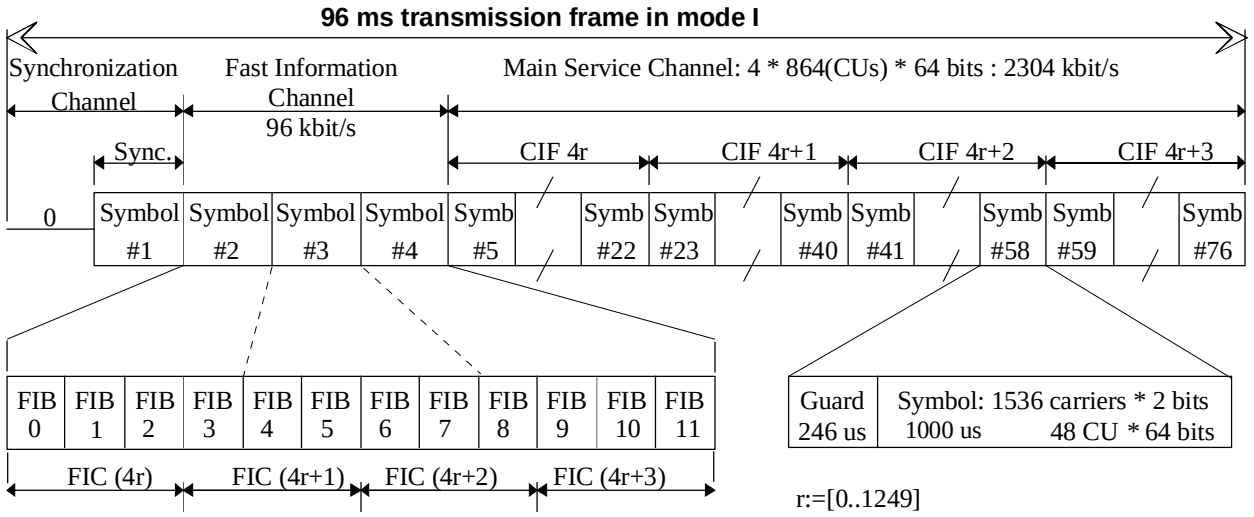


Figure 3.2.1: Structure of Transmission mode I

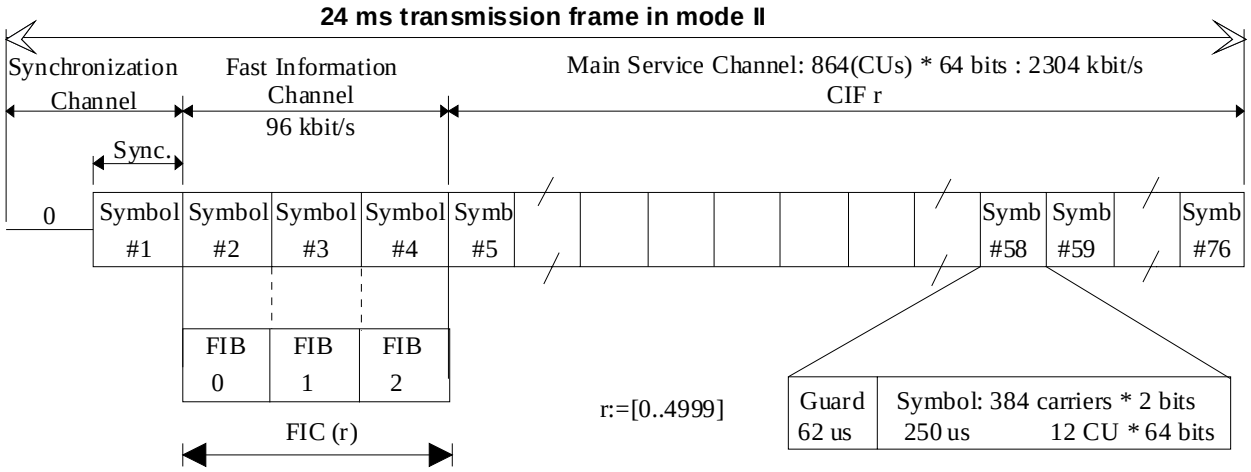


Figure 3.2.2: Structure of Transmission mode II

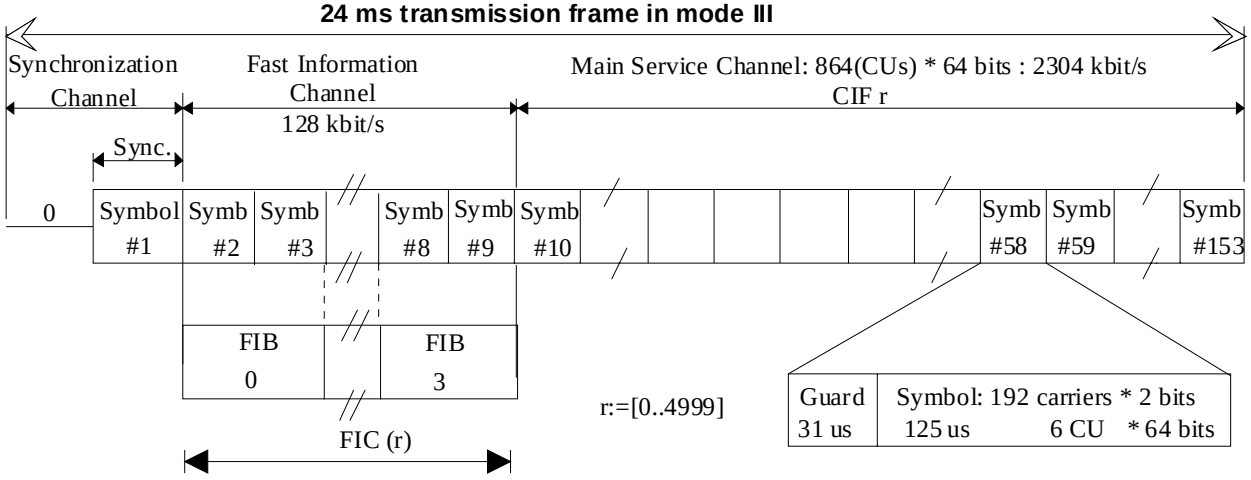


Figure 3.2.3: Structure of Transmission mode III

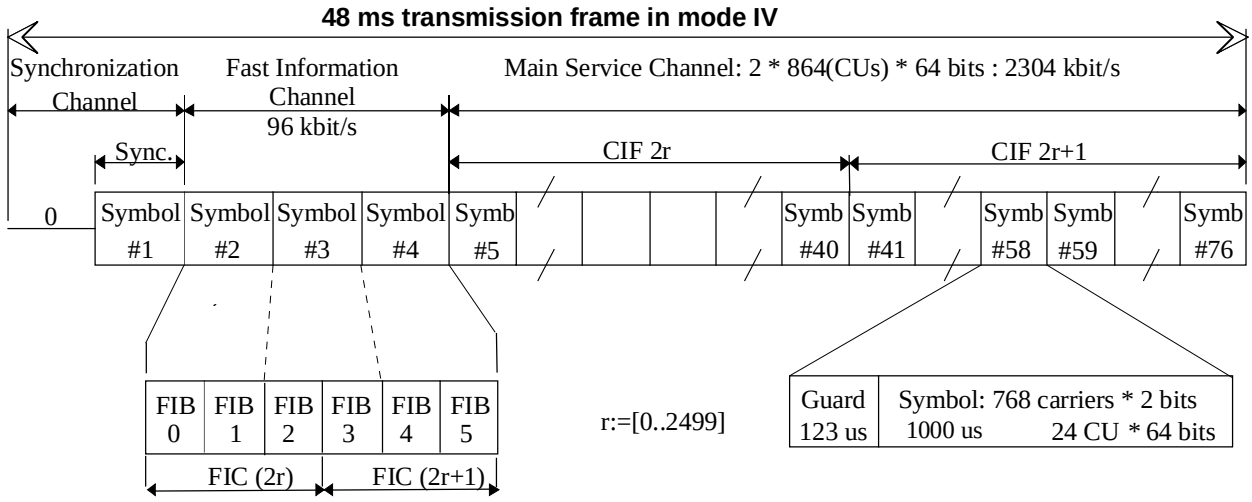


Figure 3.2.4 Structure of Transmission mode IV

A FIB contains 32 bytes comprising a FIB data field of 30 bytes and a CRC of 2 bytes in accordance with 5.2.1 in [1]. The FIB data field contains Fast Information Groups (FIGs), End marker and padding bytes (see 5.2.1 in [1]). Different FIG types are defined (see table 3.2.1). The maximum size of a FIG is 30 bytes. In a FIB it is possible to carry several FIGs but in any case a FIG cannot be transmitted in more than one FIB. A FIG header comprises 2 bytes. The syntax of the first byte is common to all FIGs: the three first bits indicate the FIG type and the following 5 bits form a length indicator. The second byte is FIG type dependent. The length of the FIG header can be used to derive the length of the FIG datafield or the number of subfields contained within it, but is not intended to provide different means of decoding the FIG datafield or to determine the length of specific identifiers (data fields) within this subfield. Thus, only length values given in table 3.2.2 are allowed for which a corresponding decoding is defined in [1]. Variable sub-subfield sizes or interpretations shall have an associated indicator within the FIG datafield. The decoding of a FIG subfield shall not depend on the length field in the FIG header.

Table 3.2.1: List of FIG types

FIG type number	FIG type	FIG application
0	000	MCI and part of the SI
1	001	Labels, etc. (part of the SI)
2	010	Reserved
3	011	Reserved
4	100	Reserved
5	101	FIC Data Channel (FIDC)
6	110	Conditional Access (CA)
7	111	In house (except for Length 31)

Generally, FIGs can be arranged in any order except where special operational requirements dictate otherwise. The FIG types 0, 1, 5 and 6 are defined (see 5.2.2.1 to 5.2.2.4 in [1]). The End Marker of useful data within a FIB consists of one byte all "1" and this is the reason why FIG type 7 ("111") having its length set to 31 ("11111") is defined for this purpose. According to the FIG type, the first byte of the FIG data field carries different information including FIG type Extension. In FIG type 0, the following flags can be present: the C/N flag, the OE flag, and the P/D flag. The Other Ensemble flag (OE flag) indicates whether the content of the FIG is related to the current Ensemble, or to another DAB Ensemble, or to an AM or FM Service. The Programme/Data service flag (P/D flag) is used to signal whether the Service identifier is the 16-bit (Programme service) or 32-bit (Data service) version.

3.2.1.2 Mandatory requirements

3.2.1.2.1 For broadcasting

FIGs shall be assembled into FIBs. Checksums (CRC) shall be calculated and applied to these FIBs (see 5.2.1 in [1]). Considerations should be given to efficient packing of FIGs into FIBs.

For each of the four Transmission modes the appropriate number of FIBs per Transmission mode shall be formed and maintained in the Transmission frame association defined in 5.1 in [1]. The Ensemble provider shall ensure that the information carried in the FIC meets the recommended repetition rates demanded by different features (see 3.6.19). To accommodate very simple receivers which decode only the first FIB of every CIF, a subset of the MCI (FIG 0/1, FIG 0/2, FIG 0/3, FIG 0/4) shall be carried in the first FIB of successive 24 ms periods, corresponding to CIFs. Because FIG 0/3 and FIG 0/4 are less important for very simple receivers than the first two, they can be transmitted less frequently in the first FIB. Additionally, the MCI can be carried in other FIBs to increase its repetition rate to repetition level A. Any spare capacity in the first FIB of a frame can be utilized to carry other FIGs. In any 96 ms period, the frame count information (FIG 0/0) should be transmitted in a fixed time position. In Transmission mode I, this should correspond to the beginning of the first FIB of each Transmission frame. In Transmission modes II and III, this should be the beginning of the first FIB of every fourth Transmission frame. In Transmission mode IV, this should correspond to the beginning of the first FIB of every second Transmission frame (see figures 3.2.1, 3.2.2, 3.2.3, 3.2.4).

3.2.1.2.2 For receiving

All receivers shall decode FIG headers carried in FIBs in the FIC.

3.2.1.3 Optional requirements

If required, FIGs shall be scrambled and descrambled (see 3.8).

3.2.1.4 Operational aspects of broadcasting

3.2.1.4.1 Functional Minimum Requirements

The MCI shall be given priority over other information carried in the FIC. Recommended data repetition rates shall be adhered to.

3.2.1.4.2 Receivers Implementation Aspects

Except for receivers dedicated for special applications, receivers shall process information related to MCI and should be able to process those related to SI. Some receivers can be required to process FIDC.

3.2.1.4.3 Vital interaction between Service provider and Multiplex Operator

The only interaction between the Service provider and the Ensemble provider is regarding the information content of the FIC.

Table 3.2.2: Permitted FIG "Lengths"

FIG Type/Ext	Description	Permitted "Length" values	C/N
FIG 0/0	ENSEMBLE INFORMATION	5, 6	Rfu
FIG 0/1	SUB-CHANNEL ORGANIZATION	4, 5, 7 - 29	C/N
FIG 0/2	SERVICE ORGANIZATION	4, 6 (both for no. of comp's = 0), 8 - 29	C/N
FIG 0/3	SERVICE COMPONENT IN PACKET MODE	6, 8, 11, 13, 15, 16, 18, 20 - 23, 25 - 29	C/N
FIG 0/4	SERVICE COMPONENT IN STREAM MODE OR FIC WITH CA	4, 7, 10, 13, 16, 19, 22, 25, 28	C/N
FIG 0/5	SERVICE COMPONENT LANGUAGE	3 - 29	Rfu
FIG 0/6	SERVICE LINKING INFORMATION	3, 4 (no.of Id's = 0) 5 - 29	SIV
FIG 0/7	DATA SERVICE COMPONENT TYPE EXTENSION	2, 3 (both for no. of comp's = 0), 4 - 29	C/N
FIG 0/8	SERVICE COMPONENT GLOBAL DEFINITION	5 - 29	C/N
FIG 0/9	COUNTRY, LTO & INTERNATIONAL TABLE	4 - 29	SIV
FIG 0/10	DATE & TIME	5, 7	Rfu
FIG 0/11	REGION DEFINITION	4, 7 - 29	SIV
FIG 0/12	PROGRAMME TYPE PREVIEW	6 - 13, 18 - 21, 26 - 29	Rfu
FIG 0/13	USER APPLICATION INFORMATION	6 - 29	Rfu
FIG 0/14, 15	Rfu	1 - 29	Rfu
FIG 0/16	PROGRAMME NUMBER (PNum)	6, 10, 11, 15, 16, 19, 20, 21, 24- 26, 28, 29	Rfu
FIG 0/17	PROGRAMME TYPE (PTy) [STATIC & DYNAMIC]	5 - 29	Rfu
FIG 0/18	ANNOUNCEMENT SUPPORT	6 - 29	SIV
FIG 0/19	ANNOUNCEMENT SWITCHING	5, 6, 9 - 11, 13, 15 - 17, 19 - 29	Rfu
FIG 0/20	SERVICE COMPONENT TRIGGER	5, 8, 9, 12, 13, 15 - 17, 19 - 29	Rfu
FIG 0/21	FREQUENCY INFORMATION (FI)	6 - 29	SIV
FIG 0/22	TRANSMITTER IDENTIFICATION DATABASE	3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29	SIV
FIG 0/23	LOCAL SERVICE AREA	5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29	SIV
FIG 0/24	OTHER ENSEMBLES SERVICES	4, 6 - 29	SIV
FIG 0/25	OTHER ENSEMBLES ANNOUNCEMENT SUPPORT	6, 8, 10 - 29	SIV
FIG 0/26	OTHER ENSEMBLES ANNOUNCEMENT SWITCHING	8, 9, 15 - 17, 22 - 25, 29	Rfu
FIG 0/27	FM SERVICES ANNOUNCEMENT SUPPORT	4, 6 - 29	SIV
FIG 0/28	FM SERVICES ANNOUNCEMENT SWITCHING	5, 9, 13, 17, 21, 25, 29	Rfu
FIG 0/29	SATELLITE HANDOVER INFORMATION	3	Rfu
FIG 0/30	SATELLITE DATABASE	6 - 15	SIV
FIG 0/31	FIC RE-DIRECTION	6	Rfu
FIG 1/0	ENSEMBLE LABEL	21	n/a
FIG 1/1	PROGRAMME SERVICE LABEL	21	n/a
FIG 1/2	PROGRAMME TYPE DOWNLOADING	21 - 24	n/a
FIG 1/3	REGION LABEL	20	n/a
FIG 1/4	SERVICE COMPONENT LABEL	22, 24	n/a
FIG 1/5	DATA SERVICE LABEL	23	n/a
FIG 1/6-7	Rfu	1 - 29	n/a
FIG 2/x	Rfu	1 - 29	n/a
FIG 3/x	Rfu	1 - 29	n/a
FIG 4/x	Rfu	1 - 29	n/a
FIG 5/0	PAGING	1 - 29 (D1 = 0) 1, 9, 13 (D1 = 1)	n/a
FIG 5/1	TRAFFIC MESSAGE CHANNEL	1, 6, 11, 15, 20, 25, 29	n/a
FIG 5/2	EMERGENCY WARNING SYSTEM	1 - 29	n/a
FIG 5/3-7	Rfu	1 - 29	n/a
FIG 6/0	ENTITLEMENT MANAGEMENT MESSAGES	1 - 29	n/a
FIG 6/1-63	ENTITLEMENT CHECKING MESSAGES	1 - 29	n/a
FIG 7/x	IN HOUSE, END MARKER	1 - 29, 31	n/a

Key: Rfu = reserved for future use; SIV = SI version; OE = Other Ensembles; n/a = not applicable

3.2.2 Stream mode

3.2.2.1 Introduction

3.2.2.1.1 Purpose

The Stream mode in the MSC shall be used for basic audio Service components as described in clause 7 in [1] and also for Data service components when not carried in packets.

3.2.2.1.2 End user

The receiver, the listener and other end-users via dedicated receivers.

3.2.2.1.3 Provider

The Service provider (Programme service provider and Data service provider), the Ensemble provider.

3.2.2.1.4 Description

Audio service components shall be allocated a sub-channel size which matches the audio data rate and protection level required, according to tables 7, 8 and 9 in 6.2 in [1]. Table 7 offers a short form signalling of 64 possibilities of the coding described in clause 7 in [1]. These possibilities employ the Unequal Error Protection, which is particularly adapted for Audio (see 3.4). Tables 8 and 9 offer a long form signalling of 4 possibilities each, which define different Equal Error Protections. Possible future forms of coding would require either an alternative table (signalled by the table switch in the MCI) or the use of a new long form of signalling (see 6.2 in [1]). In the Stream mode, Data service components shall be divided at source into regular 24 ms bursts corresponding to the sub-channel data capacity of each CIF. Each burst of data constitutes a Logical frame (see 3.3.4). At any one time, the data rate of the application shall be fixed in multiples of 8 kbit/s for use of code rates according to table 7 or 8 in [1], and in multiples of 32 kbit/s for use of code rates according to table 9 in [1]. The application shall either supply information to fill the channel or a converter to fill the channel.

3.2.2.2 Mandatory requirements

3.2.2.2.1 For broadcasting

Only one Service component shall be carried in one Sub-channel. For Audio service components using the 48 kHz sampling frequency, the DAB audio frame has a duration of 24 ms and shall map on to the logical frame structure in such a way that the first bit of the DAB audio frame corresponds to the first bit of the logical frame (see 3.3.4). For Audio service components using the 24 kHz sampling frequency, the DAB audio frame has a duration of 48 ms and shall map on to the logical frame structure in such a way that the first bit of the DAB audio frame corresponds to the first bit of a logical frame (see 3.3.4). Data service components shall be divided at source into regular 24 ms bursts. The data rate shall be fixed in multiples of 8 kbit/s, if use of code rates according to table 7 or 8 in [1], and in multiples of 32 kbit/s if use of code rates according to table 9 in [1]. The application shall either supply information to fill the channel or a converter to fill the channel.

3.2.2.2.2 For receiving

All the receivers (except those used for special applications, for example, paging) shall be capable of decoding data carried in FIG 0/1 and 0/2 to determine what Audio and Data service components are carried in the Ensemble, together with their associated data capacity, protection level, and decoding method.

3.2.2.3 Operational aspects of broadcasting

3.2.2.3.1 Functional minimum requirements

The Service provider should signal the overall data capacity and data protection level required for the Service component supplied so that an appropriate sub-channel size can be allocated by the Ensemble provider.

3.2.2.3.2 Recommendations on contents and real-time aspects

For audio Service components, data capacities should be chosen from the standard options available in order to make the data packing efficient (see 6.2 in [1]).

3.2.2.4 Receiver implementation aspects

3.2.2.4.1 Functional minimum requirements

In order to select and decode the content of a stream mode component, certain parameters in the MCI need to be interpreted:

- all receivers shall be capable of decoding data carried in FIGs 0/1 and 0/2 which contain the Sub-channel and Service definitions.
- the decoding of FIG 0/0 is necessary to manage properly multiplex reconfigurations, Triggering and Conditional Access (see 3.3.5, 3.3.6.9 and 3.8).

In addition, if Conditional Access is implemented FIG 0/4 shall be decoded (see 3.8).

- if the receiver deals with Service Component Labels in order to select Components having the same DSCTy, FIG 0/8 and FIG 1/4 shall be decoded (see 3.6.13).
- if the receiver deals with extended Data service components signalled by the Data Service Component Type (DSCTy) Extension, FIG 0/7 shall be decoded (see 3.3.5).

3.2.3 Packet mode

3.2.3.1 Purpose

Sub-channels of the Main Service Channel can be organized in Packet mode. In this mode, the total data capacity of such a Sub-channel can be shared by several (up to 1 023) Service components. The data of each Service component can be organized in MSC Data Groups (of up to about 8 kbytes length) which are treated as transport entities. A Session header can be attached to the MSC Data Group Header to handle segmentation of data and end user addressing. A packet mode transport without the use of MSC data groups is also available.

3.2.3.2 End user

The receiver, the listener and other end-users via dedicated receivers.

3.2.3.3 Provider

The Service provider (Programme service provider and Data service provider), the Ensemble provider.

3.2.3.4 Description

3.2.3.4.1 Data Sub-channel Organization

Data Sub-channels have data rates of $n \times 8$ *kbit/s*, where n is an integer, when Protection levels given in tables 7 or 8 of [1] are used, and data rates of $n \times 32$ *kbit/s*, when Protection levels given in table 9 in [1] are used . They can be encoded with eight different Protection levels when using Equal Error Protection profiles. The number of Capacity Units required depends on the data rate as well as on the Protection level (see 6.2 in [1]). Due to the lack of other synchronizing mechanisms, an integral number of packets per CIF and Sub-channel is required, and the first bit of the logical frame shall correspond to the first bit of a Packet. Therefore, it is not allowed to transmit a single packet over two frames. This requirement results in the availability of four packet length types (0, 1, 2, and 3) with associated total packet lengths of 24, 48, 72, and 96 bytes, respectively (see 5.3.2 in [1]).

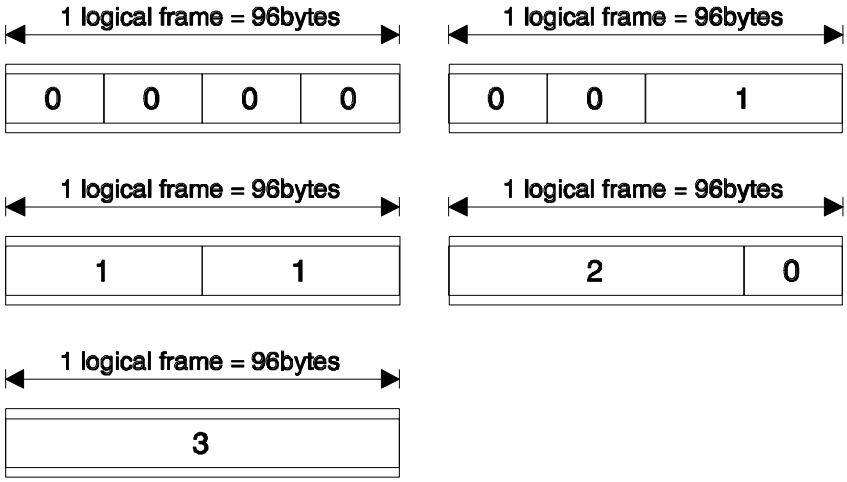


Figure 3.2.3: Examples for packet arrangements in the Logical frame of a 32 kbit/s Sub-channel

In a $n \times 8$ *kbit/s* Sub-channel (using table 8 in [1]) with n = 1, 2 or 3, only packets of length type $\leq (n-1)$ can be used. However, the total length of all the packets in a Logical frame should add up to $24 \times n$ bytes. In a $n \times 32$ *kbit/s* Sub-channel (using table 9 in [1]) all packet length types are permitted. Figure 3.2.3 shows the possible arrangements of packets in a Logical frame for a 32 kbit/s Sub-channel. In this example, the order of the packets is arbitrary. The use of Sub-channels with small data rates ($< 32 kbit/s$) and short packet lengths leads to a significant amount of "wasted" capacity for the Packet mode. The housekeeping overhead of each packet amounts to 5 bytes for the header and the CRC, irrespective of the length type. This overhead is a significant proportion of the total data rate when short packets are used. In a sequence of K packets, which is made up from k_i packets of length type *i*, *i* = 0, 1, 2, 3, where $\sum_{i=0}^{3} k_i = K$, the actual useful data rate R_u in terms of the total sub-channel net data capacity R is given by:

$$\frac{R_u}{R} = 1 - \left| \frac{5}{24} \cdot \frac{K}{K + \sum_{i=0}^{3} i \cdot k_i} \right|$$

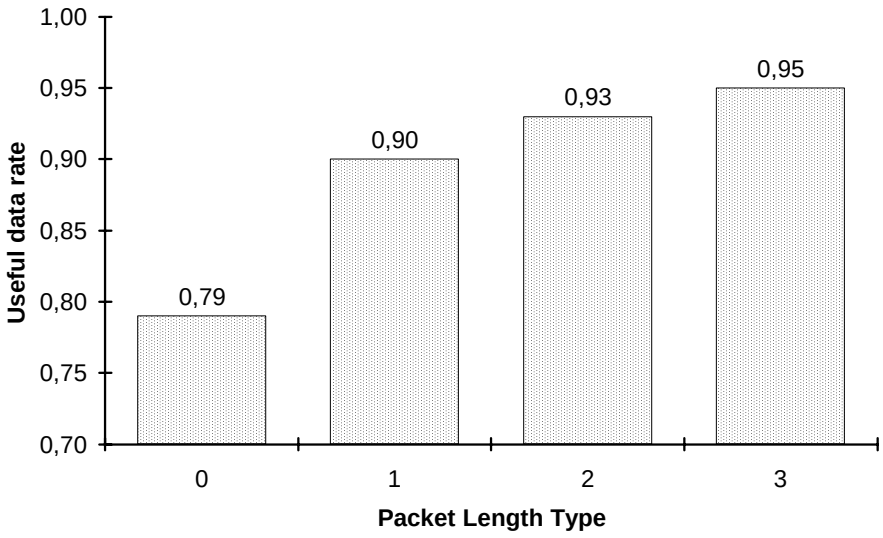


Figure 3.2.4: Useful data rate (proportion of Sub-channel net capacity) when all the packets have the same length

The useful data rates can be calculated easily if all the packets have the same length as shown in figure 3.2.4. Thus, if the MSC Data Groups of all the Service components have large data fields (considerably longer than the packet length), it is strongly recommended that packets with the maximum length available for a given Sub-channel are used. Additionally, in this case, the data rates of the different Service components should be controlled by adjusting the number of packets, with a given Packet address, transmitted in a given time period. Packets having different addresses can be mixed in any order whilst maintaining the order of packets with the same address. "Command" Packets are used for specific messages such as ECM and EMM (see 3.8). « Command » Packets can be mixed with « non-command » Packets of the same address (as if they had a different address). If the total capacity of the Data Sub-channel is not used, Padding packets shall be used (Packet address 0, (@0) in figure 3.2.5). Because they carry only Padding bytes, the Useful data length of these Padding Packets shall be set to "0". In figure 3.2.5, a 48 kbit/s Sub-channel is shared by two Service Components in Packet Mode (having Packet address 1 (@1) and Packet address 2 (@2)). Two successive logical frames are represented:

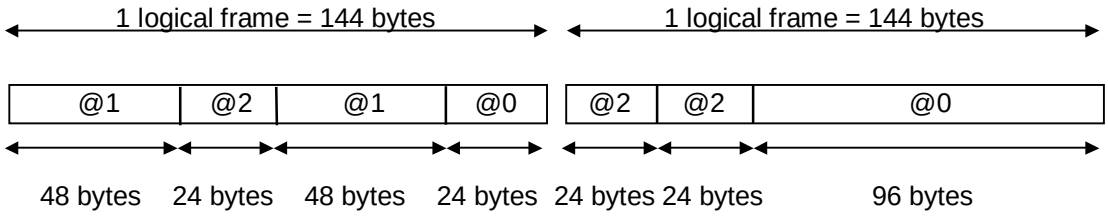


Figure 3.2.5: Multiplexing of Packets in one Sub-channel

It is important to notice that the Packet CRC is calculated over the total packet, including Packet Header. It means that, if a CRC error is detected in a packet, the length of the packet could be wrong, and therefore, the receiver cannot simply skip the wrong packet. An error management strategy should be implemented.

3.2.3.4.2 MSC Data Groups

For transport in Packet mode, data of each Service component are organized in MSC Data Groups (see figure 3.2.6) if the DG flag in FIG 0/3 is set to "1" (see 6.3.2 in [1]). MSC Data Groups consist of a Header, an optional Extension field, an optional Session Header, a Data field, and an optional CRC. MSC Data Groups can be carried by a number of packets (see 5.3.4 in [1]). The "First" Packets shall always contain the first part of the MSC Data Group, and the "Last" Packet signals the end of the MSC Data Group.

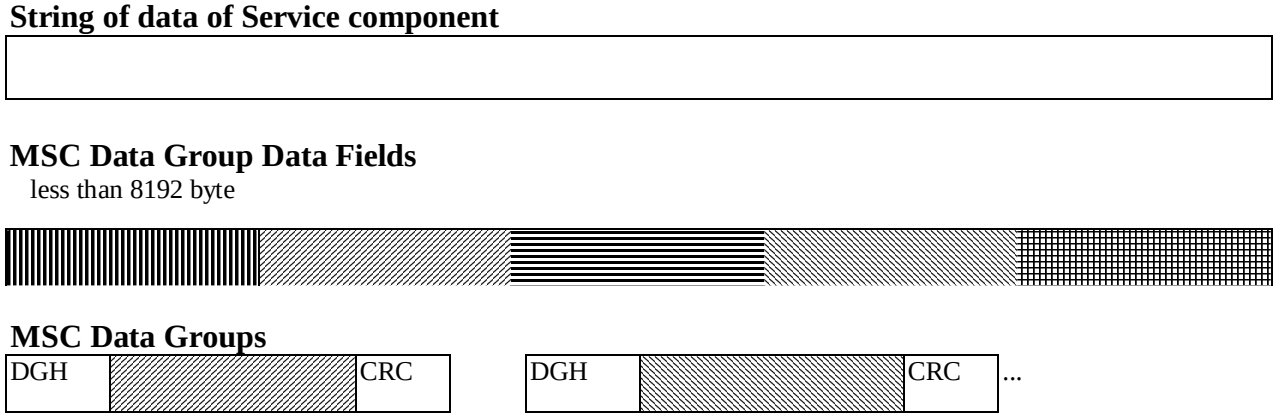


Figure 3.2.6: Formation of MSC Data Groups from a string of data of a Service component.
DGH: MSC Data Group Header

The "Last" Packet can contain padding bytes if the length of the last part of the MSC Data Group does not feed totally the payload of the packet. MSC Data Groups of different Service components can be transmitted together in one Sub-channel, i.e. packets with different packet addresses can be sent in any order whilst maintaining the order of packets with the same address and transporting the same MSC Data Group. Different MSC Data Group Types are defined, depending on the kind of data transported. Two methods of transmitting MSC Data Groups are envisaged. Let A, B, C... denote MSC Data Groups carrying different data but associated with the same Service component (Packet address) and with the same MSC Data Group type (e.g. 0000, general data):

- Method i) linear broadcast without repetition of single MSC Data Groups, e.g.

  ABCDEFG...;

- Method ii) linear broadcast with repetition of single MSC Data Groups, e.g.

  AABBBCCDDDDDEEFGGG...;

When MSC Data Groups are repeated, the repetitions shall occur in successive MSC Data Groups of the same type, i.e. in the transmission order "ΔΦΔΓΛ..." the second appearance of "Δ" is not recognized as a repetition of the first "Δ" if "Φ" is of the same type as "Δ" (even if "Δ" and "Φ" have different TransportIds), but it is a repetition of the first "Δ" if "Φ" is of a different type. The Data group type in the MSC data group header is used to distinguish between different types of data carried in the data group. It is defined individually for each non-DAB transport protocol that can be used in packet mode. The used non-DAB transport protocol is specified by DSCTy signalled in the MCI (FIG 0/3) and extension DSCTy (FIG 0/7). The only exception is the transport of FIBs in the AIC with data group type 0 and packet address 1 023 (see 5.4 in [1]). Because of backwards compatibility, the data group types 3, 4 and 5 should not be defined before 2 003 for other protocols than MOT. The Repetition and Continuity Indexes in the MSC Data Group Header can be used to detect the loss of a particular MSC Data Group. The way to use these Indexes is shown in figure 3.2.7.

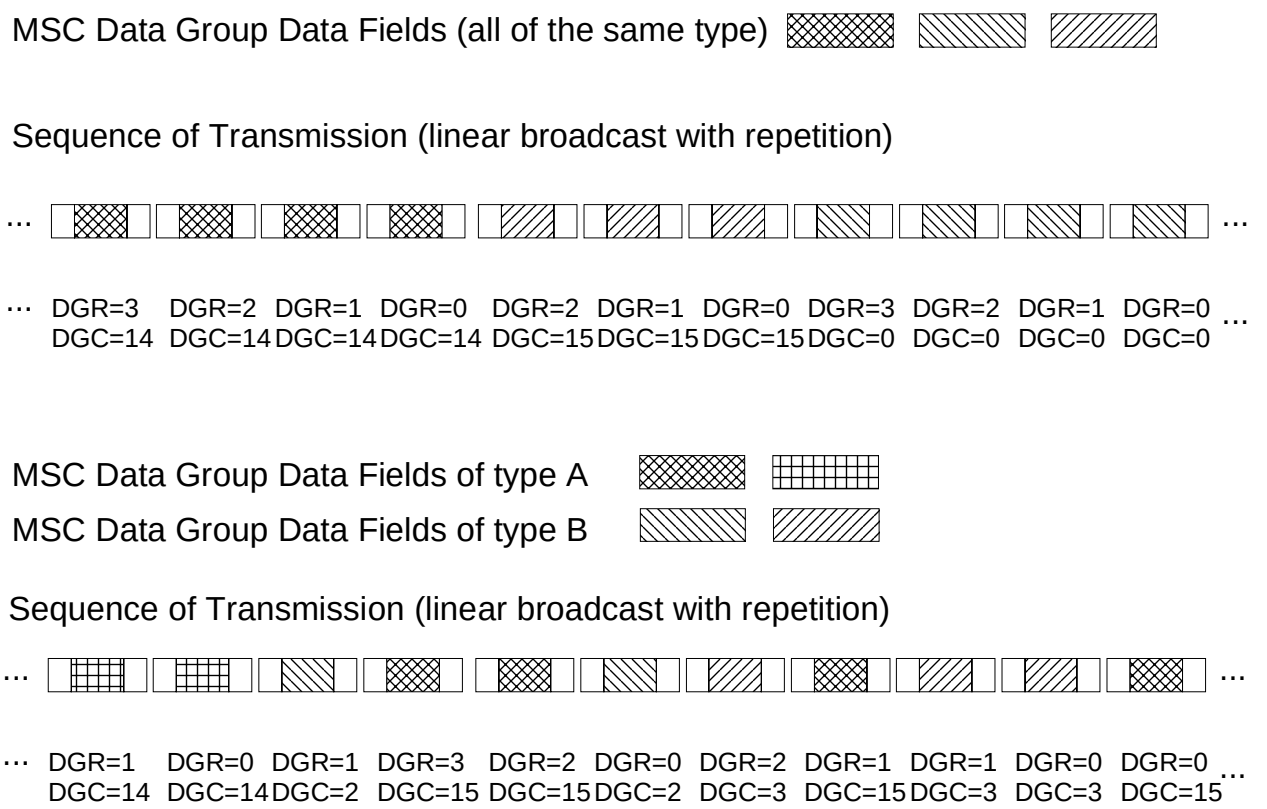


Figure 3.2.7: Use of MSC Data Group Repetition (DGR) and MSC Data Group Continuity (DGC) indexes

NOTE: In this figure, only MSC Data Groups of the same type are sent, in the lower part MSC Data Groups of two different types are sent alternately.

Repetition Index "1111" shall be used to signal that the repetition of a MSC Data Group continues for an undefined period, i.e. more than 15 times. When the remaining number of repetitions equals 15, the Index is decremented after each following Repetition. The optional Extension field is used when Conditional Access applies (MSC Data Group types 0010 and 0101): see 9/2/3 in [1]. It can be used in the future by other MSC Data Group types for other purposes.

3.2.3.4.3 Session header

Optionally, MSC Data Groups can include a Session header (see 5.3.3 in [1]). The Session header provides for the numbering and assembling of segments in data transfer and extended addressing of users or user groups. Both Segment number (including the "Last" flag) and User access field, or only one of them, can be present in the Session Header, depending on the "Session" and "User access" flags. In most cases, a complete entity (a data file for example) has to be split into several segments because:

- it is too big to ensure an error free reception;
- the time for its complete transmission would be too long, so that other (urgent) information would be unduly delayed;
- the receiver can not process too long messages.

At the receiving side, Segment numbering and TransportId can be used for randomly collecting segments of a data file and for checking the integrity of the data. Segment numbering is achieved by employing two fields; a one-bit Last flag and a 15-bit Segment number. Segment number « 0 » shall be assigned to the first segment of a data file. The Last flag is set to « 1 » for the last segment of the data file. When a data file is segmented, all the segments shall have the same size, except the last one, which can be smaller than the others (it contains the remaining bytes). When Packets of fixed size are used to transport segments the size of these segments should be calculated in order to minimize the padding bytes inside the packets (the « Last » Packets). If a data file is split into only one Segment and therefore transported in only one MSC Data Group, the two fields "Last, Segment number" can be absent (« Session flag »=« 0 »). This has the same meaning as "Last=1, segment number=0", and the advantage of saving 2 bytes. A TransportId can be used to uniquely identify an entity during its transmission or to establish a link between an entity and information related to it (for instance, ECM needed to descramble the file). It shall be unique within one Packet Address, and reused as infrequently as possible. During the repetition of an entity, it is not allowed to alter its TransportId. The End user Address field can be used for directing parts of a User Application to individual receivers or groups of receivers. There could be a structured format of the End user address field comprising a Group address and an End user address. The use of the End user Address field should be individually defined for each User Application, defined by the UAId. For CA messages, the use of the End user address field is defined (see 9.3.2.1 in [1]).

3.2.3.5 Mandatory Requirements

3.2.3.5.1 For broadcasting

The total data capacity of a Sub-channel cannot be shared by more than 1 023 Service components in Packet mode. Special attention shall be given to the Sub-channel identified by SubChId 63, in which several addresses are reserved (see 3.6.19 and 3.8). Packets Header, Packets CRC, and MSC Data Group Header shall be managed properly. Padding packets (Packet address 0) shall be added when the total capacity of the Sub-channel is not used. Within one CIF, it is not allowed to mix Padding Packets together with other Packets: Padding Packets shall not be followed by other packets within one CIF. If there is no useful data to be transported, Padding packets shall be transmitted.

3.2.3.5.2 For receiving

All the receivers (except those used for special applications, for example paging) shall be capable of decoding data carried in FIG 0/1, 0/2 and 0/3 to determine what Data service components are carried in the Ensemble, together with their associated data capacity, protection level and decoding method.

3.2.3.6 Operational aspects of broadcasting

3.2.3.6.1 Functional minimum requirements

The Service provider should signal the average data capacity and data protection level required for the Service component supplied so that appropriate sub-channel size and packet size can be allocated by the Ensemble provider.

3.2.3.6.2 Recommendations on contents and real-time aspects

Packet Mode Data can be sent with (DG flag in FIG 0/3 set to "0") or without (DG flag in FIG 0/3 set to "1") the use of MSC Data Groups, depending on whether the features of MSC Data Groups (repetition, segmentation, advanced transmission error control, special user access) are used. For secure transmission of data over a Packet mode sub-channel, a suitable strategy for repeating MSC Data Groups can be developed. To choose the appropriate parameters, it is necessary to understand how bit errors are distributed in different channels at different S/N ratios. A suitable approach is to simulate or measure the Error Gap Distribution of the channel for which the transmission strategy is developed.

3.2.3.4.2.1 Repetition of complete data files:

A data file can be transmitted several times, so that the receiver can replace a file or segments of a file, which were received previously with transmission errors, with the repetition of the same file or segments of this file if they are received without errors. This is only possible when Segment numbering and TransportId are used. Let (A, B, C, D) denote MSC Data Groups of the same type carrying different segments of the same file (e.g. having the same TransportId), associated with the same Service component (Packet address). A, B and C shall have the same size. D carries the last Segment of the file and can be smaller. The sequence below shows the repetition method based on transmitting the entire file a number of times:

ABCD ABCDABCD ABCD

3.2.3.4.2.2 Interleaving of data files:

Using the TransportId functionality, it is also possible to transmit several data files in parallel in the same Service component (in the same Packet address) and using the same MSC Data Group Type. Interleaving is only possible on MSC Data Group level, i.e. the transmission of an MSC Data Group shall be completed before an MSC Data Group of another file can be transmitted.

(A, B, C, D) have the same meaning as in the above example. Let assume that (a, b, c, d) belong to the same Service component, have the same MSC Data Group type as (A, B, C, D), but carry a complete file, different from the above one (they shall have a different TransportId than the one used for (A, B, C, D). The transmission of these two files can be done as follows:

AaBbCcdD

3.2.3.6.3 Interrelation with other features

The implementation of the Packet mode is required to achieve flexible handling of the data capacity of a Data Sub-channel. It is also needed to implement the "Auxiliary Information Channel" (AIC, see 3.6.19.). It is also used by the Multi-media Objet Transfer (MOT) protocol (see [14]).

3.2.3.7 Receiver implementation aspects

3.2.3.7.1 Functional minimum requirements

A receiver decoding a Packet mode Sub-channel shall filter the packets carrying the desired Service component according to their addresses and also check the integrity of data. This is achieved by evaluating first the CRC of each packet. All the receivers shall be capable of decoding data carried in FIGs 0/1, 0/2 and 0/3 which contain the Sub-channel, Service and Component definitions.

3.2.3.7.2 Recommendations on implementation and presentation

If a CRC failure is detected, the whole packet shall be rejected. Note also that the address and the length of such a packet is not necessarily correct. However, the Continuity Index in the Packet header allows the receiver to detect the rejection of one to three consecutive Packets of a Service component. The data carried in successive packets beginning with a packet carrying the "First" flag are stored, and, as soon as the packet carrying the "Last" flag is received, the contents of the memory is expected to constitute a complete MSC Data Group. If there is a CRC at the end of the MSC Data Group, the integrity of the whole MSC Data Group can be verified. Otherwise, since a loss of four or more successive packets cannot be detected by the Continuity Index of the Packet header, an error will not be recognized and the decoder using the data has to check the validity of the data itself. As soon as the integrity of an MSC Data Group has been verified, a check using the Continuity and Repetition Indexes is possible whether any MSC Data Groups have been lost since the last one of the same Service component and MSC Data Group type. The combination of Segment Number and TransportId can be used to improve the receiver behaviour in case of transmission errors. If the receiver deals with Service Component Labels in order to select Components having the same DSCTy, FIG 0/8 and FIG 1/4 shall be decoded (see 3.6.13). If the receiver deals with extended Data service components signalled by the Data Service Component Type (DSCTy) Extension, FIG 0/7 shall be decoded (see 3.3.5).

3.2.4 Programme Associated Data (PAD)

In each DAB audio frame a number of bytes is reserved for carrying data that is intimately related to the encoded audio. This data is called "Programme Associated Data". In general, it has a strong relation to the audio with which it is carried - in contents, in time, or both - and its use is inherently combined with that audio. Since the Programme Associated Data is carried inside the DAB audio frame, it offers a data channel fully controlled by the Service provider: he can determine its capacity and its contents independently from other parties in the DAB chain. Another advantage is that the PAD can be transported through a DAB transmission chain without losing its real-time relation with the audio. This real-time relation is defined as follows: "The data contained in the PAD fields of a particular DAB audio frame relate to the audio information contained in the subsequent frame". This definition applies to the currently defined applications of PAD. Future applications can depend on a different time-relation, which can then be defined together with the application details. The PAD bytes are always located at the end of each DAB audio frame. With a sampling frequency of 48 kHz (High Sampling Frequency), the whole DAB audio frame fits into the 24 ms frame structure of the CIF, and a new set of PAD bytes is available at the receiver every 24 ms. However, in the case of a 24 kHz sampling frequency (Low Sampling Frequency), the DAB LSF audio frame is divided into two parts of equal length (i.e. an even and odd partial frame) and spread across two CIFs. In this case, a new set of PAD bytes is available only every 48 ms. Figures 3.2.8 and 3.2.9 show the location of the PAD bytes within the DAB audio frames for HSF and LSF.

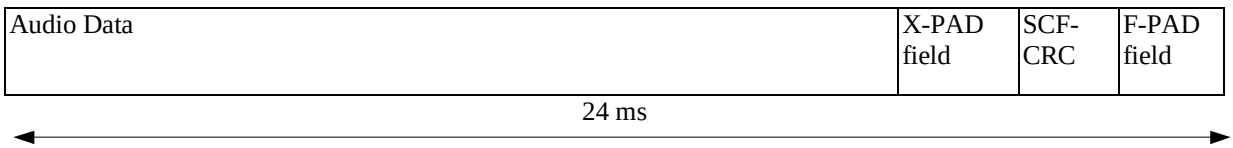


Figure 3.2.8: Case of High Sampling Frequency (24 ms Audio frames)

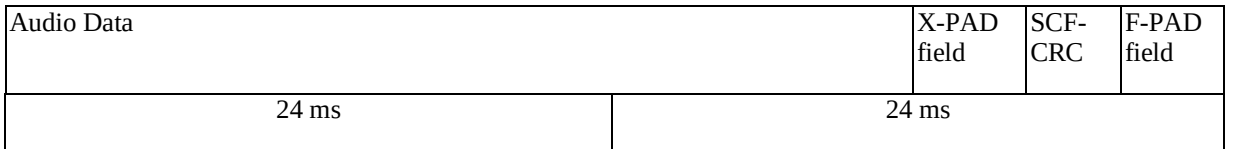


Figure 3.2.9: Case of Low Sampling Frequency (48 ms Audio frames)

The channel which carries the Programme Associated Data is divided, both physically and functionally, into two parts: a fixed part and an optional extended part - see figure 25 in [1]. The fixed part, called the F-PAD channel, is formed by the last two bytes in successive audio frames. These bytes are always available for data and carry control information with a strong real-time character and data with a low bit rate. If the Service provider wishes to send more information he can extend the PAD channel by using a number of bytes preceding the Scale factor CRC in the DAB frame. This optional part is called the X-PAD channel. The X-PAD occupies the part of the frame which is also available for the encoded audio: therefore, the use of X-PAD can reduce the audio quality.

3.2.4.1 Basic transport mechanism in the F-PAD channel

The two bytes which make up the F-PAD channel are called "Byte L" and "Byte L-1", being the last and the penultimate bytes in the DAB audio frame, respectively. Byte L, bits 7...2 form a data channel which conveys a continuous stream of information - six bits per frame. Two applications are presently defined: Dynamic Range Control and In-house information (see 3.5.1 and 3.5.5). The latter application is for the consumer-type receiver equivalent to "no information". The application in use is indicated in Byte L-1. Byte L, bit 1 contains the Contents Indicator flag. This flag is used in conjunction with the X-PAD field - see 3.2.4.2.1. Byte L, bit 0 (the last bit of the audio frame) shall be set to "0" for compatibility with the synchronization requirements of serial communication links within the DAB transmission chain. Although this demand is not applicable for the on-air signal, no function is defined for this bit. The information in Byte L-1 is time-multiplexed. This means that different data fields can be carried in different frames. In effect, Byte L-1 can carry multiple data channels "in parallel", each with a reduced capacity. It is suitable for transporting short data fields which require a regular low repetition rate (but do not need to be conveyed in each frame). Longer data fields can be used at correspondingly lower repetition rates. The (two or four) most-significant bits of Byte L-1 signal which data fields are conveyed in the remainder of the byte; they identify the "F-PAD type" and "F-PAD type Extension". Clause 7.4.1 in [1] lists the F-PAD types and the data fields conveyed in each F-PAD type.

The F-PAD type "00" signals the type of information (e.g. IH or DRC) carried in Byte L (bits 7...2) and the presence and length of the X-PAD field, i.e. the structure of the X-PAD field (see table 3.2.3). The F-PAD type "10" Extension "01" contains two parameters of different types, the M/S flag and the Origin parameter. Concerning the M/S flag, this information remains valid until it is replaced by a new value. Concerning the "Origin" parameter, the receiver has to buffer the information until it has the complete code, and then this code remains valid until it is replaced by new information. If no information is transmitted, the code "0" is used. It is recommended that the F-PAD type "00" (X-PAD Indicator plus an indicator of the contents of Byte L bits (7...2) is transmitted about ten times per second, i.e. every fourth frame in case of 24 ms frames. It is further recommended that the F-PAD type "10" Extension "01" (Music/Speech flags plus ISRC + UPC/EAN serial channel) are transmitted about five to ten times per second, when any of these applications are supported.

NOTE: The sequence of the transmission of F-PAD types is not rigid. Different Service providers can wish to transmit a different mix of PAD information, and the needs can vary in time. This also implies that the repetition rate of some data fields can be decreased for a short period when other data of higher priority are sent in a burst-like manner.

An example of a sequence of frames carrying different Byte L-1 data fields is shown in table 3.2.4A. The bits which identify the F-PAD type and Extension are underlined.

Table 3.2.4A: Example sequence of F-PAD fields

Frame	Byte L-1 b7 b0	Description
1	0001 0001	Size of X-PAD is four bytes (see 3.2.4.2.1); Byte L bits 7...2 contain DRC data ([1], 7.4.1.1);
2	1001 0101	Music/Speech = music (see 3.5.2); One bit of ISRC + UPC/EAN message (see 3.5.3);
3	0001 0001	Same as frame 1 because no other information is required more urgently;
4	1001 0100	Same as frame 2 because no other information is required more urgently; (the next bit of ISRC + UPC/EAN message);
5	0001 0001	Same as frame 1 because no other information is required more urgently;
6	1000 xxxx	An In-house command is inserted (see 3.5.5);
7	1001 0101	The original cycle is continued;
8	1010 xxxx	A command is started in the serial command channel (see 3.5.4);
9	1011 xxxx	The command continues. It is assumed that it has the highest priority, thereby suspending all other F-PAD types;
10	1011 xxxx	Another nibble of the command;
11	1011 xxxx	Another nibble of the command;
12	1011 xxxx	Another nibble of the command;
13	1011 xxxx	Another nibble of the command;
14	0001 0001	The command has ended and the original cycle is resumed;
15	1001 0101	etc.

If a Service provider does not include any Programme Associated Data (or perhaps only In-house information in Byte L) in the DAB audio frame, then Byte L-1 shall contain all zeros.

The receiver shall interpret this as:

- Byte L contains no relevant information: DRC data is not provided;
- Music/Speech flags are not provided: apply default setting;
- ISRC and UPC/EAN are not signalled;
- X-PAD size is zero bytes;
- Contents Indicator flag is irrelevant.

3.2.4.2 Basic Transport Mechanism in the X-PAD

The X-PAD channel allocated to an audio service component provides capacity to convey additional data associated with that service component. This additional data serves specific functions, which are described in [1] as applications.

(NOTE 1: The term application has another meaning elsewhere, e.g. in the specification of the MOT.)

X-PAD applications that are defined are:

- Programme related text coded either as Dynamic Label or as ITTS;
- Files and Multimedia objects coded according to MOT [14];

- Conditional Access (CA) messages for MOT [14];
- Closed user Group Information;
- In-house Information (for the internal use of the service provider and the broadcaster);
- Table of Contents of this specific X-PAD channel.

The X-PAD offers the possibility to transfer several applications in parallel by multiplexing the different types of them within one single X-PAD frame or within a sequence of several X-PAD frames. However, the transport mechanism allows only one application of a specific type. Consequently, one X-PAD data channel can carry e.g. not more than one Dynamic Label at a time. If the listener should be provided with several options in parallel to select from (e.g. several languages in ITTS or several topics in MOT) these have to be managed within the application itself). The different applications are identified by an appropriate addressing mechanism, i.e. by their application type. By this, the data capacity of an X-PAD channel is partitioned into several application channels, e.g. one for transferring a stream of MOT objects, another one for transferring Dynamic Labels. Furthermore the multiplexing of different applications within one X-PAD frame requires the application data stream to be partitioned into small pieces, the X-PAD data subfields, that can be mapped to one and/or subsequent X-PAD frames. (Note: The X-PAD data subfields can be compared with packets defined for the use in the Main Service with the transport mechanism Packet Mode, see 5.3.2 in [1]). Using the variable size X-PAD (one of the defined X-PAD field structures) the X-PAD subfield length can be selected according to the actual needs from one of eight values. (In packet mode 4, different values are available.) X-PAD subfields of different application types can be sent in any order in the PAD channel. However, the sequence of X-PAD subfields of the same type of application shall be maintained. Most of the applications are structured in data groups. Whereas in packet mode the packets allow the start, the continuation and the end of a (Main Service Channel) data group to be indicated, this mechanism is not provided by the X-PAD Data subfields directly. This is signalled indirectly instead: the start of an X-PAD group and its continuation are identified by different application types. This rule is applied e.g. with Dynamic Label and ITTS. These applications therefore have pair of applications types, one for start and one for continuation of the X-PAD data group. The end of the X-PAD data group is not signalled, but has to be found by the application decoder.

NOTE 2: In the case of MOT applications the length (and therefore also the end) of the MOT X-PAD Data group is indicated by an X-PAD data group of application type 1 which is immediately preceding the MOT X-PAD -Data group. The same principle can be applied for applications other than MOT, which can be defined in future.

All information, necessary for multiplexing several applications in one X-PAD channel and needed for demultiplexing at reception side, is combined in the contents indicator. It contains:

- at least the application types (either start or continuation, if appropriate); and
- the subfield length (not required in short X-PAD structure).

In 7.4.2 of [1], two figures (figure 29 and 30) illustrate the basic multiplexing mechanisms applied in the X-PAD channel. The use of application types, X-PAD subfields and contents indicators including subfield length will be explained in detail in the following clauses.

NOTE 3: Any references to the order of the bytes are made with respect to the logical order of the bytes. This is the order in which the bytes are read out of the receiver, not the reversed order during transmission.

3.2.4.2.1 The X-PAD field descriptors

Two fields contained in the F-PAD channel describe the X-PAD: these are the X-PAD Indicator and the Contents Indicator flag. The X-PAD Indicator is carried in Byte L-1, in bits 5 and 4 of F-PAD type "00". The Contents Indicator flag is carried in bit 1 of Byte L. The X-PAD Indicator signals the structure of the X-PAD field. This structure is intended to change infrequently, say during transitions to other programme items. The structure of the X-PAD field needs to be made known to the receiver regularly. Therefore when X-PAD is used, it is recommended that the F-PAD type "00" is transmitted once every four frames. This ensures a sufficiently short access time for a receiver newly switched on. The Contents Indicator flag is provided in every frame: it indicates whether or not Contents Indicators are included in the X-PAD field of that frame. It enables receivers newly switched on to monitor the starting of an application.

3.2.4.2.1.1 The X-PAD Indicator

The X-PAD Indicator indicates which of three structures is applied in X-PAD - see table 3.2.4B.

Table 3.2.4B: The X-PAD indicator

Byte L-1, bitnumber 7 6 5 4 3 2 1 0	X-PAD structure
0 0 0 0 x x x x	No X-PAD
0 0 0 1 x x x x	Short X-PAD (4 bytes)
0 0 1 0 x x x x	Variable size X-PAD
0 0 1 1 x x x x	Reserved for future use

For the "Short X-PAD" structure, the X-PAD field has a fixed size of four bytes and data from only one application can be carried in the X-PAD field. For the "Variable size X-PAD" structure, data from several applications can be carried in the same X-PAD field. The total size of the X-PAD field depends upon the size(s) of the X-PAD data subfield(s) carried in successive frames. A method for calculating the actual size of the X-PAD field is described in 3.2.4.2.4. If no X-PAD channel is used, the F-PAD type "00" shall signal "no X-PAD". In this case the F-PAD type "00" can be transmitted less frequently than the recommended rate of once every four frames. Alternatively, F-PAD type "00" can be omitted entirely while no X-PAD channel is applied. However, this is not recommended and is suggested here only for those situations when the amount of other information to be conveyed in F-PAD, is large.

NOTE 1: If b_5 b_4 ="11" state is signalled in the future, some receivers interpret this as signalling as "variable-sized X-PAD" as recommended by the first version of the present document. Therefore it is recommended to broadcasters not to use the "11" state whilst there are old receivers assuming this original interpretation. As long as the X-PAD structure signalled by b5b4 = "11" is not defined and reserved for future use, it is recommended that receivers ignore the X-PAD field for this configuration.

If no F-PAD type "00" is received (either because it is not transmitted or because the receiver has not yet captured it), then the receiver and X-PAD decoder shall assume that no X-PAD channel is applied.

NOTE 2: The audio decoder is not affected by the X-PAD field descriptors in F-PAD; it finds this information from the Bit Allocation field.

3.2.4.2.1.2 The Contents Indicator flag

The X-PAD field can contain (in its first bytes) an indication of the application(s) carried in its X-PAD data sub-field(s). Alternatively, under certain conditions explained in 7.4.2 in [1], the entire X-PAD field can contain application data. In the latter case no Contents Indicator(s) are carried in X-PAD. The Contents Indicator flag (in bit 1 of F-PAD Byte L) indicates which of the two situations applies. It is set ("1") when the X-PAD field of this audio frame contains at least one Contents Indicator. It is not set ("0") if the entire X-PAD field of this audio frame contains a continuation of an X-PAD Data group which has already begun, i.e. identified by the latest Contents Indicator which has been transmitted.

NOTE: The Contents Indicator flag is of no relevance if Byte L-1 signals "no X-PAD".

3.2.4.2.2 The X-PAD field

The X-PAD field can contain (in its first byte(s)) one or more Contents Indicators which describe the contents of the remainder of the X-PAD field. In this case, the remainder of the X-PAD field contains one or more X-PAD data sub-field(s). Each X-PAD data sub-field carries data from one application (or more correctly from one X-PAD Data group) - see figures 29 and 30 in [1]. Under certain conditions, explained in 7.4.2.2 in [1], the Contents Indicator can be omitted; thus the entire X-PAD field can be used for carrying application data. This is particularly useful when the short X-PAD is used.

3.2.4.2.2.1 The Contents Indicator

A Contents Indicator identifies the type of application carried in an X-PAD data sub-field, for example, In-house information, an ITTS text application or a Dynamic Label. If the "Variable size" X-PAD structure is applied, it further indicates the length of the associated X-PAD data subfield which is used to carry (part of) this application. If the "Short X-PAD" structure is used this indication is implicit, because the size of the X-PAD field is fixed at four bytes and only one X-PAD data sub-field can be carried. Because of these differences, the structure of the Contents Indicator differs with the X-PAD structure: With "Short" X-PAD the Contents Indicator consists of one byte which signals only the type of the application. Up to 255 different application types can be signalled (type numbers 1...255). With "Variable size" X-PAD the Contents Indicator consists of one or two bytes, depending on the application type. The application types in the range 1...30 are signalled directly in a single byte. Application types in the range 31 to 286 require two bytes: the first CI byte is set to the application type number 31 and the second CI byte signals the application type number minus 31. The first (possibly only) byte of the CI further indicates the length of the associated X-PAD data subfield carrying data from this application, according to the table in 7.4.4.2 in [1]. The Contents Indicators are always conveyed in the first four bytes of the X-PAD field, because these have a better protection ("medium protection level") than the rest of the X-PAD field. If the "Short X-PAD" structure is used, then there cannot be more than one Contents indicator. If the "Variable size XPAD" structure is used, there can be several Contents indicators and the first four bytes of the X-PAD field can be allocated as follows:

- four single-byte Contents Indicators; or
- two single-byte Contents Indicators plus one double-byte Content Indicator; or
- two double-byte Contents Indicators.

If all four of these medium-protected bytes are not needed for Contents Indicators, for example because only one application is carried in the current X-PAD frame, then a Contents Indicator of application type "0" shall be added after the last useful Contents Indicator. This Indicator of type "0" signals the end of the list of Contents Indicators and thus the beginning of the X-PAD data sub-fields. The size of the data subfield of an application of type "0" shall be regarded as zero bytes, irrespective of the size indicated in its CI. If occasionally no application data is to be transmitted, the only Contents Indicator in the X-PAD field is of application type "0" (End marker) and the Contents Indicator flag in the F-PAD is set to "1" to signal that this X-PAD field does not contain a continuation of an X-PAD data group which has already begun, i.e. identified by the latest Contents indicator which has been transmitted. The application type number generally includes an indication of whether the current X-PAD field contains the start of a specific X-PAD Data group or a continuation of that Data group (this does not apply to some applications). By using this mechanism a (long) X-PAD Data group can be interrupted by a Data group from another application, for example one which should be transmitted at a specific time, and then continued after the interruption. If a Data group continues in a following X-PAD field without being interrupted, the "continuation-CI" can be used as well. However, it is more efficient to reset the Contents Indicator flag and to use the full X-PAD field for that Data group. In this case, no Contents Indicator is needed. This situation is possible when only one application is conveyed in the X-PAD frame. The Contents Indicator does *not* signal the end of an X-PAD Data group. In general, the application decoder itself needs to know when a Data group is complete and whether the application data is followed by error-detection and/or correction information like a CRC. Moreover, following the end of the application data and CRC if present, some padding bytes (all zero) can be appended in order to make up the X-PAD data sub-field to a number of discrete sizes. In case of MOT applications (application types 12/13, 14/15, (16/17)), the length of an X-PAD Data Group (i.e. the MOT Data group) can always be derived from the immediately preceding X-PAD data group with application type 1. By this the position of the CRC-Bytes of the MOT Data group can be found and padding bytes can be identified, so that the MOT application decoder can be fed only with application data.

3.2.4.2.2.2 The X-PAD data sub-field

If the X-PAD structure is "Short" then only one X-PAD data sub-field can be conveyed in any X-PAD field, i.e. the whole of this X-PAD field is assigned to one application. If the X-PAD structure is "Variable size" then Data groups from up to four applications can be contained, in whole or in part, in the X-PAD field of the current frame. In both X-PAD structures, the X-PAD Data group of one application can be interrupted by that of another, for example for time-critical applications. The mechanism for doing this is supported by those applications which are assigned a pair of application-type numbers (to signal the start and continuation of an X-PAD Data group separately). The example in table 3.2.4C illustrates this mechanism for a sequence of applications in X-PAD, assuming that the maximum size of the X-PAD field is 16 bytes. Note that if the Contents Indicator flag is not set, the X-PAD field data in the current audio frame contains one application only. If the Data group of an "old" application continues in a frame in which a new application is introduced, then the Contents Indicators of both the continued and the new application shall be included in the X-PAD. As a consequence of this, the Contents Indicator flag shall be set. The example in table 3.2.4C illustrates how X-PAD data groups are carried in a sequence of X-PAD data sub-fields, each application with its application type according to the start and continuation of the X-PAD data group. The example includes:

- X-PAD data fields without contents indicator list (i.e. Contents Indicator flag set to 0), but filled completely with application data
- Interruption of an application by another
- Padding
- X-PAD size optimized to fit a maximum X-PAD size (here 16 bytes)

Table 3.2.4C: Example sequence of X-PAD fields

Frame	X-PAD information	Notes
1	Application type 2 CI (sub-field size = 12 bytes) Application type 0 CI 12 bytes of Dynamic Label information	Start of a Dynamic Label Segment; No more Contents Indicators; Application data.
2	Application type 3 CI (sub-field size = 8 bytes) Application type 4 CI (subfield size = 4 bytes) Application type 0 CI 6 bytes of Dynamic Label 2 bytes CRC for Dynamic Label 4 bytes of ITTS data	Contin. of the Dynamic Label Segment; Start of ITTS data; No more Contents Indicators; Application data; Error detection bytes; Application data.
3	15 bytes of ITTS data	Application data; Contents Indicator flag is set to "0", because no CI is needed. The previous frame used 15 X-PAD bytes, therefore the current size of the data sub-field is also 15 bytes.
4	15 bytes of ITTS data	Same remarks as for frame 3.
5	Application type 6 CI (subfield size = 12 bytes) Application type 0 CI 12 bytes of In-house information	ITTS is interrupted by In-house information; No more Contents Indicators; In-house Data group.
6	Application type 7 CI (subfield size = 6 bytes) Application type 5 CI (subfield size = 6 bytes) Application type 0 CI 6 bytes of In-house information 6 bytes of ITTS data	In-house information is continued; ITTS is resumed; No more Contents Indicators; In-house Data group; Continuation of ITTS.
7	Application type 5 CI (subfield size = 12 bytes) Application type 0 CI 8 bytes of ITTS data 2 bytes CRC for ITTS data 2 bytes of padding	ITTS data is continued. (Now the Contents indicator flag is set to "1"); Last part of ITTS packet; Error detection bytes; Filling the X-PAD data subfield.

Table 3.2.4D illustrates further properties of the transport mechanism (Note: it is not optimized for coding efficiency):

- The use of the X-PAD data group length indicator for MOT DGs and MOT DGs with CA;
- Multiplexing of several applications;
- Great variation of X-PAD size (here: by a factor of 2 and more).

Table 3.2.4D: Second Example sequence of X-PAD fields

Frame	X-PAD information	Notes
1	Application type 2 CI (sub-field size = 12 bytes) Application type 0 CI 12 bytes of Dynamic Label information	Start of a Dynamic Label Segment (#3); No more Contents Indicators; Application data.
2	Application type 1 CI (subfield size = 4 bytes) Application type 12 CI (subfield size = 4 bytes) Application type 3 CI (subfield size = 8 bytes) Application type 13 CI (subfield size = 16 bytes) 4 bytes of length indicator 4 bytes of MOT data 6 bytes of Dynamic Label information 2 bytes CRC for Dynamic Label 16 bytes of MOT data	Length of next MOT DG; Start of MOT DG; Continuation of the Dynamic Label segment (#3); Continuation of MOT DG; Length of next DG;MOT; Application data Application data (Error detection bytes); Application data.
3	Application type 13 CI (subfield size = 8 bytes) Application type 2 CI (subfield size = 8 bytes) Application type 3 CI (subfield size = 12 bytes) Application type 13 CI (subfield size = 4 bytes) 8 bytes of MOT data 8 bytes of Dynamic Label information 7 bytes of Dynamic Label 2 bytes CRC for Dynamic Label 3 bytes Padding 4 bytes of MOT data	Continuation of the MOT data; Start of Dynamic Label Segment (#4); Continuation of the Dynamic Label segment; Continuation of the MOT data; Application data; Application data; Application data; Error detection bytes; Filling the X-PAD data subfield; Application data.
4	36 bytes of MOT data	Application data; Contents Indicator flag is set to "0", because no CI is needed. The previous frame used 36 X-PAD bytes, therefore the current size of the data sub-field is also 36 bytes.
5	Application type 6 CI (subfield size = 12 bytes) Application type 1 CI (subfield size = 4 bytes) Application type 0 CI 12 bytes of In-house information 4 bytes Length indicator	MOT DG is interrupted by In-house information; Length of next MOT DG; No more Contents Indicators; In-house Data group; Length of next DG (MOT) including 2 bytes CRC.
6	Application type 14 CI (subfield size = 12 bytes) Application type 7 CI (subfield size = 6 bytes) Application type 13 CI (subfield size = 6 bytes) Application type 0 CI 12 bytes of MOT data with CA messages 6 bytes of In-house information 6 bytes of MOT data	Start of MOT DG with CA messages; In-house information is continued; MOT DG is resumed; No more Contents Indicators; Application data, CA messages; In-house Data group; Continuation of MOT DG.
7	Application type 15 CI (subfield size = 12 bytes) Application type 0 CI 10 bytes of MOT data 2 bytes of padding	MOT data with CA messages is continued. No more Contents Indicators; Last part of MOT segment; Filling the X-PAD data sub-field.

Figure 3.2.10 shows the multiplexing and sequencing of X-PAD DG with different contents. It refers to the frames 2 and 3 of the table 3.2.4D. Numbers in brackets indicate the application type applied in the associated X-PAD subfield.

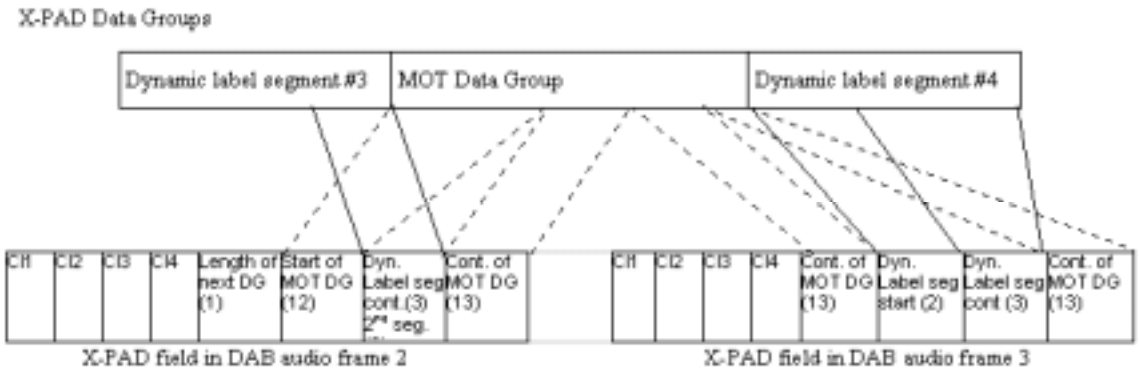


Figure 3.2.10: Example of multiplexing and sequencing of X-PAD Data Groups with different contents

3.2.4.2.2.3 Real-time aspects

The structure of the X-PAD field - "Short", "Variable size" or "no X-PAD" - is expected to be changed only rarely. However, when it is changed, some special measures shall be taken to ensure that receivers do not miss important data conveyed in the X-PAD. The simplest and safest method is to send no relevant data during and shortly after the change in structure and to signal the new structure several times (in F-PAD type "00") before the useful data transmission in X-PAD recommences. To send no relevant data in X-PAD and to signal this clearly to the receiver, a Contents Indicator of type "0" (end marker) should be the only contents indicator of that X-PAD data field. In the F-PAD, the Contents Indicator flag shall be set to 1. So the receiver is ensured, that this X-PAD field does not contain a continuation of an X-PAD data group which might have been started in an earlier frame. It is recommended not to change the X-PAD structure frequently. When the X-PAD structure is changed, the new X-PAD structure becomes effective in the frame which carries the X-PAD Indicator and which signals the new X-PAD structure for the first time. However, as described above, it is recommended that the X-PAD Indicator is repeated several times before any useful information is introduced into the X-PAD. If the X-PAD changes to "Variable Size", then at least the PAD field with the first useful Contents Indicator (not that CI of type "0") shall also contain (in F-PAD), the X-PAD Indication, i.e. the complete X-PAD field descriptor for the same DAB audio frame. An X-PAD Data group can be continued in the next frame without repeating its Contents Indicator only if the number of X-PAD bytes is not changed. This does not necessarily mean that a Data group cannot continue after a change in X-PAD structure. The X-PAD Data group can be regarded as being interrupted by a Data group of type "0" whilst the change in structure takes place. After this interruption, the X-PAD Data group can be continued using the new X-PAD structure. To signal the continuation, the Data group's Contents Indicator (the "continuation" type) shall be inserted and the Contents Indicator flag shall be set. In poor reception areas the receiver can find that PAD data is corrupted more frequently by transmission errors. This has to be taken into account by the Service provider, for example by repeating the same message a number of times. This applies especially for receiver control messages, for example information for display control, and even more for a change in the X-PAD structure.

3.2.4.2.3 Further Considerations

When the Service provider is faced with the decision whether to structure the X-PAD field as "Short", or "Variable size", it has to consider not only its requirements on data rates, but also the properties of the different transport mechanisms:

3.2.4.2.3.1 Short X-PAD

- minimum overhead, because the Contents Indicator of an application is transmitted only once (provided there is no need for an interrupt) and always in one byte only, so that the application can be transmitted efficiently;
- within one X-PAD field there is always only one application's Data group;
- direct addressing of all application types (0...255) by the one-byte Contents Indicator;
- applications of types 256... 286 (not defined at the time being) cannot be used;
- all data is protected equally at the medium protection level (used also with the scale factors).

3.2.4.2.3.2 Variable size X-PAD

- all applications' Data groups shall be segmented into X-PAD data sub-fields, of which the length is taken from a coarsely graded set of subfield lengths;
- several applications can share the X-PAD field of a DAB audio frame;
- direct addressing of only the first application types; the other application types (up to 286) are addressable by using 2 CI bytes (one "escape" byte, one for addressing);
- only the first (in logical order) 4 bytes of the X-PAD field are protected against bit errors at the medium protection level; so mainly the Contents Indicators benefit from this protection. The remainder, i.e. the X-PAD data sub-fields, is protected at the lower level (as used with the audio samples);
- the Service provider can try to optimize the use of the X-PAD field by choosing an appropriate maximum data rate: appropriate values can be taken from the set of lengths possible for an X-PAD data subfield (or sum of those values) increased by 4 (the maximum number of Contents Indicators within the same DAB audio frame): e.g. 8, 10, 12, 16, 20, 28, 36, 52 bytes etc. Residual X-PAD capacity can be used by in-house information of the Service provider (if not used for the audio signal and if applicable);

- theoretically, a total X-PAD field size of 196 bytes could be used: four X-PAD data sub-fields of 48 bytes each plus four Contents Indicator bytes. In practice, however, it must be borne in mind that receiver/decoders can be unable to handle X-PAD field sizes of more than 52 bytes. If more than 52 bytes of X-PAD in a frame are transmitted, then it is advisable to convey the more basic applications fully within the 52-byte area that can be handled by the first-generation receivers.

3.2.4.2.4 Rules for the management of the applications in the X-PAD

3.2.4.2.4.1 Application type 1: Indication of Data Group Length

This X-PAD Data group indicates the length of the next, immediately following X-PAD Data Group (of type MOT). It consists of 4 bytes only and fits - in the case of variable X-PAD size - therefore completely within a single X-PAD subfield of the smallest possible length. So there is no need for signalling a continuation of this "application", i.e. not a pair, but only one application type is defined for it. In case of short X-PAD size, this application type requires 2 X-PAD fields (with 4 bytes each), starting with the content indicator and the first 3 bytes in the first frame, ending with the last byte of the X-PAD group and 3 padding bytes in the second frame. In this case, this application shall never be interrupted. Furthermore, this application shall be directly followed by the application to which it refers (e.g. MOT application type 12 or 14).

NOTE: Application type 1 has been defined for an easier handling of X-PAD data groups carrying MOT applications. In future it can also be used for other applications. Therefore MOT application decoder should evaluate X-PAD Data group of application type 1 only, if it is preceding directly an X-PAD Data group carrying MOT data (of application type 12 or 14), i.e.: MOT decoders should not be disturbed, if application type 1 precedes other data groups than MOT and can refer to other applications.

3.2.4.2.4.2 Interruption of Applications

The transmission of an X-PAD data group of a certain type can be interrupted by that of another type.

In the case of X-PAD structure "Variable Size" this is done:

- by transmitting the last complete X-PAD subfield of the application to be interrupted; and
- then inserting the start of the application (that is interrupting) into the next available X-PAD data subfield, possibly in the same X-PAD field.

In case of X-PAD structure "Short Size" the start of the interrupting application is indicated by its contents indicator in the beginning of the next X-PAD field. Applications of different types can interrupt each other several times, if this is required. However, it is not allowed that an application of a specific type is interrupted by another application of the same type. This means: the X-PAD data group of an application of a specific type has to be transmitted completely before the start of another X-PAD data group of the same type can be sent. X-PAD Data Group length Indicator (Application type 1) shall not be interrupted, because there is no continuation defined for that application. There is another additional limitation for interrupting an application: If the X-PAD Data Group length Indicator (Application type 1) is sent, the next X-PAD subfield (or the next X-PAD field in case of short X-PAD size) shall be the start of the application (i.e. application type 12 for MOT objects or 14 for CA messages for MOT) the X-PAD Data Group length indicator is referring to. This implies that in case of short X-PAD size it can happen, that an interruption by an urgent application has to be delayed by 3 DAB audio frames (e.g. 72 ms), because an X-PAD Data Group length Indicator (Application type 1) has just started and an interruption is not allowed before the subsequent start of the X-PAD Data Group for MOT application. However, it could be argued whether the rather limited data capacity in short X-PAD sized channel allows MOT applications to be transmitted with acceptable performance.

3.2.4.2.4.3 Principal rules for multiplexing of Data Groups in the case of variable X-PAD size

- It is allowed to transmit up to 4 subfields in one X-PAD field with information of the same Data Group (Application type), i.e. the Data Group is continued in several subfields with contents indicator signalling continuation of this application.
- It is advisable to convey the more basic applications fully within the first 52-byte area that can be handled by the first-generation receivers, because they are unable to handle X-PAD field sizes greater than 52 bytes.
- X-PAD subfields of different Application types can be sent in any order. However, the sequence of those X-PAD subfields which carry information of the same type of application shall be maintained. Padding is only allowed at the end of the last subfield of an X-PAD Data group.

- The X-PAD field may have no contents indicator list (contents indicator flag set to "0"). This would reduce the capacity needed for signalling and provide it for the sake of the applications, i.e. especially for X-PAD channels with lower data rates efficiency can be raised.

  The contents indicator list can be omitted if an X-PAD field has the same length as the previous X-PAD field and in addition the X-PAD field contains the continuation of the X-PAD Data Group carried in the last X-PAD subfield in the DAB audio frame before.

- For error control, repetition of information can be applied. However it is not allowed to repeat X-PAD subfields. Repetition can be realized on the X-PAD Data Group level and has to be defined in context with the application. For MOT and Dynamic Label Segments complete X-PAD Data groups can be repeated (each with start and optionally continuation of application): So single segments of MOT objects or Dynamic Label are repeated. Alternatively the whole object or the complete Dynamic label can be repeated. In any case, appropriate repetition is recommended to overcome bit errors in X-PAD corrupting information in the less well protected part of the DAB audio frame.

3.2.4.2.5 Hints for the calculation of the size of X-PAD fields with a "Variable size" structure

When an X-PAD Data group is continued in an X-PAD field without signalling its Contents Indicator, then the receiver obtains no information about the size of the X-PAD field. If the "Short X-PAD" structure is applied, then the receiver recognizes that it has to interpret four bytes as continuation of the Data group. If the "Variable size" structure is applied, then the receiver shall remember from a previous audio frame exactly how many X-PAD bytes are in use. The total size of the X-PAD field, valid for the last frame that carried a Contents Indicator, remains valid until another Contents Indicator is found. This total size contains the continuation of the last started Data group, irrespective of the number of bytes that were assigned to that Data group in the frame where it started. The total size of the X-PAD field is the sum of the number of bytes occupied by the Contents Indicators and the size(s) of the X-PAD data subfield(s).

The number of bytes, occupied by Contents Indicators, is calculated by using the following rules:

- Applications of type 1...30 have a CI of one byte.

- Applications of type 31...286 have a CI of two bytes; "extended Application type".

If the useful Contents Indicators together occupy less than four bytes, then a Contents Indicator of the type "0", i.e. "End of Contents Indicators List", is added after the last useful CI. This CI of type "0" occupies one byte. The number of bytes, occupied by Contents Indicators, shall be in the range of 2...4, except when there is only a CI of the type "0". In this case only one byte is occupied, and this is also the total X-PAD field size as no application data is present. The number of bytes, which is occupied by each X-PAD data subfield, is indicated in the application's Contents Indicator, coded according to 7.4.4.2 in [1].

NOTE: The size of the data subfield of an application of type "0" shall be regarded as zero bytes, irrespective of the size indicated in its CI.

3.3 Multiplex Configuration Information (MCI)

The Multiplex Configuration Information (MCI) defines the organization of the Sub-channels, Services and Service components in an Ensemble and provides information for managing multiplex configuration. The MCI serves five principal functions (see 6.1 in [1]):

a) to define the organization of the Sub-channels in terms of their position and size in the CIF and their error protection;

b) to list and describe the Services available in the Ensemble (including Service component descriptions);

c) to establish the links between Service and Service components;

d) to establish the links between Service components and Sub-channels;

e) to signal a multiplex re-configuration.

It also signals the conditions required to access Service components. The MCI is machine-readable information which is transported in the FIC and encoded in Fast Information Groups (FIGs 0/0, 0/1, 0/2, 0/3, 0/4, 0/7 and 0/8) - see table 3.3.1. The FIGs are carried in Fast Information Blocks (FIBs) (see 6.1 in [1]). FIGs 0/0, 0/1 , 0/3 and 0/4 of this information has to be carried in the first FIB of successive 24 ms periods, which correspond to the Common Interleaved frames (CIFs) for the Main Service Channel. In addition to this requirement, other FIGs can also be carried in this first FIB position and the MCI can be repeated in any other FIB.

Table 3.3.1: Fast Information Group (FIG) Type allocation for the MCI

Fig Type	Description	C/N	OE	P/D
FIG 0/0	Ensemble information	Rfu	Rfu	Rfu
FIG 0/1	Sub-channel organization	C/N	Rfu	Rfu
FIG 0/2	Service organization	C/N	Rfu	P/D
FIG 0/3	Service component in packet mode with or without CA	C/N	Rfu	Rfu
FIG 0/4	Service component in stream mode of FIC with CA	C/N	Rfu	Rfu
FIG 0/7	Data service component type extension	C/N	Rfu	Rfu
FIG 0/8	Service component global definition	C/N	Rfu	P/D

Each Service is identified by a Service Identifier (SId), 16 bits (Sid) for Audio and 32 bits (Sid) for data. The use of an Extended Country Code (ECC), makes a service unique world-wide. These parameters are described first, followed by the Sub-channel and Service organization. Succeeding CIFs (see 3.2) are identified by the value of the CIF counter which provides a clock for managing multiplex re-configurations which is described at the end of this clause.

3.3.1 Service and Ensemble identification & labelling

Services and their components, and the ensembles in which they are carried, are identified by both machine-readable codes ("electronic" tags) and textual labels. The machine-readable code for a Service is the "Service Identifier" (SId) and for a Service component it is the "Service Component Identifier within the Service" (SCIdS). Similarly an Ensemble is identified by the "Ensemble Identifier" (EId). The additional use of the Extended Country Code (ECC), makes both the SId and the EId unique world-wide. Textual labels are defined for "Programme" and "Data" services, Service components and Ensembles. All these parameters are described in this clause.

3.3.1.1 Introduction

A Service is "the user-selected output from a receiver" and can be either a "Programme Service" or a "Data Service". Each service contains at least one and can contain several Service components. The intention is that a user can select this commodity and the receiver should try to decode as many of the components as possible within its hardware/software constraints. Different receivers will be able to respond to different combinations of components. The mandatory component is termed the Primary service component and any others are termed Secondary service components. A service having a Primary audio service component is called a Programme service and a Service having a Primary data service component is called a Data service (see 3.1 in [1]).

3.3.1.2 Purpose of the features

The Service Identifier (SId) is a machine-readable code which is allocated to each service and allows a receiver to distinguish between different services (see 6.3.1 in [1]). In any given area, transmissions which carry the same service, share the same SId. The SId is suitable for storage in a receiver, typically in association with "preset" service-selection buttons, so that services can be "programmed" into the receiver for subsequent direct selection by the user. The SId is not intended for direct display in a receiver: the Service label is used for that purpose. By checking the SId, the receiver can confirm the identity of a potential "better" alternative source of a selected service: such an alternative source can for example be another ensemble, an FM or AM transmission, a satellite channel or some other delivery method. The SId also provides the "hook" to identify other information associated with the service, for example the service label (see also 3.6.13). The coding range of the SId is limited and services used in different parts of the world can share the same SId. In order to remove this ambiguity, the machine-readable Extended Country Code (ECC) is introduced (see 8.1.3.2 in [1]). The combination of the SId with an ECC, allows each service to be identified uniquely on a world-wide basis. Each service component can be individually identified using the machine-readable Service Component Identifier within the Service (SCIdS) (see 6.3.6 in [1]). This code can be used by the receiver to find alternatives sources of the component and also to identify the associated Service component label so that a listener can make an informed choice when choosing between service components with the same type ASCTy or the same DSCTy (see 3.3.3). Services broadcast by other transmission delivery methods can have similar codes to identify the service. For example on FM, the RDS Programme Identification (PI) code is used for this purpose (see [22]) and provides a means whereby FM transmissions can be tested reliably for an alternative service source. When it is impossible to identify a service directly by such an electronic tag, a "dummy" service identifier can be used within DAB for the purpose of identifying a service label and a limited range of other service information.

3.3.1.3 End user of the features

The end-user shall be the receiver because all these features are machine-readable codes.

3.3.1.4 Provider of the features

Each DAB Service shall be allocated an SId and an ECC, and where appropriate SCIdSs, by the Service provider. Where secondary service components are present, the Ensemble provider assigns the appropriate identifier for use within the ensemble, according to the chosen transport mechanism (see 3.3.3). Dummy service identifier codes for AM and FM services without RDS are assigned by the Service provider.

3.3.1.5 Involvement of other parties

The Country identifier part of the service identifier code (see 3.3.1.6) shall be allocated at an international level by the appropriate broadcasting authorities: this is expected to be a task for the European Broadcasting Union (EBU) via CENELEC in Europe. The remainder of the SId (Service reference) permits up to 4 095 services to be identified for each Country identifier code. The Service reference shall be agreed at a national level and it is up to the Service providers of each country to agree the structure, bearing in mind that all services share this same coding field regardless of their means of delivery (DAB, FM, AM, etc.) (see 3.3.1.6).

3.3.1.6 Description

3.3.1.6.1 Service identifiers

The SId is a machine-readable code which is either in a 16-bit or 32-bit format.

The 16-bit format is used for Programme services and is structured as a Country Id (4-bit) and a Service reference (12-bit). Unlike the Radio Data System (RDS) Programme Identification (PI) code [22], there is no "Service type" element. The Service reference fields are allocated on a national basis. On the other hand, the Country Id is allocated internationally: it allows groups of up to 16 countries to be identified within the SId. The ECC is a machine-readable (8-bit) code which is defined in the same way as for RDS and allows 256 groups of countries to be identified. When used in combination, the Country Id and the ECC provide a world-wide unique country identification (see TS 101 756 [20]). Thus in total, twelve bits specify the country associated with the originating Service provider and twelve bits are used for service identification within a country. The 32-bit format is used for Data services. It contains the world-wide unique (12-bit) country identification (ECC and the Country Id) and an extended (20-bit) Service reference.

3.3.1.6.2 Service component identifiers

Each service can consist of several Service components at any one time. One service component is denoted the Primary service component and the others are Secondary service components. A Programme service has a Primary *audio* service component. A Data service has a Primary *data* service component. There can be up to 16 Service components at source, although only up to 12 (in case of Sld in 16-bit format) or up to 11 (in case of Sld in 32-bit format) can be delivered at one time in a DAB ensemble. The SCIdS is a machine-readable code (encoded in 4-bits) which identifies each component within a service. The combination of the SCIdS and SId provides a Service component identifier that is unique within the geographical bounds associated with the Country Id. The addition of the ECC provides a Service component identifier that is unique world-wide. Within an ensemble, each Service component is identified by a parameter which depends on the transport mechanism used (see 3.3.3 and [1], 6.3.4): In the case of a service component conveying audio in stream mode, the Service component identifier acts as an identifier for the PAD also because the PAD is an integral part of the component (see 7.4 in [1]). The relationship between the SCIdS and the Service component identifiers, which are only valid within an ensemble, is signalled in the Global service component information (FIG 0/8, see 3.3.3 and [1], 6.3.6). Using this information, the receiver can "follow" a service component if a better source is available in another ensemble.

3.3.1.6.3 "Dummy" identifiers

In general, service identifiers enable a receiver to recognize a service and, if an alternative source is sought, confirm that the service matches the one sought after. For DAB services, the SId is used for this purpose and for FM services, equipped with RDS, the PI code is used. There is no equivalent that can be signalled directly with programme services transmitted on AM or FM without RDS. This shortcoming can be partially met by assigning a "dummy" service identifier code to such services. Dummy identifiers can be signalled indirectly using DAB and can serve as a tag for service labels and a limited range of other service information features. The only difficulty with this approach is that it cannot provide the confirmation mechanism that is available for DAB services and FM services with RDS. The radio frequency associated with AM services or FM services without RDS cannot be relied upon for service identification because the same frequency can be re-used several times for different services. The Dummy service identifier takes the same form as the PI code [22] for FM services without RDS and the same form as the SId for other services.

3.3.1.7 Mandatory requirements

3.3.1.7.1 For broadcasting

Services are assigned identifiers on a national basis. The Country Id element is fixed for each country (see TS 101 756 [20]) and only the Service reference number (12-bit range) has to be considered by the Service provider. In the case of Programme services, this provides up to 4 095 services for each country Id code. This same pool of codes is used for all services, including DAB, FM and AM. For FM with RDS, the 12-bit code is translated into a Service type (4-bit) and a reduced-length Service reference (8-bit) to comply with the RDS-PI coding [22]. In the case of AM or FM without RDS, a dummy code is used. The SId is transmitted, for each Service, with a given minimum repetition rate (see 3.3.1.8). For each Service, the SId is carried in FIG 0/2 together with the description of the service. It is recommended that the ECC is transmitted, using a FIG 0/9 at repetition rate B for the "short" form and rate C for the "long" form, increasing to rate B at multiplex re-configurations.

3.3.1.7.2 For receiving

All receivers (except those used for special applications, for example paging) shall process the FIG(0/2) to extract the SId information. The SId shall be used to identify each Service; for example, the SId can be stored against a user-selected service to allow subsequent retrieval. The SId is also used as a "tag" to identify any other Service Information, for example, the number and detailed description of Service components or the status of interruption by other services if the announcement feature is implemented. There are no differences between the ways this information is handled in mobile, stationary or other special purpose receivers.

3.3.1.8 Operational aspects of broadcasting

3.3.1.8.1 Functional minimum requirements

The SIds for all Services, carried in an Ensemble, shall be transmitted in FIG 0/2 at repetition rate A. If a service is transmitted in several ensembles at least the same primary component of the service shall be present. Additionally it is recommended that all the secondary components should be present. There should be no conflicts in the service information delivered by the other ensembles. If a Programme service is simulcast on FM, it is the Primary service component content that is considered to come from the same original source (it does not imply that there will be a match of delivered subjective quality). Furthermore, no regard should be taken of the Programme Associated Data (PAD). There should be no conflicts in the service information delivered by other means. The service identifier for the simulcast service should be chosen, taking into account the Service type (area) element of the PI code (second nibble) which is associated with the planned service coverage area. Several services can share the same Service component for efficient use of the DAB ensemble transmission capacity. For example, when several Service providers broadcast the same news programme from the same source simultaneously, the Audio service component can be common and each Service can identify the same component in its MCI description. When services from different countries share the same ensemble, care should be taken to ensure that the SIds are unique within the ensemble. For example, it is theoretically possible for a service originating in Sweden to be given the same SId as a service from Spain. This constraint is a result of using shortened (16-bit) service identifiers, which is generally entirely satisfactory and more efficient from a data signalling capacity point of view than if 24-bit service identifiers had been used.

3.3.1.8.2 Optional extensions

When a service contains secondary components, they can be changed from time to time and shall not be regarded as permanent adjuncts of a service. As a result, the number of secondary components can vary from time to time. Different secondary components can be included in the service, depending on the form of delivery to the listener (DAB, satellite, cable, internet, etc.), although it is recommended that the full service is transmitted when possible. Not all secondary components need to be included in every broadcast transmission. For each secondary service component, the global definition should be transmitted in FIG 0/8 (see 3.3.7). This becomes mandatory if there is an associated label transmitted, but is strongly recommended if alternative service sources are also signalled. When PAD is carried in an audio service component, the PAD content can be changed from time to time and shall not be regarded as a permanent adjunct of a service component.

3.3.1.8.3 Inter-relations with other features

Apart from the use of the SId (in combination with the ECC) in the Service organization description and the global service component description in the Multiplex Configuration Information (MCI) (see 3.3.3 and 3.3.7), the SId is used as a tag in association with other service-related information. In the following there are examples from what has been defined so far:

- **Programme services**: Programme Number (see 3.6.4), Programme Type (see 3.6.5), Announcement Support (see 3.6.8), Programme service label (see 3.6.13), Service Linking Information (see 3.6.14), Local Service Area (see 3.6.16), and Ensemble Identifiers of other DAB Ensembles carrying the same Service (see 3.6.12).

- **Data services**: Data service label, Service linking information (see 8.1.15 in [1]), Local Service area and Ensemble Identifiers Eld of other DAB Ensembles carrying the same Service.

The following Service Information features are linked to a particular Service component: Announcement switching (FIG 0/19, for audio components only), Service component language (FIG 0/5), Service component trigger (FIG 0/20) and the Service component label (see 3.6.13). The link between these SI features and the Service component is established by identifying the Service component using the internal ensemble "hooks" (see 3.3.3), except for the label which uses the global identifier SCIdS (see 3.3.7). The Programme Type codes and Programme Number cannot be assigned to individual service components. All the components of one service share the same programme type classification and programme number: secondary service components can be assigned different languages in the PTy coding.

3.3.1.8.4 Preferred transport mechanisms and alternatives

The SId and SCIdS are part of the MCI and shall be transported in the FIC (using FIG 0/2 and FIG 0/8 respectively). Although not being part of the MCI, it is strongly recommended that the ECC information, encoded within the Country, LTO and International table feature (FIG 0/9), is also transported entirely in the FIC at the recommended repetition rate.

3.3.1.8.5 Recommendations on contents and real-time aspects

When the same primary audio service component content is permanently simulcast in a DAB ensemble and on FM, the SId and PI codes should be identical and there should be no conflict in any associated service information. This approach avoids the need to signal Service linking information.

If simulcasting cannot be guaranteed for all time, separate SId and PI codes should be assigned in the DAB and RDS signalling respectively and the Service linking information should be used to signal a hard link when the primary audio service component content is identical (see 3.6.14).

3.3.1.8.6 Default contents in the event of failing service

There is no substitute for the SId, SCIdS and ECC information.

3.3.1.8.7 Hints and remarks

The service access time at the receiver depends on the rate at which the SId is transmitted. In general, the minimum requirements are expected to provide satisfactory performance.

3.3.1.9 Receiver implementation aspects

3.3.1.9.1 Functional minimum requirements

FIG (0/2) shall be decoded. The SId shall be used to identify a Service and to allow service-related information to be gathered for each Service. At least the Primary service component shall be decoded by the receiver. When there is no distinction between the SId and the PI code, the receiver can be assured that the DAB Primary service component matches the FM audio content and that there are no conflicts in the service-related service information (PTy/PTY, PNum/PIN, etc.). The DAB receiver should attach no special significance to the second nibble of the service identifier: on the other hand, an FM receiver should interpret the Service type element of the PI code in order to decode the area information and any implied "soft" service linking (generic linking) (see also 3.6.14).

3.3.1.9.2 Optional extensions and alternatives

In order to avoid ambiguity in service identification using the SId alone, FIG 0/9 should be decoded and the Extended field examined to retrieve the ECCs of the services. Receivers which ignore the FIG 0/9 information can not operate reliably outside a confined geographical area. When there are secondary components in a service, a component identifier used within the ensemble is insufficient to identify the service component nation-wide. If it is required to switch to an alternative source of a component or if there are any service component labels available, the global service component identifier (SCIdS) should be decoded from FIG 0/8. When Service components share the same SCIdS within one service, the receiver can be assured that at least the service component type matches. When audio service components share the same SCIdS within one service, the receiver can be assured that they are fed from the same programme source and have the same audio content. However, the PAD can be different. When data service components share the same SCIdS within one service, the receiver can be assured that they carry the same content. In the case of local information, it is possible that the components have different contents to reflect the local region, for example different weather forecasts for different regions. The allocation of an SCIdS to a particular service component by a Service provider cannot be relied upon to remain unchanged over a long period of time. This means that the receiver can rely on using the SCIdS for checking for a component when it switches from one ensemble to another. On the other hand, the receiver should not store the SCIdS on presets so that a service component can be retrieved directly (because the SCIdS can change).

3.3.1.9.3 Recommendations on implementation and presentation

When a service is selected, the receiver can automatically attempt to acquire as many components as it is capable of decoding and presenting to the user without confusion. This usually means that two components of the same type cannot be presented simultaneously. Generally, only one service shall be selected at a time. However, the receiver can allow several services to be accessed simultaneously if this causes no confusion to the user and the user interface can be managed satisfactorily. A Service shall be selected before any of its secondary components can be selected. For service components of the same type, the user has to choose the desired component. An automatic selection/combination of these components is not possible. The Service component label provides the means for achieving this. If a particular secondary service component is not available from an alternative service source, the primary service component can be offered.

3.3.1.9.4 Fall-back in the event of failing service

Whenever Services cannot be identified by the SId and ECC, they cannot be offered to the listener.

3.3.1.9.5 Hints and remarks

The SId is essential for managing service access, service following to alternative service sources and identifying relevant service-related information. The SCIdS is necessary for identifying secondary service component labels so that users can be offered an informed choice of secondary component. The ECC is required in order to avoid any ambiguity which arises when different services share the same Sid.

3.3.2 Sub-channel organization

3.3.2.1 Purpose of the feature

The Main Service Channel (MSC) of a DAB Ensemble is divided into a maximum of 64 Sub-channels. Each Sub-channel is individually convolutionally encoded and comprises an integral number of contiguous Capacity Units (CU). The Sub-channel organization information allows the receiver to access a specific Sub-channel.

3.3.2.2 End user of the feature

The end-user shall be the receiver for Sub-channel identification (in a machine-readable form only).

3.3.2.3 Provider of the feature

It is provided by the Ensemble provider.

3.3.2.4 Description

Each Sub-channel is characterized by the following parameters:

- Sub-Channel Identifier (SubChId);
- start address of the first CU of the Sub-channel;
- size (in CU) of the Sub-channel;
- applied protection scheme;

  Two forms of signalling the sub-channel description are used. The first form (short form) is used for service components employing the Unequal Error Protection (UEP) profiles. In this case, a table index is signalled, indicating which of all permitted combinations of sub-channel size, protection level and bit rate is actually applied.

  The second form (long form) requires the sub-channel description to be signalled explicitly. In this case, eight options for defining these parameters are allowed; only the first two are defined and are used for Equal Error protection (EEP).

  UEP profiles are designed for use with audio services, but the use of UEP profiles for other applications is not excluded. EEP profiles can be used for audio as well as for data. In particular, UEP profiles are not defined for audio bit-rates 8, 16, 24, 40 and 144 kbit/s. For these audio bit-rates, EEP profiles should be used. (see 6.2 in [1]).

The parameters of a Sub-channel are fixed and can only be changed via multiplex reconfiguration (see 3.3.5).

3.3.2.5 Mandatory requirements

All the Sub-channels shall be described completely in the MCI and encoded in FIG (0/1).

3.3.2.6 Operational aspects of broadcasting

The Sub-channel organization shall be broadcast frequently at repetition rate A, so that receivers, newly switched on, have rapid access to the desired Sub-channel. Changes in Sub-channel organization are signalled in advance, during a preparation phase sufficiently frequently, before the actual change (see 3.3.5). The DAB Ensemble supports up to 64 Sub-channels. The values for the SubChId can be assigned arbitrarily by the Ensemble provider, except for SubChId 63. This Sub-channel is to be used, if redirected service information is to be sent in the Auxiliary Information Channel (AIC, see 3.2.4). Optionally conditional access information (EMM, ECM: see 2.8 in TR 101 496-1 [13]) can be sent in this Sub-channel, too. Packet addresses are reserved for AIC, EMM and ECM. Other packet addresses can be used freely at the same time. If there is no need for AIC, EMM or ECM, the sub-channel with SubChId 63 can be used for another purpose such as for a stream mode component.)No conflicting Sub-channel information shall be assigned. The Sub-channels shall not overlap so that each CU can be allocated only once.

3.3.2.6.1 Inter-relation with other features

Some features of the Service Information SI are linked to a particular component of that Service. (cf. Service organization, see 3.3.3). For Service components in Stream mode this link is established by the Sub-channel identifier SubChId. The following features are associated directly with the Sub-channel organization:

- Announcement switching (FIG 0/19);
- Service component language (FIG 0/5);
- Service component trigger (FIG 0/20).

3.3.2.7 Receiver Implementation aspects

Every receiver intending to access any Service component, shall be capable of decoding the Sub-channel organization in FIG 0/1.

3.3.2.8 Vital interaction between Service provider and receiver

The Sub-channel parameters are fixed between configurations (see 3.3.5).

3.3.3 Service organization: Services, Service Components

3.3.3.1 Purpose of the feature

The DAB Ensemble carries a number of Services, each of which can be selected by the listener. Each Service can be either a Programme service or a Data service and can comprise one or more Service components. The Service organization information lists and describes the Services and Service components.

3.3.3.2 End user of the feature

The end-user shall be the receiver for Service description (in a machine-readable form only).

3.3.3.3 Provider of the feature

It is provided by the Ensemble provider according to the needs of the different Service providers.

3.3.3.4 Description

The Service organization information lists and describes the Services and Service components carried in the multiplex. Each Service is identified by its Service Identifier SId (see 3.3.1). All Service components associated with a Service are described within a single Fast Information Group FIG 0/2. This allows up to 12 (in the case of programme services, Sld in 16-bit format) or up to 11 (in the case of Data services, Sld in 32-bit format) Service components (per service) to be signalled within one multiplex. The P/D flag in the FIG 0/2 header signals whether a particular FIG 0/2 contains information either on programme services or on data services, i.e. programme services and data services cannot be described in the same FIG. The Service organization information in FIG 0/2 also signals the conditional access system (if any) that applies to all the components and whether the service is available over the whole ensemble coverage area

or over only a part of the ensemble coverage area. Additional information about Service components in Packet mode is carried in Fast Information Group FIG 0/3. When Service components are carried in stream mode or in the FIDC and subject to Conditional Access, the additional information needed to access them is given in FIG 0/4. When a Service comprises several Service components, one is denoted the Primary service component and the others are Secondary service components. A Programme service has an Audio service component as its Primary component. The Primary service component of a Data service is a Data service component. FIG 0/8 gives a global definition of the Service Components. Additionally, further information about the Data Service Component type can be provided in FIG 0/7.

Service components can be carried

- in the FIDC (Fast Information Data Channel) (see 3.7); or
- in the Main Service Channel (MSC).

3.3.3.4.1 Service component identifiers

Service components are identified in different ways, depending on their transport mechanism (see 3.3.1.6 and [1], 6.3.4):

- Service components conveying audio or data both in Stream mode do not require a special identifier. They are identified - within a particular multiplex uniquely - by the Sub-channel they occupy, i.e. its corresponding Sub-Channel Identifier "SubChId" because this transport mechanism allows only one Service component in one Sub-channel.
- Service components in the FIDC are identified by the FIDCId (Fast Information Data Channel Identifier). The FIDCld comprises two parts, the Extension (3 bit) and the Type Component Identifier TCld (3 bit). The Extension specifies which of the service features is carried in the FIDC (Paging, TMC and EWS have been defined so far). The TCId allows up to eight different Service components for the same feature (sharing the same Extension, for example TMC).
- Service components with data conveyed in the Main Service Channel in Packet mode are identified by the Service component Identifier SCId.

3.3.3.4.2 Global Identification of Service components

Two different functionalities are supported by the global identification of the service components: service following and labelling of service components. Within a particular multiplex, the service components are uniquely identified by the SubChId, by the FIDCId or the SCId. If the same service is transmitted also in another (e.g. second) ensemble, operational constraints can require other values for the service component identifiers within the second ensemble. To enable the receiver to follow easily the service including the reception of all the available service components, when it is passing from one ensemble to another, a more global definition of the service components identifier is needed. This is given by the "Service Components Identifier within the Service" SCIdS. It allows for a particular service (having its own specific SId) to identify 16 different service components. So each service component is identified globally by the pairs of values of SId and SCIdS. The globally valid SCIdS of a service component is linked to the "local" service component identifier within the ensemble received. This link information is given differently in each of the ensembles in the FIG 0/8 if necessary (see 3.3.7).

NOTE: For global identification of service components the SCIdS in FIG 0/8 would be required only for secondary service components. A primary service component is completely identified by referring to the SId of the service it is belonging to. But if service components are provided with labels (see 3.6.13), it is necessary to assign the primary service component also its SCIdS.

In cases when Service component labels are not broadcast and the receiver has to switch immediately, it can find the primary service component and can start immediately decoding it, after having found the FIG 0/2, which provides all the necessary information for the primary service component at an appropriate high repetition rate.

3.3.3.4.3 Service component type

Each Service component is characterized by its Service component type, which is either carried in FIG 0/2 (see 6.3.1 in [1]) or FIG 0/3. Further information about data service component types can be carried in FIG 0/7. The type is used to indicate what the receiver can do with the Service component, for example selecting the decoder to which the Service component (audio, TMC, ITTS etc.) should be directed. Further details are to be found in 3.3.6.

3.3.3.4.4 Additional information

Service components in Packet mode require a second Fast Information Group FIG 0/3 in addition to FIG 0/2. FIG 0/3 contains the following information:

- Service Component Identifier SCId (as link between FIG 0/2 and FIG 0/3);
- packet address: which packets contain the information of the Service component;
- the Service component type DSCTy;
- the Sub-channel carrying the packets of interest (SubChld);
- the parameters for de-scrambling (SCCA), if scrambling is applied to the Service component.

If scrambling is applied to a Service component carried in Stream mode (audio or data) or in the FIC, the de-scrambling parameters SCCA are carried in another Fast Information Group FIG 0/4.

3.3.3.5 Mandatory requirements

All the Services shall be described completely in the MCI and encoded in FIGs 0/2, 0/3, 0/4, 0/7 and 0/8.

3.3.3.6 Operational aspects of broadcasting

The Service organization shall be transmitted frequently at repetition rate A , so that receivers, newly switched on, can have rapid access to the desired Service. Changes in Service organization should be signalled in advance, during a preparation phase and sufficiently frequently, before the actual change. (see 3.3.5). The values for the SCld and the SubChld can be assigned arbitrarily by the Ensemble provider, except for SubChld 63: this Sub-channel can be used for the Auxiliary Information Channel (see 3.6.19) and/or for conditional access information (see 5.8 in TR 101 496-1 [13]). However, a particular Sub-channel shall be associated with a single Transport Mechanism (identified by the TMId in FIG 0/2). In particular, if a Sub-channel carries Service Components in packet mode, it is not allowed to signal it also as a Sub-channel conveying a Data stream. Moreover, all Service Components pointing to the same stream mode Sub-channel shall have matching descriptions (for example, TMId, SCTy and CA flag). The Extension part of the FIDCld is fixed according to the conveyed service feature (e.g. TMC), the TCld part can be assigned arbitrarily by the Ensemble provider. The SIds, both in 16- and 32- bit format, should be regulated and follow the rules of figure 14 in [1]. The Local flag shall be used to indicate if the service is available over the whole ensemble coverage area or if the Local windows technique is being used within a Single Frequency Network to provide different content to different areas of the ensemble. If the local flag is set to 1, then the Local Service Area feature coded in FIG 0/23 shall be used to determine which service is available in which region (see 3.6.16). The local flag shall not be set to 1 since local windows shall not be implemented.

3.3.3.6.1 Inter-relation with other features

Each Service in a DAB Ensemble is identified by its Service Identifier (SId). Other information associated with a Service can be linked to it also by using the SId (see 3.3.1). Some of the Service Information features are linked to a particular Service component, in the case of Programme services: Announcement switching (FIG 0/19, only for audio components), Service Component Language (FIG 0/5), Service Component Trigger (FIG 0/20). The link between these SI features and the Service component is established by identifying the Service component by its local identifier (within the ensemble), the SubChId, the FIDCId or the SCId, depending on the transport mode. Service component labelling is not linked to the local identifier, but makes use of the global identification of the service components (see 3.3.7).

3.3.3.6.2 Recommendations on contents and real-time aspects

Several Services may share the same Service component for efficient use of the DAB Ensemble transmission capacity. For example, when several Service providers broadcast the same news programme from the same source simultaneously, the Audio service component may be common and each Service can identify the same component in its description. For some service arrangements, service components carried in packet mode cannot be sent with a service component description. This shall not result in malfunctions of a receiver.

3.3.3.7 Receiver Implementation aspects

All the receivers shall decode the Service organization carried in FIG 0/2. Receivers, which decode Service components in Packet mode, shall additionally evaluate FIG 0/3. Receivers designed for handling scrambled Audio services in Stream mode or scrambled components carried in the FIDC shall also evaluate FIG 0/4. Further information about the Service Component type can also be found in FIG 0/7. If an equivalent secondary Component is to be recognized by the receiver, FIG 0/8 shall be decoded.

The listener can have different possibilities for selecting his Service, e.g.:

- direct access to Services by buttons each pre-set to a particular Service (or Service label respectively);
- access to a Service by automatic search according to criteria offered in the Service Information (PTy, Announcement Support, etc.);
- selecting only Services which offer a specific desired Service component (e.g. TMC, specific language).

For those services which have more service components of the same type (e.g. several audio service components), the user can be offered the additional selection of one of the service components using service component labels (see 3.6.13). The decoding of FIG 0/8 is needed in this latter case. When a receiver has been switched on, it begins to collect information on the Service organization and Sub-channel organization of the selected DAB Ensemble. The next step is to find out which Services are available and how to access them. This is achieved by evaluating the Service list encoded in FIG 0/2. This contains the following information necessary for Service access:

- The local flag indicates whether a service is available over the whole, or only over a partial area served by the ensemble. Additional information regarding the local service area shall be signalled using the FIG 0/23, see 3.6.16 and also [1], 8.1.17.
- The Conditional Access Identifier (CAId) identifies which Access Control System is used. It applies to all components of the service;
- The number of Service components belonging to the Service;
- The description of each Service component belonging to the Service:
  - Service component identifier within the multiplex (FIDCId, SCId or SubChId);
  - Service component type (see 3.3.6);
  - Primary or Secondary service component;
  - with or without scrambling according to CA flag. The CA flag identifies, for each of the service components of a service, whether conditional access is applied.

The access to the Service components in Stream mode (without conditional access) is straightforward by searching the list with the Sub-channel organization (FIG 0/1) for the required SubChId and evaluating the corresponding part of the MSC. Service components carried in the FIDC can be accessed by selecting all the FIGs of type 5 with the appropriate identifier, the FIDCId. Service components in Packet mode can be accessed only, if in addition to FIG 0/2, FIG 0/3 is evaluated. If scrambling is applied to a Service component carried in Stream mode (audio or data) or in the FIC, the de-scrambling parameters SCCA are to be found in FIG 0/4. They have to be acquired first, before the scrambled Service component can be accessed and the selected Service can be presented to the listener.

3.3.3.8 Vital interaction between Service provider and receiver

The Service organization remains unchanged between two multiplex re-configurations. (see 3.3.5). Changes of the SCCA parameter do not require a multiplex re-configuration to be signalled.

3.3.4 CIF Counter and Logical frame counter

3.3.4.1 Introduction

The CIF counter is a modulo-5000 counter, provided by the Ensemble provider, which is incremented at the beginning of every common interleaved frame. The logical frame counter is a notional modulo-5000 counter, linked to the CIF

counter (it is not transmitted but deduced from the CIF count), which is incremented at the beginning of every logical frame.

3.3.4.2 Purpose of the feature

The CIF counter serves the purpose of identifying Common Interleaved Frames (CIFs). It is also used for identifying Logical frames, which have a fixed relationship to CIFs (see 5.3 in [1]). This is particularly important for those features which require actions that have to be synchronized to the CIF or the Logical frame, i.e.:

- Multiplex re-configuration: The new configuration replaces the old configuration at a well-defined CIF count (see 3.3.5);
- Conditional Access (CA): In some of the CA options the initialization of the PRBS generator depends on the Logical frame count (see 3.8);
- Service component trigger and Paging: The receiver is informed about the beginning or the end of the data transmission for particular (for example, sporadic) Services by means of the Logical frame count. This controls the hibernation of power saving receivers (see 3.6.9 and 3.7.1);
- Transmission of TII: From the CIF count the transmitter can generate a signal which controls the insertion of the TII symbol according to the rules given in 14.8 in [1] (see also 3.6.11);
- Clock frequency synchronization: From the CIF count low-frequency clock signals with a period of 120 seconds or six seconds can easily be generated. However, these clock signals have no defined phase relationship to UTC.

3.3.4.3 End user of the feature

The CIF counter and the Logical frame counter are used internally in the Ensemble multiplexer, in the transmitters and receivers of a DAB ensemble. They are not intended to be presented to the listener in any form.

3.3.4.4 Provider of the feature

The CIF counter is provided by the Ensemble provider. The Logical frame counter is a notional counter, which is never transmitted.

3.3.4.5 Involvement of other parties

None.

3.3.4.6 Description

The CIF counter is a modulo-5000 counter which is incremented at the beginning of every CIF. It is organized as follows:

- a modulo-250 counter (lower part CIF counter) which is incremented at the beginning of every CIF. When changing from 249 to 0 it generates a carry signal;
- a modulo-20 counter (higher part CIF counter) which is incremented on the carry signal of the lower part CIF counter.

Since the CIF period equals 24 ms, the lower part CIF counter has a period of six seconds and the higher part has a period of 120 seconds. The CIF counter is sent in the FIC as a 13-bit field in FIG(0/0) (see 6.4 in [1]), where the five MSbs signal the value of the higher part CIF counter and the eight LSbs signal the value of the lower part CIF counter. The transmitted CIF count applies to the CIF which corresponds to the FIB that carries the FIG(0/0). The Logical frame counter is a notional modulo-5000 counter which is incremented at the beginning of every Logical frame. It is linked to the CIF counter by the following rule: The Logical frame count of any Logical frame is identical to the CIF count of the earliest CIF which carries data from that Logical frame (see 5.3 in [1]). The Logical frame count is never transmitted but always deduced from the CIF count.

3.3.4.7 Mandatory requirements

3.3.4.7.1 For broadcasting

The transmission of the CIF count is mandatory. FIG 0/0 shall be broadcast at a fixed repetition rate and at a fixed position in the FIC (see 6.4 in [1]):

- In transmission mode I, this should be the first FIB (of the three) associated with the first CIF (of the four) of every transmission frame.
- In transmission modes II and III, this should be the first FIB of every fourth transmission frame.
- In transmission mode IV, this should be the first FIB (of the three) associated with the first CIF (of the two) of every alternate transmission frame.

Redirection to the AIC is not permitted.

3.3.4.7.2 For receiving

The decoding of the CIF count is optional, but it is required for the features listed in 3.3.4.2.

3.3.4.8 Operational aspects of broadcasting

None.

3.3.4.9 Receiver implementation aspects

3.3.4.9.1 Functional minimum requirements

The receiver shall use the CIF counter for managing multiplex re-configurations.

3.3.4.9.2 Inter-relations with other features

The implementation of the CIF counter is required for those features listed in 3.3.4.2.

3.3.4.9.3 Fall-back in the event of failing service

If the receiver fails in recovering FIG 0/0, its local CIF counter runs free. It is then re-synchronized as soon as the system CIF count becomes available again.

3.3.4.9.4 Vital inter-action between broadcaster/provider and receiver

The CIF counter is used to manage multiplex re-configurations (see 3.3.5).

3.3.5 Multiplex re-configuration

3.3.5.1 Introduction

3.3.5.1.1 Purpose of the feature

Multiplex re-configuration is a mechanism for synchronizing any change of the multiplex configuration between the Ensemble provider and the receiver to achieve service continuity. However, broadcasters should be aware that some multiplex re-configurations are harder to achieve seamlessly than others. Service continuity in stream mode means that no interrupts occur to data integrity due to multiplex re-configuration. In the case of audio this means that no impairment will be heard in ideal reception conditions. For packet mode, service continuity means that no packet is missed and for the FIDC it means that no FIGs for that service component are missed (in ideal reception conditions).

3.3.5.1.2 End user

The receiver.

3.3.5.1.3 Provider

The Ensemble provider in agreement with the appropriate Service provider(s).

3.3.5.1.4 Involvement of other parties

Generally, a multiplex re-configuration requires synchronous actions from the Service provider and the Ensemble provider, and has to be controlled via the distribution network.

3.3.5.1.5 Description

The multiplex re-configuration (see 6.5 in [1]) is a mechanism for synchronizing any change of the multiplex configuration between the Ensemble provider and the receiver. This is achieved by:

- announcing the event of a forthcoming multiplex re-configuration and its kind;
- defining the time instant of the multiplex re-configuration, i.e. when to switch from the current MCI to the next;
- transmitting the relevant part of the next Multiplex Configuration Information (MCI) in advance.

A forthcoming multiplex re-configuration is announced by setting at least one of the two Change Flags in the Ensemble Information field carried in FIG 0/0. Changes to SCCA parameters do not require a multiplex re-configuration. The combination of these Change flags (b_{15} and b_{14}, see 6.4 in [1]) also indicates the kind of the re-configuration.

b_{15}	b_{14}	
0	0	No re-configuration signalled;
0	1	Forthcoming re-configuration of Sub-channel organization (any change of FIG 0/1);
1	0	Forthcoming re-configuration of Service organization (change of FIG 0/2, 0/3, 0/4, 0/7, 0/8);
1	1	Forthcoming re-configuration of both Sub-channel and Service organizations.

With the first appearance of a set Change flag, the preparation phase of a multiplex re-configuration has started. It will last until the re-configuration instant. During this preparation phase, the change flags maintain their values for all the transmitted FIG 0/0s. In principle, multiplex re-configurations occur at the time boundary between two successive CIFs. When an LSF audio sub-channel is concerned in a multiplex re-configuration, the multiplex re-configuration should occur at the boundary between two successive LSF audio frames. During the preparation phase, the occurrence change field of the FIG 0/0 is used. The Occurrence change indicates the time instant of the announced multiplex re-configuration: The earliest CIF of which the lower part CIF count (see 3.3.4) equals to the value signalled as occurrence change will be the first CIF to which the next configuration applies.

During the preparation phase, the receiver shall get the information about the next multiplex configuration. This is managed by transmitting the relevant part of the next MCI in parallel with the current MCI in the FIC. The MCI (see 3.3.3 and 3.3.4) comprises information about the organization of the:

- Ensemble (carried in FIG 0/0);
- Sub-channels (carried in FIG 0/1);
- Services (carried in FIG 0/2);
- Service Components (carried in FIG 0/3, FIG 0/4, FIG 0/7 and FIG 0/8).

The Ensemble Identifier is static and is therefore not included in the multiplex re-configuration mechanism. The FIG type 0 data field (see 5.2.2.1 in [1]) includes the C/N flag, which indicates whether the information of this FIG type 0 applies to the current MCI (C/N=0) or to the next MCI (C/N=1). This flag is only used in extensions 1, 2, 3, 4, 7 and 8 of FIG type 0 (see 6.1 in [1]). Depending on the kind of multiplex re-configuration, different parts of the MCI of the next configuration shall be transmitted. With a reconfiguration of the Sub-channel organization only, at least the full Sub-channel organization shall be sent for the next configuration. In the case of a re-configuration of the Service

organization, at least the full Service organization, including the information about Service Components, shall be sent for the next configuration. With a re-configuration of both Sub-channel and Service organization, the full Sub-channel and Service organization, including Service Component information, shall be sent for the next configuration. A multiplex re-configuration can be given an index which indicates its complexity. The value of the index depends on the MCI parameters that change at the re-configuration. The table below summarizes the four complexity indices:

Table 3.3.5: Multiplex re-configuration complexity index

Re-configuration complexity index	MCI Parameters
1	Start Address Protection Profile Protection Level Bit-rate SCId FIDCId SCIdS (for primary component)
2	SubChId Packet Address (for packet mode components)
3	P/S flag CAId CA flag
4	TMId ACSTy/DSCTy, ExtDSCTy SCIdS (for secondary component)

Index value 1 is the minimum requirement for multiplex-reconfiguration. Index value 2 is more complex and should be handled, but service continuity is not assured. Index value 3 is still more complex and requires very careful management. Changing the parameters given for index level 4 shall cause service interruption.

3.3.5.2 Mandatory Requirements

3.3.5.2.1 For broadcasting

Multiplex re-configurations are optional for broadcasting.

3.3.5.2.2 For receiving

Receivers, intending to access the MSC, shall handle changes in the Multiplex Configuration Information (see 3.3.3 and 3.3.4). The support of this feature is especially important for the continuity of Audio service components and is therefore essential for all audio receivers.

3.3.5.3 Operational aspects of broadcasting

3.3.5.3.1 Functional minimum requirements

Change Flags, Occurrence Change and next MCI according to the description in 3.3.5.1.5 shall be transmitted.

3.3.5.3.2 Inter-relation with other features

Multiplex re-configuration can influence a large number of other features. For example, the Other Ensemble Information about a re-configured Ensemble, which is sent inside another Ensemble, requires an update. Multiplex re-configurations are managed by the CIF counter (see 3.3.4).

3.3.5.3.3 Preferred transport mechanisms and alternatives

In the FIC.

3.3.5.3.4 Recommendation on contents and real-time aspects

The Occurrence change field allows the re-configuration event to be announced up to six seconds in advance. It is recommended that it is announced as early as possible. During the preparation phase, which is considered to be between six seconds and four frames before the reconfiguration instant, the relevant part of the next MCI (see 3.3.5.1.5) shall be entirely transmitted at least three times. However, it is also recommended that the "next configuration" information is sent in the four frame periods immediately before the reconfiguration instant. Also, SI for new Services can be signalled in the preparation phase. A multiplex configuration shall remain stable for at least six seconds (see 6.5 in [1]). So the minimum time between two re-configurations equals to six seconds. At a re-configuration, the instant at which the "next" MCI becomes the "current" one shall be the signalled re-configuration instant.

3.3.5.3.5 Hints and remarks

The multiplex re-configuration instant is defined on the level of CIFs but re-configurations often require actions on the level of Logical frames, e.g. change of audio data rate or protection profile. Because of the delay introduced by the time Interleaving, careful timing of these actions is required (see 6.5 and annex D in [1]).

3.3.5.4 Receiver implementation aspects

3.3.5.4.1 Functional minimum requirements

The receiver, intending to access the MSC, shall process Change flags, Occurrence change and next MCI according to the description in 3.3.5.1.5.

3.3.5.4.2 Inter-relations with other features

Multiplex re-configurations can influence a large number of other features. Special care is required for the case where one or more Services are removed from the multiplex. All the SI related to a discontinued Service or Service component, including Service component language, Programme Number, Programme Type, and Announcement Support Information become obsolete at the re-configuration instant. The Other Ensemble Information is not included in the re-configuration mechanism. As a consequence, during a short period after the multiplex re-configuration of another Ensemble, the available Other Ensemble Information can be inconsistent with the actual service configuration of that Ensemble.

3.3.5.5 Vital interaction between Service provider and Ensemble provider

Multiplex re-configurations require interactions between the Service provider and Ensemble provider (e.g. change of sub-channel size) but not in others (e.g. change of sub-channel position only).

3.3.6 Service Component Type (ASCTy and DSCTy)

3.3.6.1 Introduction

3.3.6.1.1 Purpose of the feature

The Service Component Type parameter (ASCTy for audio and DSCTy for data) is used to signal the non-DAB transport protocol associated with the content of the service component. This information helps the receiver to select an appropriate decoder.

3.3.6.1.2 End user

The receiver uses this information to determine the used non-DAB transport protocol.

3.3.6.1.3 Provider

The Service provider sets the ASCTy/DSCTy information according to the non-DAB transport protocol which it uses for the service component.

3.3.6.1.4 Involvement of other parties

The assignment of the ASCTy and DSCTy parameters is independent of other players.

3.3.6.1.5 Description

The Service organization part of the MCI contains detailed descriptions of the Services and their Service components (see 3.3.3 and also [1], 6.3.1). A basic element for any service component is the Component Type parameter which is used to signal the non-DAB transport protocol of the content of the service component. This information is independent of the DAB transport protocol (TMId), which is signalled separately within the MCI, and can be considered to apply to the layers of the ISO-OSI model which lie above the DAB-specific transport part (see table 3.3.6).

Table 3.3.6: ISO-OSI model for DAB component type

Layer 1	Layer 2	Layer 3	Layer 4	Layer > 5
DAB channel	**DAB Transport (TMId)**	**Addressing**	**Non-DAB Transport**	
MSC	Stream mode	SubChId		ITTS EWS
	Packet mode	SCId MSC DG Type		TMC MOT UDP-IP
FIC	FIDC	TCId + Ext.		CORBA MPEG X
	FIG X	FIG Type/Ext.	DSCTy signalling	
DAB-specific part			**Content of service component**	

Separate parameters are used for Audio (ASCTy) and data (DSCTy). For audio components, just three out of 64 possible "ASCTys" are defined. The first two entries (Foreground sound and background sound) both effectively signal MPEG 1 or 2 audio. The third entry "multi-channel audio extension" effectively signals MPEG 2. For data components, a table containing DSCTy entries is defined although only a few data service component types are currently identified (see table 2 in TS 101 756 [20]. The first entry signals "unspecified data" and is reserved for specialist purposes. Some types of data are defined:

- TMC (Traffic Message Channel)
- EWS (Emergency Warning Systems)
- ITTS (Interactive Text Transmission System)
- Paging
- Transparent Data Channel
- Embedded IP packets
- MOT (Multimedia Object Transfer protocol)
- Proprietary service

NOTE: The entry for Paging has been changed since the first edition of [1].

In all these cases the data format for the application is defined and published elsewhere. In the case of the first four types, the application is fixed and is not signalled. In the case of MOT (see [14]), the DAB channel provides the transport for MOT applications. Individual MOT applications are signalled within the data stream. The data stream has to be decoded first in order to establish what data applications are carried inside it unless the MOT directory is used which allows the appropriate details of applications, carried by MOT, to be recoverable by the receiver without interrogating the whole data stream. In the case of a proprietary service the data format for the non-DAB transport protocol is defined but remains confidential to the Service provider and receiver manufacturer. Two further entries in the DSCTy table serve as pointers to two Extension tables, each containing room for 1 024 entries. The Extension tables are encoded in FIG 0/7 (see 6.3.5 in [1]). One of the extension tables supports proprietary services and is not a matter for standardization, the other table is reserved for general service types which can be defined in the future.

3.3.6.2 Mandatory Requirements

3.3.6.2.1 For broadcasting

The assignment of the ASCTy parameter for audio service components and the DSCTy parameter for data service components is mandatory.

3.3.6.2.2 For receiving

Receivers shall decode the Service component type information in order to establish the type of non-DAB transport protocol associated with the content of the component and to apply the appropriate decoder.

3.3.6.3 Operational aspects of broadcasting

3.3.6.3.1 Functional minimum requirements

Service component type information shall be assigned for all service components. It is an essential part of the service organization information, signalled by the MCI. Transport protocols are defined by reference to the ASCTy table for audio components and to the DSCTy table for data components. The ASCTy is encoded in FIG 0/2 and the DSCTy is encoded in FIG 0/2, FIG 0/3 or (in the case of the extension table being used) FIG 0/7.

3.3.6.3.2 Optional extensions

An extension table can be signalled using FIG 0/7, but this is currently reserved for future use. For data services carried by MOT or by some future transport protocol, where the DSCTy parameter alone cannot signal the vast amount of additional information that is required to identify particular user applications the User Application Information signalling shall be used (see 3.6.24).

3.3.6.3.3 Preferred transport mechanisms and alternatives

All MCI is transported in the FIC.

3.3.6.3.4 Recommendation on contents and real-time aspects

Broadcasters are recommended not to use the ASCTy background sound.

3.3.6.4 Receiver implementation aspects

3.3.6.4.1 Functional minimum requirements

In order to determine the type of service component and apply the appropriate decoder, the receiver shall process the ASCTy or DSCTy parameters contained in the MCI, encoded in FIG type 0/2, 0/3 or 0/7 (see 3.3.6.3.1).

3.3.6.4.2 Optional extensions and alternatives

There are currently no entries defined in the extension table (encoded in FIG 0/7), but this situation can change in the future.

3.3.7 Service Component global definition

3.3.7.1 Introduction

Services and their components, and the ensembles in which they are carried, are identified by both machine-readable codes and textual labels. The basic machine-readable code for a service component simply identifies one of a number of components of a service: it is referred to as the service component identifier within the service (SCIdS). Textual labels are defined for service components and these are described elsewhere (see 3.6.13). If a service component is carried in an Ensemble, the component acquires a specific form of identification, based on the particular transport mechanism

used, for example an audio component carried in stream mode is assigned a Sub-channel identifier (SubChId). These specific identifiers can be different if the same component is carried in different Ensembles.

3.3.7.2 Purpose of the Service Component global definition

The Service Component global definition is intended to provide a link between the basic Service component identifier (SCIdS) and the particular component identifier used in one or more DAB Ensembles. The basic identifier can be used universally and is independent of the DAB delivery mechanism. Therefore it is said to be applicable in a "global" context (the ECC is also required to make the Service Component Identifier unique worldwide, see 3.3.1). The Service Component global definition is a part of the multiplex configuration information (MCI). There are two considerations concerning the signalling of the Service Component global definition. Firstly, if a secondary Service component is broadcast on more than one Ensemble, a receiver needs the information in order to identify the particular component identifier used in each Ensemble. Secondly, if a service supports several secondary components, particularly those of the same type, and the associated labels are broadcast, a receiver needs to be able to link each component with its correct label.

3.3.7.3 End user of the feature

The end-user is the receiver.

3.3.7.4 Provider of the feature

It is provided by the Ensemble provider, in collaboration with the Service provider (who is also responsible for the Service components).

3.3.7.5 Involvement of other parties

None.

3.3.7.6 Description

The Service Component global definition, encoded in FIG 0/8, comprises the cross-referencing information between each basic Service component description and the corresponding identifier assigned within the Ensemble (see 6.3.6 1 in [1]). The basic identifier consists of the Service Identifier (SId) combined with the Service component Identifier within the service (SCIdS). The internal ensemble identification is based on the identification used for other service component features and takes two forms, depending on whether the component is carried in packet mode. This is signalled using the L/S flag. For the packet mode, the component is identified by the SCId parameter (see 6.3.1 in [1]). For other transport modes, the shorter form is used to signal either the SubChId (for stream mode or audio components) or the FIDCId (for components carried in the FIC). These are distinguished using the MSC/FIC flag. The Service Component global definition information supports two particular applications. For service component recognition, it allows a receiver to identify the appropriate service component after switching to another ensemble. This information is not required for service following when there is only a single "primary" service component. For that a listener can choose from a selection of different alternative service components, the Service component label provides an important user-selection aid. The Service component label is defined in terms of the global Service component identifier and the global definition information is required to identify the appropriate service component carried in the ensemble.

3.3.7.7 Mandatory requirements

The service component global definition is optional.

3.3.7.8 Operational aspects of broadcasting

3.3.7.8.1 Functional minimum requirements

If an ensemble carries a service which has one or more secondary components and if at least one of those secondary components is broadcast in another ensemble within a common geographical area, the Service Component global definition information shall be broadcast for each such service, in FIG 0/8 at repetition rate B. This enables the receiver to verify the identity of a secondary service component after switching to another ensemble. If an ensemble carries a

service which has one or more secondary components and if labels are also broadcast for those secondary components, the Service Component global definition information shall be broadcast for each such service, at repetition rate B.

3.3.7.8.2 Inter-relation with other features

Each secondary service component can be identified by a textual Service Component label (see 3.6.13).

3.3.7.8.3 Preferred transport mechanisms

The Service Component global definition is part of the MCI and shall be transported in the FIC (using FIG 0/8).

3.3.7.8.4 Recommendations on contents and real-time aspects

There are times when several Services may share the same secondary Service component, for example when a common news programme is carried. At these times a single sub-channel slot can be assigned and the SubChId becomes the common internal service component identifier. However, the label for this service component requires a global identifier in its coding. In the sharing situation, the global identification can be attributed to any of the services taking part. Thus there are several global identifier alternatives and it is recommended that all are signalled, in rotation (see also 3.6.13). The value SCIdS = "0000" is reserved for the Primary service component. Therefore it does not have to be signalled.

3.3.7.9 Receiver Implementation aspects

3.3.7.9.1 Functional minimum requirements

From the basic Service organization information carried in FIG 0/2, receivers can determine whether there are several secondary service components of the same type. If so, the receiver shall decode FIG 0/8 for the global definition information.

3.3.7.9.2 Optional extensions

From Service linking information, carried in FIG 0/6 (see 3.6.14), receivers can determine whether the currently tuned service is linked to any other services that are likely to offer alternative service sources. In addition, if the currently tuned service contains several secondary service components, there can also be alternative sources for some or all of these components.

3.3.7.9.3 Inter-relations with other features

If the global definition information is decoded because there are several secondary service components of the same type, the receiver should look out for service component labels, carried in FIG 1/4.

3.3.7.9.4 Recommendations on implementation and presentation

Using the global definition information and service component labels, a receiver can offer a simple selection of these service components to the user by using the appropriate labels. The value SCIdS = "0000" is reserved for the Primary service component, even though this may not be signalled.

3.3.8 Ensemble Identification & Ensemble ECC

3.3.8.1 Introduction

The DAB ensemble represents a collection of services which can be received and which can be available as an entity in the receiver. An ensemble can be broadcast terrestrially using one or more radio frequency channels. It is important to understand the difference between the terms *Single Frequency Network (SFN) service area* and *Ensemble service area.* The *Single Frequency Network (SFN) service area* is the area over which an ensemble is broadcast using one radio frequency channel allocation. The *Ensemble service area*: is the area over which the ensemble is planned to be receivable. If the ensemble is broadcast on one SFN, the ensemble service area is the same as the SFN service area. If the ensemble is broadcast on several SFNs, the ensemble service area is the union of the SFN service areas.

3.3.8.2 Purpose of the features

The Ensemble Identifier (EId) is a machine-readable code which is allocated to each ensemble and allows a receiver to distinguish between different ensembles (see 6.4 in [1]). The EId is not intended for direct display in a receiver: the Ensemble label is used for that purpose. The coding range of the EId is limited and ensembles used in different parts of the world can share the same EId. In order to remove this ambiguity, the machine-readable Ensemble Extended Country Code (Ensemble ECC) is introduced (see 8.1.3.2 in [1]). The combination of the EId with an ECC allows each ensemble to be identified uniquely on a world-wide basis.

3.3.8.3 End user of the feature

The end user is the receiver because these features are machine-readable codes.

3.3.8.4 Provider of the feature

Each DAB Ensemble shall be allocated an EId by the Ensemble provider. The Ensemble ECC is also supplied by the Ensemble provider, based on internationally agreed codes (see TS 101 756 [20]).

3.3.8.5 Involvement of other parties

There needs to be regulation at a national level to ensure that all ensembles are unique within a country. There needs to be regulation at an international level to ensure that ECCs (and the Country identifier part of the EId) are unique worldwide (see TS 101 756 [20]).

3.3.8.6 Description

The Ensemble Identifier is encoded as a 16-bit word in FIG 0/0 and is structured as shown in 6.4 in [1]. The Country identifier occupies the four MSbs. Note that the Country code "0" is not used. The remaining 12-bits are used as a Reference field and this part is assigned by Ensemble providers on a regulatory basis to ensure unique identification within each country. When used in combination with the Ensemble ECC, the resulting 24-bit code makes the ensemble identification unique worldwide. The Ensemble ECC is encoded in FIG 0/9. For normal Single Frequency Network (SFN) operation, the transmitted signal from all the transmitters shall be bit-by-bit identical, as if it was produced by the same multiplexer, in order to avoid signal interference. The service organization, sub-channel organization and all service information are identical from every transmitter. Generally, the same EId can be used whenever the same collection of services is carried in one or more SFNs. However, when local services are carried in an ensemble, the ensemble consists of a collection of services, which are expected to be available over the whole ensemble service area, and in addition, the ensemble consists of a number of local services, each of which is available in only a part of the ensemble service area. The "Local flag" carried in the service organization information (see 6.3.1 in [1]) is used to signal these local services. When the ensemble is delivered to different SFNs operating on different frequencies, there can be certain relaxations in the make-up of the ensemble, identified by a particular EId. This means that the service organization can be different, provided that all primary service components are present. Also, the sub-channel organization information does not need to be the same and the service information does not need to be duplicated exactly. There should be sufficient cross-referencing FI and no conflict in the ensemble-related service information such as the TII codes, Region identifiers and region labels (see 3.6.15). It can be advantageous to fulfil further conditions on the similarity and synchronization of the signals in order to permit "faster switching" when receivers seek alternative service sources. The Continuity flag carried in the FI is used to signal this situation and also other situations (see 3.6.10). For the same collection of services, the same EId can be assigned regardless of the way the ensemble is delivered to the receiver. For example the same ensemble can be available from a terrestrial Single Frequency Network (SFN) or a satellite frequency or a cable channel. Also, the same ensemble can be available from different terrestrial SFNs. In this case, the term "Ensemble service area" defines the total area over which the ensemble of services is available. It is important to note that when "regions" are defined, they are assigned for the entire Ensemble service area and not within the service areas of individual SFNs (see 3.6.15).

3.3.8.7 Mandatory requirements

3.3.8.7.1 For broadcasting

The EId shall be transmitted, for each ensemble, within the Ensemble information (FIG 0/0) with a given minimum repetition rate (see 3.3.8.8). Ensembles are assigned identifiers on a national basis. The Country Id element is fixed for each country (see TS 101 756 [20]) and only the Ensemble reference number (12-bit range) has to be considered nationally.

3.3.8.7.2 For receiving

Receivers shall process the FIG (0/0) to extract the EId, if the identity of the current ensemble needs to be known, such as when there is also FI that contains references to alternative sources of the ensemble.

3.3.8.8 Operational aspects of broadcasting

3.3.8.8.1 Functional minimum requirements

The Ensemble identification information shall be broadcast in FIG 0/0 at repetition rate A. It is strongly recommended that the Ensemble ECC is transmitted, using a FIG 0/9 at repetition rate B.

3.3.8.8.2 Inter-relations with other features

The EId is used as a tag in association with other ensemble-related information. In the following there are examples from what has been defined so far: Programme Type preview (FIG 0/12) (see 3.6.7), Frequency Information (FIG 0/21) (see 3.6.10), Other Ensembles services (FIG 0/24) (see 3.6.12), Other Ensembles announcements (FIG 0/25 and FIG 0/26) (see 3.6.8), Satellite database (FIG 0/30) (see 3.6.17) and the Ensemble label (FIG 1/0) (see 3.6.13). The Local service area (FIG 0/23) (see 3.6.16) is also related to ensemble information because it is by means of that feature that local service areas within an Ensemble service area are defined.

3.3.8.8.3 Preferred transport mechanisms and alternatives

The EId is part of the MCI and shall be transported in the FIC (using FIG 0/0). There is a special requirement to carry the FIG 0/0 in the first FIB of the transmission frame (see 3.2.1). Although not being part of the MCI, it is strongly recommended that the Ensemble ECC information, encoded within the Country, LTO and International table feature (FIG 0/9), is also transported entirely in the FIC.

3.3.8.8.4 Recommendations on contents and real-time aspects

There is a benefit in using the same sub-channel organization, service organization and transmission mode for ensembles that share the same EId. This fact can be signalled using the Continuity flag in the FI (see 3.6.10) and receivers can act on this information to provide faster switching to an alternative service source.

3.3.8.8.5 Default contents in the event of failing service

There is no substitute for the EId and ECC information.

3.3.8.8.6 Hints and remarks

The EId is essential for following to alternative ensemble sources and identifying relevant ensemble-related information. The Ensemble ECC is required when it is necessary to avoid any ambiguity, which arises when ensembles from countries, outside a certain international area, are of interest to the user.

3.3.8.9 Receiver Implementation aspects

3.3.8.9.1 Functional minimum requirements

Decoding FIG (0/0) is not mandatory, but the information is required to identify an Ensemble and interpret ensemble-related information for each ensemble, for example FI. In order to avoid ambiguity in ensemble identification using the EId alone, FIG 0/9 should be decoded to retrieve the Ensemble ECC. Receivers which ignore the FIG 0/9 information cannot operate reliably outside a confined geographical area. When ensembles share the same EId, the receiver can be assured that the same services and in particular the primary service components are present in each ensemble. However, if the Local flag (see 6.3.1 in [1]) is raised for any of the services signalled in the service organization information, those services will only be available over a limited service area. Also, the receiver can be assured that there are no conflicts in the ensemble-related information (Region definition and region labels, etc.).

3.3.8.9.2 Optional extensions and alternatives

When the "Local flag" (see 6.3.1 in [1]) is set, the service area is restricted to only a part of the Ensemble service area. In this case, the Local service area information (FIG 0/23) and the Region definition information (FIG 0/11) can be used to determine the actual service area in terms of the transmitters broadcasting the service (see 3.6.15 and 3.6.16). When the Continuity flag (see 8.1.8 in [1]) is set in the FI for alternative ensemble sources, the receiver can be expected to switch over to the alternative source faster (see 3.6.10).

3.3.8.9.3 Inter-relations with other features

See 3.3.8.8.2.

3.3.8.9.4 Fall-back in the event of failing service

The transmission of the EId supports the Ensemble label and other ensemble-related information. Whenever Ensembles cannot be identified by the EId, no Ensemble label can be displayed and no other ensemble-related information processed.

3.3.8.9.5 Vital interaction between Ensemble provider and receiver

If the Ensemble information ceases to be transmitted whilst the receiver is accessing the associated ensemble, the receiver shall remain with the ensemble, even though the normal checks for ensemble identification cannot be made.

3.4 Audio Coding

3.4.1 Audio modes

The DAB system allows for three audio modes: Single channel, Stereo and Joint Stereo. Independent from the audio mode, the complete audio signal is encoded in one DAB audio bit stream and can be accessed by the receiver as one integral Service component. In the case of the Stereo or Joint stereo audio mode, a stereo receiver will automatically reproduce the audio signal as a two-channel stereo signal comprising a left and a right channel. In the case of Single channel mode, the receiver will reproduce the audio signal as a mono audio signal. In the case of a monophonic programme, it is recommended to select the Single channel mode at the audio encoder. For such a programme, only the Single channel mode provides all the flexibility and service features defined within the DAB system.

3.4.2 Audio quality

The DAB System uses the ISO/IEC 11172-3 standard (or MPEG1 Audio) [6] and ISO/IEC 13818-3 standard (or MPEG2) [12] Layer II coding algorithm, following the ITU-R recommendation for the use of bit-rate reduced audio systems in broadcasting applications. In general, the audio quality depends on the bit-rate which is used for the encoding of the audio signal. Roughly speaking, the higher the bit-rate, the better the quality. In tests performed by ISO and ITU-R in the period 1990-1993, the following quality levels have been demonstrated [7]. ITU-R concluded after extensive testing that a very high level of quality can be reached at a bit-rate of 256 kbit/s (2×128 kbit/s) for a stereo programme: "there is no perceptible difference between an original sequence and its coded version". Higher bit-rates provide ample coding margin for cascading of codecs and post-processing. At a net bit-rate of 192 kbit/s using the Joint stereo mode, transparency is still maintained for most audio material. For the most critical sequences, "perceptible but not annoying" differences between the reference and coded signals can occur. If this is not acceptable, a bit-rate of 224 kbit/s could be considered. At low bit-rates the use of Joint stereo mode is preferred. At a bit-rate of 128 kbit/s for a stereo programme, using the Joint stereo technique, an intermediate audio quality is obtained. Annoying artefacts can occur for the most critical sequences. Note that neither the ISO/IEC 11172-3 and ISO/IEC 13818-3 standards nor the DAB standard EN 300 401 prescribe the encoder. This has the great advantage that encoders can be optimized for certain applications and that new psycho-acoustic results can be exploited to improve encoders, without need to change existing decoders. The consequence is however, that different encoders will have different audio qualities. The results of the above mentioned tests are valid for the state of the art of encoder implementation during 1992/1993. In the DAB system, 1,333 or 2 kbit/s per programme is used for transmission of scale factors CRC's and fixed PAD. In addition, 0...66 kbit/s can optionally be used for extended PAD. These bit-rates should be subtracted from the overall audio bit-rate to obtain a net audio bit-rate that determines the audio quality.

3.4.3 De-emphasis

The DAB system does not permit the transmission of emphasized signals, i.e. the emphasis bits in the bit stream should always have the value "00". If an emphasized signal is to be transmitted, de-emphasis has to be performed on the input signal prior to encoding. The ISO standard defines two types of emphasis characteristics (CCITT Recommendation J17 emphasis and 50/15 µs CD-emphasis). The required de-emphasis filters have one pole and one zero in the Laplace domain. This definition of the de-emphasis function ensures that it can be realized by simple, passive, analogue filters. In the digital domain, an exact implementation of the de-emphasis function would require an infinite number of poles and zeroes, and is thus impossible. However, a good approximation can be realized by a filter with one pole and one zero in the z-domain. The position of the pole and zero can be obtained simply by a bilinear transformation of the pole and zero in the Laplace domain, or, more accurately, by applying numerical optimization techniques.

3.4.4 Error detection and concealment for audio data

A DAB coded audio bit stream complies with the syntax defined in [1]. This clause describes the handling of residual bit errors in a received bit stream. These errors are detectable either because of failures of the CRC parity checks provided by the DAB audio bit stream, or as the result of bit stream syntax violations. In order to minimize the subjective annoyance resulting from these errors, a concealment strategy can be applied. The error status can be used for other purposes as well, such as indicating the reliability of the PAD. It should be noted that the concealment strategies described in this clause could be replaced by more advanced (which usually means also more complex) or simpler methods. Furthermore, future developments can provide more effective concealment techniques than those proposed here.

3.4.4.1 Handling of ISO-CRC failures

The 16 bit CRC word contained in each frame (**crc_check**, see 7.2.1.4 in [1]) enables the source decoder to check the validity of the received last 16 bits of the header, the bit allocation and the scale factor select information. Correctness of these bit stream elements is crucial for the successful decoding of a frame, as together they imply the composition of the rest of the frame. Trying to decode a frame with incorrect header, bit allocation or scale factor select information is likely to result in a very annoying burst of noise. Consequently, at an ISO/MPEG CRC failure, the whole frame contents should be discarded. Some concealment strategy has to be applied to substitute the sub-band samples missing from the discarded frame. The DAB channel appears to have bursty error characteristics; often a frame with an ISO/MPEG CRC failure is followed by more frames with a CRC failure. Therefore, it is recommended that the missing sub-band samples of the discarded frames be replaced by samples with value zero, i.e. to mute the sub-band signals during the discarding of the frames (as opposed to using interpolation or extrapolation schemes, which are only successful over a short period of time). When going into the muted state or returning into normal decoding state, the smearing effect of the reconstruction sub-band filter bank in the source decoder leads to "soft" muting and de-muting without audible "clicks".

3.4.4.2 Handling of SCF-CRC failures

The reliability of the received scale factor indices can be checked with the 8 bit scale factor CRC words, as described in annex B.3 in [1]. Decoding of a bit stream with incorrect scale factor indices is very likely to lead to annoying artefacts. As described in this annex, each scale factor CRC word applies to all scale factors within a group of sub-bands for one frame. Each sub-band with a non zero allocation carries 3 scale factors in each frame (packed into 1, 2 or 3 transmitted scale factors, as indicated by the scale factor select information). Therefore, if a CRC failure occurs, the 3 scale factors of all sub-bands in the corresponding group are assumed to be unreliable. The consecutive scale factors within a sub-band usually vary slowly with time. Therefore, it is very effective to replace the 3 unreliable scale factors in a sub-band by the third scale factor used in the preceding frame. This preceding scale factor can be assumed to be 0 if the sub-band was zero allocated in the previous frame, or if the frame was muted as a whole (e.g. due to ISO/MPEG CRC failure).

3.4.4.3 DAB-audio bit stream syntax check

The following syntactical elements in the bit stream have a restricted range, and therefore bit errors in these syntactical elements can result in violations of the DAB syntax definition. In the frame header, the **bitrate_index** cannot have the value "0000" or "1111". In most cases, the conditions causing these indices to occur will lead to an ISO/MPEG CRC failure. In the unlikely case that no CRC failure occurs, the same concealment as with an ISO/MPEG CRC failure (see 3.4.4.1) should be applied. Within DAB, the **sampling_frequency** index is fixed to "01", indicating a sampling frequency of 48 kHz or 24 kHz. A dedicated DAB source decoder should ignore any other sampling rate index, and substitute it by "01". In DAB, the **padding_bit** can only have the value "0". A DAB source decoder should ignore a received value "1" and substitute it by "0". In DAB, audio is always encoded without pre-emphasis. Consequently, the **emphasis** bits can only have value "00". In a DAB receiver, the received value of the these bits should be ignored and substituted by "00". The bit allocation and scale factor select information imply the number of bits in the respective frame actually assigned to each of the sub-bands. The maximum total number of assignable bits per frame depends on the bit-rate. Should the total number of assigned bits, as indicated by the received bit allocation and scale factor select information, exceed the number of assignable bits, then a bit-stream syntax error is to be inferred. Normally, such an error will be accompanied by an ISO/MPEG CRC failure. In the unlikely case that no CRC failure occurs, the syntax error should be handled in the same way as an ISO/MPEG CRC failure (see 3.4.4.1). The 6 bit scale factor indices range from "000000" to "111110"; value "111111" is illegal. If reception of a scale factor index "111111" is accompanied by a corresponding scale factor CRC failure, this results in proper concealment. If not, the scale factor index should be replaced by the maximum legal scale factor index "111110" (representing the minimum scale factor). Note that only the corrupted scale factor is concealed, as opposed to the proposed scale factor CRC concealment in 3.4.4.2, which concerns all scale factors in a group of sub-bands.

3.5 Programme Associated Data

3.5.0 General

Each audio frame contains Programme Associated Data' (PAD). In general, it has a strong relation with the audio, both in terms of its content and time-relation. The PAD is located in the ancillary data field of the ISO/IEC bit stream, in a way that is fully compatible with the ISO/IEC standard. The PAD has two parts - a fixed part (F-PAD) and an optional, extended part (X-PAD) - see 7.4 in [1]. The data rate of the F-PAD is 0,667 kbit/s and the data rate of the X-PAD is in the range 0 - 65 kbit/s. As shown in the error protection profile (see 4.5.2.3.2 in [1]) the F-PAD is better protected than the sub-band samples. There is no direct error detection available for the PAD. Information from error detection measures for other data in the DAB frame, such as SCF CRC check and/or ISO CRC check, could be used as an "indirect" indication of error events. This can be useful because errors are mostly of a bursty nature, so that it is probable that a detected CRC violation would be accompanied by errors in the PAD. There are two key advantages of the PAD. Firstly, it is fully synchronized to the audio throughout the transmission chain. Secondly, it remains the preserve of the service provider and the trade-off of PAD size and audio quality can be judged by the service provider independently of other multiplex considerations. A disadvantage of the PAD is that it cannot be identified as a separate entity: it is considered to be a part of the audio service component and no part of it can be signalled separately. This clause describes each PAD function.(see also 5.5 in TR 101 496-1 [13]) comprising Dynamic Range Control (DRC), Music/Speech indication (M/S), ISRC [23] & UPC/EAN [24] the Command channel, in-house data, the dynamic label segment, programme-related text (ITTS) [25] and Closed user group data.

3.5.1 Dynamic Range Control (DRC)

3.5.1.1 Introduction

The DAB audio signal can be of a very high dynamic range. In some circumstances, e.g. in a noisy environment, the listener may want to reduce the original dynamic range to improve listening conditions and achieve a better subjective audio quality.

3.5.1.1.1 Purpose of the Feature

This feature can be used to compress the dynamic range of the audio signal for special listening environments, especially for mobile reception and/or in noisy environment.

3.5.1.1.2 End-user of the feature

The receiver/the listener.

3.5.1.1.3 Provider of the feature

The Service provider.

3.5.1.2 Mandatory requirements

The use of the DRC feature is optional both for the service provider and the receiver manufacturer.

3.5.1.3 Operational Aspects of broadcasting

If supported, the service provider shall transmit the gain control signal for each audio frame, real time related to the audio signal, coded with 6 bits without any redundancy, according to the specification, 7.4.1.1 in [1].

3.5.1.3.1 Transport mechanism

The presence of the DRC feature is signalled in byte L-1 of the F-PAD. If implemented, the control information for each audio frame is carried in byte L of the F-PAD of the corresponding frame, coded with the 6 upper bits of this byte. The coding is described in detail in 7.4.1.1 in [1].

3.5.1.3.2 Recommendations on contents and real-time aspects

The DRC information shall be transported in real time and in synchronism with the audio signal. The DRC data assigned to the audio information of frame (n) shall be inserted into the PAD of frame (n-1). The gain values transported as DRC data should be co-ordinated with the associated audio levels in a way that will eliminate the possibility of digital full scale clipping in receivers using DRC, taking into account the existence of both interpolating and non-interpolating receivers. The non-interpolating receivers follow the general rule for all PAD-data, stated in 3.5.0. In interpolating receivers, the DRC-based gain control signal is continually changing. It is specified to match the conveyed gain values at the end point of each frame. The gain change from one value to the next is specified to be amplitude-linear (see 3.5.1.4.1).

3.5.1.4 Receiver implementation aspects

3.5.1.4.1 Functional minimum requirements

If the DRC feature is implemented, the receiver shall check the F-PAD byte L-1 for the indication of the presence of DRC-data. This information is carried by the "byte L indicator". The DRC presence information is valid for all following audio frames, until the "byte L indicator" signals the opposite. If DRC is present, the receiver shall interpret the 6 upper bits of byte L of the F-PAD as the unsigned binary coded DRC control word describing the gain in steps of 0,25 dB. If the control word is "000000", the gain is 0 dB. If the control word is "111111" (63), the gain is 15,75 dB. In order to minimize distortion caused by the gain changes, interpolation between the decoded gain values is recommended. When interpolation is implemented, the DRC data conveyed in frame (n-1) defines the gain at the end of the audio content of frame (n). Specifically, the signal to control the gain of the audio content of frame (n) should be generated by continuous interpolation between the gain values defined by the DRC control words of frame (n-2) and (n-1) as illustrated in figure 3.5.1.The continuous gain control signal is generated by means of interpolation from each DRC-based gain value to the next. The DRC data conveyed in frame (n-1) defines the gain at the end of the audio content of frame (n). Amplitude linear, dB-linear or other appropriate interpolation functions can be used.

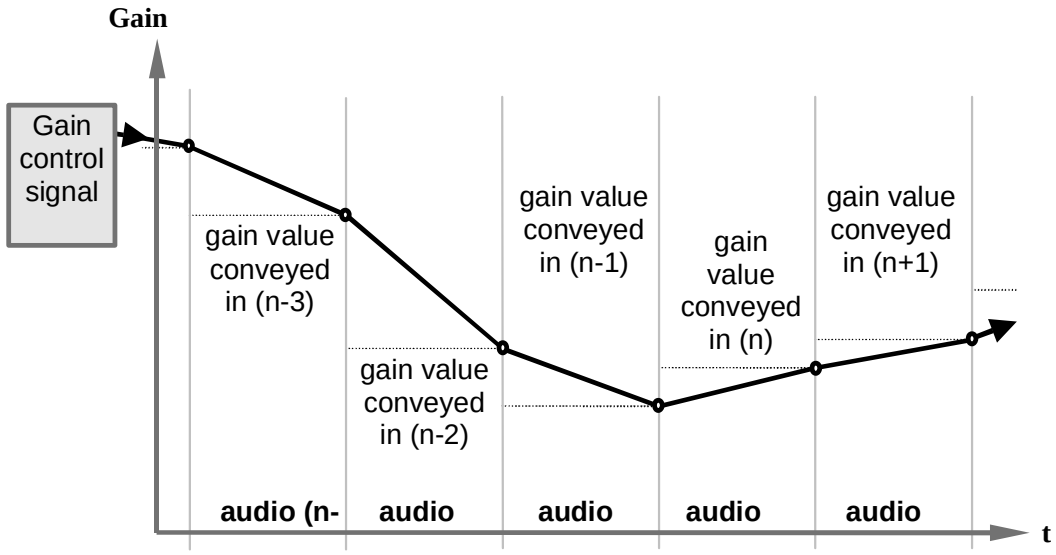


Figure 3.5.1: DRC-based gain control signal in DAB receivers

An amplitude-linear gain change should be regarded as the norm for interpolation. Other interpolation curves can also be used, provided that the instantaneous gain values of the amplitude-linear norm curve are never exceeded. A dB-linear interpolation will comply with this requirement. When interpolation is not implemented, the DRC data conveyed in frame (n-1) defines the gain of the entire audio content of frame (n). The audio content of a frame is defined as the set of sub-band samples contained within that frame or the equivalent PCM samples or analogue audio decoded from these same sub-band samples. A test method for DRC in DAB receivers is described in the annex of TS 101 757 [18].

3.5.1.4.2 Optional extensions and alternatives

There are other ways to control the dynamic range in the receiver that do not require the transmission of DRC information.

3.5.1.4.3 Recommendations on implementation and presentation

If supported by the receiver, the DRC feature should be selectable by the user. Preferably, this should not be a simple on/off switch but rather a scaling function which allows the listener to choose a preferred degree of compression.

3.5.1.4.4 Fall-back in the event of failing service

Since there is no direct error detection for PAD data available, information from error detection measures for other data in the DAB frame could be used as an "indirect" error detection criterion, such as SCF CRC check and/or ISO CRC check. This can be useful because errors are mostly of a bursty nature, so that it is probable that a detected CRC violation will be accompanied by errors in the PAD area. As an error in the DRC code can cause a large level change in the receiver, it is recommended that a protection mechanism is implemented. In the event of a failing service, the receiver should slowly step to the uncompressed situation or to a built-in default compression.

3.5.1.4.5 Vital interaction between broadcaster and receiver

If a Service provider stops transmitting DRC, the receiver should behave the same way as in the case of failing service.

3.5.2 Music-Speech-Flag (M/S)

3.5.2.1 Introduction

The M/S flag, carried in the F-PAD, can be used to distinguish between music and speech content of an audio programme (see also [22]).

3.5.2.1.1 Purpose of the feature

The purpose of this feature is to signal whether music or speech is being transmitted. The feature of the music-speech-flag allows a DAB receiver to select a specific sound processing according to the signal type.

3.5.2.1.2 User of the feature

The receiver and the listener.

3.5.2.1.3 Feature provider

The Service provider.

3.5.2.1.4 Other parties involved

No other parties are involved.

3.5.2.1.5 Description

The presence and meaning of the M/S-flag are coded in 2 bits in byte L-1 of the F-PAD. The coding scheme is described in detail in 7.4.1 in [1].

3.5.2.2 Mandatory requirements

The use of the music-speech-flag feature is optional both for the Service provider and the receiver manufacturer.

3.5.2.3 Operational aspects of broadcasting

3.5.2.3.1 Functional minimum requirements

If the Service provider signals in the M/S flag any other state than "not signalled", the flag shall be set according to the actual contents of the Audio service component.

3.5.2.3.2 Inter-Relations with other features

Due to the coding within the same phase of byte L-1 of the F-PAD, at least the absence of M/S-support should be signalled, if the ISRC and/or UPC/EAN serial channel is used in the receiver.

3.5.2.3.3 Transport mechanism

The 2 bit music/speech-flag information is carried in bits 3,2 of byte L-1 of the F-PAD, if the bits 7...4 of this byte signal equal "1001" and is coded as described in 7.4.1 in [1].

3.5.2.3.4 Recommendations on contents and real-time aspects

The M/S flag shall be transmitted according to the coding rules set up in the specification at repetition rate A. Because any change of the two states will be recognized only after a repetition of the new information for a number of 4 frames (4 x 24 ms), an appropriate timing of the remote control mechanism can be considered. Time delay for change of the status depends on the current DAB frame length according to the chosen audio sampling frequency (48 kHz or 24 kHz).

3.5.2.3.5 Default behaviour in the event of failing or unsupported service

If not supported, the information 'not signalled' (MS flag set to "00") shall be transmitted. The receiver should apply the default processing to the audio signal.

3.5.2.4 Receiver implementation aspects

The feature is intended for all **audio** receivers.

3.5.2.4.1 Interrelations with other features

The receiver can apply different DRC processing depending on the state of the M/S flags.

3.5.2.4.2 Recommendations on implementation and presentation

If the M/S feature is implemented, the receiver can be able to apply a special processing of the frequency response of the audio channel and/or dynamics of the audio signal. The usage of the feature should be switch selectable by the listener.

3.5.2.4.3 Fall-back in the event of failing service

The receiver should apply the default processing to the audio signal like in the case of "not signalled".

3.5.3 ISRC and UPC/EAN

3.5.3.1 Introduction

When a Service provider uses digital pre-recorded software as source material, these carriers usually also include the International Standard Recording Code (ISRC, see [23]) and/or the Universal Product Code (UPC) or European Article Number (EAN) (see [24]). These identifications of the source material can be conveyed in F-PAD. The purpose of this is to facilitate copyrights accounting automation. The ISRC and UPC/EAN can be carried in the F-PAD field, Byte L-1, bit 0 in F-PAD type "10" extension "01". One bit is transferred each time this F-PAD type is transmitted. Since this information is carried one bit at the time, a packet structure shall be used comprising a synchronization word, a data identifier and the actual data field. The sync word consists of the bit sequence "1111 1111 0". The data identifier consists of the three following bits. If these form the sequence "001" it means that the ISRC is transferred next, if the sequence is "010" then the UPC/EAN follows. The MSbit of the first letter/digit code in the data field immediately follows the last bit of the data identifier sequence. The data field of the ISRC consists of 58 bits that represent five letter codes (in six bit each) plus seven digit codes (in four bit each). The data field of the UPC/EAN consists of 52 bits that represent thirteen digit codes (in four bit each). Each letter/digit code is transmitted with its MSbit first. If both ISRC and UPC/EAN are transmitted, then they shall be conveyed alternately, separated by a sync word plus a data identifier. If neither ISRC nor UPC/EAN are transmitted, then no sync word shall be generated or all bits in the data field shall be zero.

NOTE: Two bits in the DAB audio header can be used to support the Serial Copy Management System (SCMS). The provision of SCMS information is subject to bilateral agreement between (radio-) Service providers and music-software providers.

3.5.3.2 Mandatory requirements

The transmission of ISRC and UPC/EAN is not mandatory, yet strongly requested by the music-software industry. If the source material does not contain the ISRC or UPC/EAN in "electronic form", but only printed e.g. on the sleeve or the inlay, then the Service provider is not required to input the codes into the transmission.

3.5.3.3 Operational aspects of broadcasting

The transmission of ISRC and UPC/EAN is assumed to be automated; the codes are read by electronic means from the digital pre-recorded carrier and inserted automatically into the F-PAD type "10" ext. "01". If no code can be read electronically from the carrier, then it is not required to read the code by other means; no code is transmitted. It is recommended to transmit F-PAD type "10" ext "01" about five to ten times per second, see 3.2.4.1. Under this assumption, transmission of the ISRC takes between seven and fourteen seconds and transmission of both ISRC and UPC/EAN takes almost twice that time. It is recommended, especially in the latter case, to transmit this F-PAD type as often as possible.

3.5.3.4 Receiver implementation aspects

ISRC and UPC/EAN are intended mainly for reception by special receivers. These receivers log the received codes for copyright accounting purposes. Nevertheless, it is conceivable that a consumer-type receiver has a mode in which it outputs the code, so that the listener can view the ISRC and/or UPC/EAN and use it for buying a recording of the song he is hearing.

3.5.4 Command channel

3.5.4.1 Introduction

The command channel is designed to convey commands of a few bytes in length but with a strong - and yet not too strict - time relation to the audio. No applications are defined yet, but this command channel would, for instance, be appropriate to instruct the receiver to switch-on a still-picture accompanying music. Such a still-picture would be read from a picture memory that was filled in advance via a data channel in the MSC. Since no applications are defined yet, no "command language" is developed. Here, only the outline of the transport mechanism is described. Commands can be carried one nibble at the time in the F-PAD field, Byte L-1, F-PAD type "10" extensions "10" and "11". Two type extensions are used because the extension number identifies a start or continuation condition: If Byte L-1 bits 7..4 equal "1010", then the bits 3..0 carry the first nibble of a command. If Byte L-1 bits 7..4 equal "1011", then the bits 3..0 carry a following nibble of a command that was started in a previous frame. Since the command is carried one nibble at the time, a packet structure is used consisting of a start sync, a main data identifier possibly extended with a sub-identifier, and the actual data field. The start sync is formed by the extension number of type "10": ext. "10" = start, ext. "11" = continuation of a command packet. The main data identifier consists of four bits and is carried in the first nibble of a command packet (see table 3.5.4). If this first nibble contains a value in the range "0000"..."1011" then the meaning of the data field is defined in a first identifier table. The values "1100", "1101", "1110" and "1111" each indicate a that a sub-identifier is to be read from the next nibble and they specify the identifier table from which the meaning of the sub-identifier can be read. The contents of the identifier tables are not yet defined. The command packet data field contains the actual command.

Table 3.5.4: Identifier table codes

bit 3 2 1 0	
0 0 0 0	identifier table 1
⋮ ⋮ ⋮ ⋮	identifier table 1
1 0 1 1	identifier table 1
1 1 0 0	Sub-identifier in the next nibble, identifier table 2
1 1 0 1	Sub-identifier in the next nibble, identifier table 3
1 1 1 0	Sub-identifier in the next nibble, identifier table 4
1 1 1 1	Sub-identifier in the next nibble, identifier table 5

3.5.4.2 Mandatory requirements

None.

3.5.4.3 Operational aspects of broadcasting

When a command is to be transmitted, the Service provider shall insert the F-PAD type "10" ext. "10" (first nibble) or ext "11" (following nibbles) in the sequence of F-PAD types. The command type can be included once per PAD-type cycle (e.g. one nibble per 200 ms.), but for urgent commands the original F-PAD type sequence can be suspended for a short period to make room for command nibbles in every frame. For commands that have a strong real-time relation to the audio, the Service provider can anticipate that the receiver reacts on a command shortly after receiving its last nibble; the command shall be transmitted in advance, with that last nibble at - or just before - the point in time where a response is due. If no command is presently to be transmitted, F-PAD type "10" extensions "10" and "11" shall not be included in the sequence of F-PAD types.

3.5.4.4 Receiver implementation aspects

These depend on the applications that will be defined.

3.5.5 In-House data (IH)

3.5.5.1 Introduction

3.5.5.1.1 Purpose of the feature

In-house data (IH) is intended only for use within a broadcasting organization and using special receivers. Examples include signalling the source of a Service, transmitter control and internal paging.

3.5.5.1.2 End user of the feature

The Service provider, Ensemble provider or Network provider via dedicated receivers.

3.5.5.1.3 Provider of the feature

The Service provider or Ensemble provider.

3.5.5.1.4 Involvement of other parties

No other party is involved.

3.5.5.1.5 Description

The definition of the application and the data coding is determined unilaterally by the Service provider and/or the Ensemble provider. IH can be transported specifically in the PAD or the FIC. The PAD provides two possibilities for carrying the IH synchronized to the audio. The first allows 4 bits to be sent in the F-PAD but is time-multiplexed with the Music/speech feature and the serial command channel. Assuming that every fourth frame is used for IH, an average data rate of about 40 bit/s is achieved. The second possibility is only available when DRC information (see 7.4.1 in [1]) is not implemented. When available, the maximum IH data rate is about 250 bit/s. In the FIC, FIG 0/7 is reserved for IH, except for the case when the "Length" indicator signals "31" because this is used for the "End marker" (see table 3 in [1]). The MCI takes precedence over other information carried in the FIC, but an IH data rate of up to 4 kbit/s might be realistic. If a large data capacity is required, a separate Sub-channel in the MSC or a particular packet could be used.

3.5.5.2 Mandatory requirements

3.5.5.2.1 For broadcasting

IH is an optional feature for which specific data channels are reserved within the PAD and FIC. Separate channels are provided for both short, audio synchronized commands and for longer strings of asynchronous data.

3.5.5.2.2 For receiving

Special receivers shall use decoders which are matched to the encoders. Commercial receivers shall ignore all in-house information.

3.5.5.3 Operational aspects of broadcasting

3.5.5.3.1 Functional minimum requirements

These are a matter for the feature provider and the particular IH application.

3.5.5.3.2 Inter-relations with other features

IH is independent of other data features. However, for the short audio-synchronized commands, the maximum data rate of 166 bit/sec can only be achieved at the expense of other features which are time-multiplexed within the F-PAD, such as the signalling of X-PAD, the Music/speech feature, copyright control and serial command signalling.

3.5.5.3.3 Preferred transport mechanisms and alternatives

IH can be carried in the PAD and the FIC.

3.5.5.3.4 Recommendations on contents and real-time aspects

This is dependent on the feature provider.

3.5.5.4 Receiver implementation aspects

3.5.5.4.1 Functional minimum requirements

Decoders shall be matched to the encoders.

3.5.5.4.2 Optional extensions and alternatives

There are no optional extensions as far as the operational aspects are concerned.

3.5.6 Dynamic label

3.5.6.1 Introduction

3.5.6.1.1 Purpose of the feature

The purpose of the Dynamic label feature is to provide short textual message labels, associated with audio programme content, for display in the receiver. Labels can have any length up to a maximum of 128 characters. The display attributes are essentially limited to basic text.

3.5.6.1.2 End user of the feature

The receiver and the listener.

3.5.6.1.3 Provider of the feature

The labels are issued by the Service provider and inserted into the MPEG audio bit stream in the Programme Associated Data field.

3.5.6.1.4 Involvement of other parties

The provider of FM services, simulcasting DAB services, can derive Radiotext from the Dynamic label or derive the Dynamic label from Radiotext.

3.5.6.1.5 Description

The Dynamic label comprises up to eight segments (each of up to 16 characters). Segmentation is for transportation only. Single segment labels are generally displayed as soon as they are received but multi-segment labels are generally buffered and displayed as a complete label. Control characters should be used to affect the display presentation, which also depends on the display size and memory/processing power available in the receiver. A "headline" part of a multi-segment label can be indicated by control characters and the headline can be presented differently from the remainder of the label. The optional control codes are hex 0B for "end of headline", hex 0A for "preferred line break" and hex 1F for "preferred word break". The purpose of hex 0B (end of headline) is to indicate a headline which can be presented differently from the remainder of the label. The purpose of hex 0A (preferred line break) is to indicate a position where the author of the text would prefer to insert a line break in order to structure the text in a particular way. The purpose of hex 1F (preferred word break) is to indicate an appropriate position to break a long word if necessary. There is no benefit in breaking the word if the display can accommodate the whole word. The Dynamic label segment is encoded in a Data group and carried as an application in the X-PAD (using Types 2 and 3). It is associated with the corresponding Audio service component. The X-PAD Data group contains a Prefix, a Character field and a CRC (see 7.4.5.2 in [1]). The Prefix contains information concerning the size, character set and treatment of the Dynamic label. The Prefix contains "Toggle", "First", "Last" and "Command" flags, a Field 1 containing a command or the number of characters minus one, and a Field 2 containing the character set identifier or the segment number. Currently, the only command is "remove label".

3.5.6.2 Mandatory requirements

3.5.6.2.1 For broadcasting

The Dynamic label feature is optional.

3.5.6.2.2 For receiving

Response to the Dynamic label feature is optional.

3.5.6.3 Operational aspects of broadcasting

3.5.6.3.1 Functional minimum requirements

When implemented, the Dynamic label text shall be divided into segments for transmission. An X-PAD Data group Prefix shall be formed for each segment and a 16-bit check word shall be calculated, based on the Prefix and Character field, using the same calculation method as for general Data services - see [1], annex E. The resulting X-PAD Data group shall be encoded into the X-PAD field of the associated Audio component, together with the necessary Contents indicator. Dynamic labels should be transmitted at least twice in succession for as long as they remain valid. This is likely to be about one second per eight to twelve characters transmitted but will vary with label content and intended audience. Headlines are treated differently, see below. When a label becomes invalid and is not replaced by another label, a "remove label" command shall be sent. Service providers should be aware that there can be different forms of receiver display used to present this feature. The Toggle bit in the Prefix field shall be toggled when a new Dynamic label is transmitted. Whilst the label remains valid and is repeatedly transmitted the Toggle bit shall remain in the same state.

3.5.6.3.2 Optional extensions

The dynamic label is segmented without observing its content, i.e. word boundaries (blank characters) or control codes. A dynamic label can start with one (and only one) headline. A "headline" can be indicated by signalling "end of headline" using the control character hex 0B after the headline text. A headline will carry information that is meaningful by itself. Headlines are restricted to a maximum length of 32 characters (including hyphens introduced as a result of a preferred word break). The adopted format for the headline is a 2×16 character display and a 1×32 character display. All characters will be counted (including control characters) in the length field. The headline should be kept stable for at least 1 minute due to safety reasons for car presentation. The headline can be complemented by the rest of the label, which can be updated more frequently. The headline can contain only one hex control code, hex 0A (preferred line break) or hex 1F (preferred word break). No headline is signalled by the absence of a hex 0B (end of headline) character or by a hex 0B (end of headline) character in position 0 of the label. The control code hex 0B indicates the end of the headline only, no character is displayed for the code hex 0B. Only if the control code hex 0B is followed by a character, such as a space or a "preferred line break", that character is implemented after the end of the headline. The headline may end within the middle of a word if this appears appropriate e.g.:

"Dire Straits in Bayern D"<0B>"igital"

The service provider can indicate a "preferred line break" by inserting the control character hex 0A and indicate a "preferred word break" by inserting the control character hex 1F, for the benefit of receivers using a display that can support more than one row of characters. The optional code hex 0A (preferred line break) will appear a maximum of once within the headline. There will be a maximum of 16 displayable characters, the "preferred line break", and 15 displayable characters, or a maximum of 15 displayable characters, the "preferred line break" and 16 displayable characters. The sum of displayable characters when using the "preferred line break" shall be less than or equal to 31 as the 1x32 display will insert a space in place of hex 0A. Code hex 1F (preferred word break) may appear only once within the headline. There will be a maximum of 15 displayable characters before the "preferred word break", and a maximum of 16 displayable characters after the "preferred word break". Words longer than 16 characters should include a "preferred word break". The control codes are constrained as to where they can be inserted in the headline.
Figure 3.5.6 shows the agreed range of positions where control codes can be inserted for the "end of headline" (hex 0B), the "preferred line break" (hex 0A) and the "preferred word break" (hex 1F). Numbers refer to displayed character position.

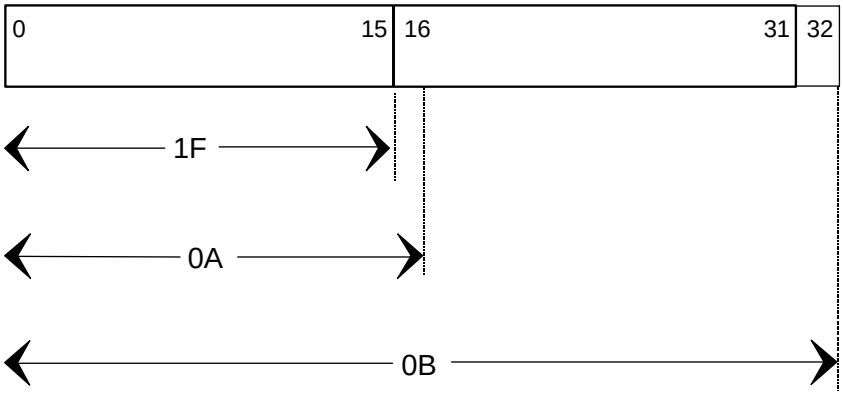


Figure 3.5.6: Range of Control Code Positions

3.5.6.3.3 Inter-relations with other features

The Dynamic label feature is independent of other features.

3.5.6.3.4 Preferred transport mechanisms and alternatives

When implemented, the Dynamic label information is transported in the X-PAD. No other transport mechanism is allowed.

3.5.6.3.5 Recommendations on contents and real-time aspects

The Dynamic label contents are a matter for the Service providers. A headline can be treated separately from the remainder of the label and is expected to remain stable for longer than 1 minute due to safety reasons for car presentation. The headline should be meaningful on its own, but the remainder of the label is not necessarily meaningful alone, without the headline. For multiple segment labels, text is generally a message which can be meaningful only when all segments are together. Dynamic labels are intended to be related in real-time to the programme contents. Therefore, the Service provider should synchronize the text to the audio programme. A tolerance of +/-200 ms with reference to the end of the first complete transmission of the dynamic label would be the strictest demand.

3.5.6.3.6 Default contents in the event of failing service

If the supply of Dynamic label information from a Programme provider fails, then the Service provider should send a "Remove label" command to avoid an obsolete label being retained in the display.

3.5.6.3.7 Examples

Consider the transmission of a single segment label, repeated cyclically whilst it remains valid (Example1):

"John Dunn Show"

Table 3.5.6A gives the details of the prefix and the character field for each segment. The details of the check word Suffix are omitted. In the first four columns, the headings "T", "F", "L" and "C" stand for the "Toggle", "First", "Last", and "Command" flags respectively. Field 1 contains the number 13, representing the 14 characters of the segment, as the "Command" flag is not set. Field 2 contains the character set identifier.

Table 3.5.6A: Data for example 1

Prefix:					Character field:	
T	F	L	C	Field 1	Field 2	
§1	1	0		1101	0000_2	"John Dunn Show"

NOTE 1: The Toggle flag is toggled for each new label. It is fixed in one state for the whole of one label, no matter how many times the label is repeated. This applies also to multiple segment dynamic labels.

NOTE 2: The complete EBU Latin-based character set [22].

Consider the transmission of the following 64 character Dynamic label (Example 2):

"A Dynamic label segment feature allows 64 character RT emulation"

where "RT" refers to the RDS feature which supports up to 64 characters. For transmission, the label is divided into segments and one way of doing this is:

"A Dynamic label/segment feature/allows 64 character RT emulation"

The resulting segments are all 16 characters long and just four segments are required. Table 3.5.6B gives the details of the prefix and the character field for each segment. The details of the check word Suffix are omitted.

Table 3.5.6B: Data for example 2

Prefix:					Character field:	
T	F	L	C	Field 1	Field 2	
§1	1	0	0	1111	0000	"A Dynamic label "
"	0	0	0	1111	0001	"segment feature "
"	0	0	0	1111	0010	"allows 64 charac"
"	0	1	0	1111	0011	"ter RT emulation"

NOTE 3: See note 1 of example 1.

Consider the transmission of the following label (Example 3):

"Veckans artist: Helsingforsuniversitets manskör"

One way of encoding this label using the "preferred line break" and "preferred word break" control characters is:

"Veckans artist:<*0A*>Helsingfors<1F>universitets manskör"

Table 3.5.6C gives the details of the prefix and the character field for each segment.

Table 3.5.6C: Data for example 3

	Prefix:				Character field:	
T	F	L	C	Field 1	Field 2	
§$_1$	1	0	0	1111	0000	"Veckans artist:<0A>"$_3$
"	0	0	0	1111	0001	"Helsingfors<1F>univ"
"	0	1	0	1111	0010	"ersitets manskör"

NOTE 4: See note 1 of example 1.

NOTE 5: Optional information to assist receivers with larger displays.

Sometimes the label contains a headline. Consider the transmission of the following label (Example 4):

"The World at One News and comment this Tuesday lunchtime"

One way of encoding this label is:

"The World at One<*0B*> News and comment this Tuesday lunchtime"

Table 3.5.6D gives the details of the prefix and the character field for each segment.

Table 3.5.6D: Data for example 4

	Prefix:				Character field:	
T	F	L	C	Field 1	Field 2	
§$_1$	1	0	0	1111	0000	"The World at One"
"	0	0	0	1111	0001	"<0B> News and comme"$_4$
"	0	0	0	1111	0010	"nt this Tuesday "
"	0	1	0	1000	0011	"lunchtime"

NOTE 6: See note 1 of example 1.

NOTE 7: Optional information to provide headline text for receivers with displays of 32 character capacity.

Consider the transmission of the following (Example 5):

"A dynamic label: commercialization, example of hyphenation"

Table 3.5.6E gives the details of the prefix and the character field for each segment using the "preferred word break" control character.

Table 3.5.6E: Data for example 5

	Prefix:				Character field:	
T	F	L	C	Field 1	Field 2	
§$_1$	1	0	0	1111	0000	"A Dynamic label:"
"	0	0	0	1111	0001	"commercial<1F>isati"
"	0	0	0	1111	0010	"on, example of h"
"	0	1	0	1001	0011	"yphenation"

NOTE 8: See note 1 of example 1.

3.5.6.4 Receiver implementation aspects

3.5.6.4.1 Functional minimum requirements

In principle, there are no differences between the ways this information is handled in mobile, stationary or other special purpose receivers. The display size should be at least 16 characters for an acceptable presentation. For multiple segment labels, a separate buffer, capable of storing at least 128 characters and related flags and control codes, should be provided. The receiver shall display or remove the text promptly, as soon as it has been checked. The receiver shall display the headline, the whole of the label or suppress the label. Any undefined non-displayable character can be ignored, which means that it does not change the display and it is not replaced by a space, apart from code hex 0A (preferred line break).

3.5.6.4.2 Optional extensions

The receiver applies the following rules: The receiver ignores the partitioning of the label into several segments, i.e. it displays the string of displayable characters and disregards the control characters. (Segmentation has been applied for transportation purposes only.) Different receivers, each with different display formats and presentation capabilities make the best use of their capabilities (number of characters per line, number of lines, etc.).

The dynamic label can be broken into several lines at word boundaries (indicated by blank characters only, irrespective of segment boundaries). If words at the start of a new line are justified to the left, "leading" blank characters have to be ignored. Several blank characters in sequence are displayed as one blank character only.

Control codes within the dynamic label string support the receiver further refining the presentation. For Dynamic labels containing control codes, the receiver can react to these if the display format permits. If the control code hex 0A (preferred line break) is implemented, then break the text if possible or insert a blank (space). If the control code hex 1F (preferred word break) is applied, then replace the code hex 1F with a hyphen and a line break, or if no hyphenation is applied, then disregard the code. The control code hex 0B indicates the end of the headline only, no character is displayed for the code hex 0B. Only if the control code hex 0B is followed by a character, such as a space or a "preferred line break", that character is implemented after the end of headline.

The receiver can apply the following strategies for formatting the dynamic label on its display: Display at least the complete headline. Evaluate preferred line break, if the display has a sufficient number of lines. Evaluating blank characters and, if necessary, evaluating the control code for "preferred word break" would avoid breaking words inappropriately.

3.5.6.4.3 Inter-relations with other features

The Dynamic label feature is independent of other labels.

3.5.6.4.4 Recommendations on implementation and presentation

The headline part of the dynamic label is designed to remain stable for a period which is intended to satisfy safety requirements associated with receivers used in vehicles. This means that if no headline is transmitted, such receivers should not display a dynamic label.

A summary of receiver strategies for displaying the Dynamic label using a number of different display formats is given in table 3.5.6F. It is recommended that the minimum display length should be 16 characters (used for supporting the unabbreviated Service and Ensemble labels - see 3.6.11).

Single segment labels can optionally be "centred" in the display field. Multiple segment labels shall be buffered and the complete label can be displayed only after all segments have been received. The label should be presented sequentially, either by displaying parts of text one at a time in sequence or by scrolling the whole label from right to left at an appropriate rate.

Labels that are shorter than the capacity of the display should not be scrolled. When scrolling, multiple "space" characters could be removed. The display can be used by other labels such as the service and ensemble labels.

Table 3.5.6F: Receiver strategies for displaying the Dynamic label

Display Size	Display Rules
16 characters	Buffer the whole label. The complete label can be displayed only after all segments have been received. Scrolling is preferred when there are more than 16 characters.
2 rows of 16 characters	Buffer the whole label. The complete label can be displayed only after all segments have been received. Scrolling should be confined to one row only. If there is an "end of headline" character, the label can be treated in two parts. In this case, the headline text can be displayed before the remainder of the label has been received. Optionally a hyphen could be added in the middle of any word broken at the end of the first row of the display. If the headline contains 16 characters or less, the headline can be displayed on the first row and the remainder of the label scrolled through the second row.
m rows of 32 characters	As for 2 rows of 16 characters except that headlines of up to 32 characters can now be displayed.

If there is a "preferred line break" character amongst the label information, the receiver should determine whether it can make use of it to improve the presentation (this will only apply for receiver displays capable of supporting more than one row of characters). If the text includes an "end of headline" character, the headline text can be treated as an independent part of the label.

3.5.6.4.5 Fall-back in the event of failing service

If the reception of the Dynamic label information becomes erratic, the receiver should default to removing the Dynamic label from the display.

3.5.6.4.6 Display of examples

The following presentations are based on the label examples introduced in 3.5.6.3.7.

	Example 2	**Example 3**
16 character display	A Dynamic Label	Veckans artist:
16 x 2 character display	A Dynamic Label Segment feature	Veckans artist: Helsingfors-

No headline, so the rest of the label is displayed in both examples.

3*2 character display*

A Dynamic label segment feature …….	Veckans artist: Helsingforsunive ……

No headline, so scrolling the label from right to left in both examples.

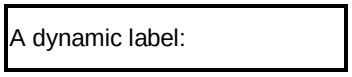
3*2 x 2 character display*

A Dynamic label segment feature allows 64 character RT emulation	Veckans artist: Helsingforsuniversitets manskör

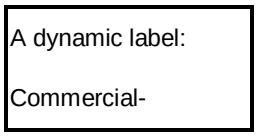
No headline, so the rest of the label is displayed in both examples.

Example 4 **Example 5**

16 character display

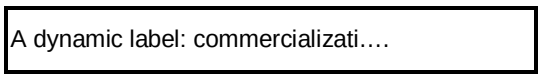


16 x 2 character display



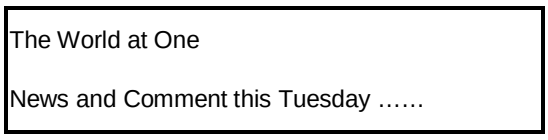
Headline remains stable, rest of label is scrolled. No headline, display rest of label

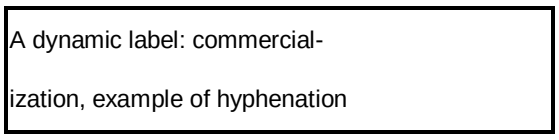
3*2 character display*



Headline remains stable. Scrolling the label from right to left.

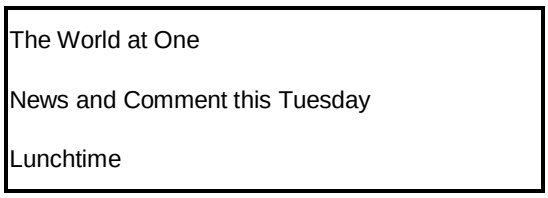
3*2 x 2 character display*

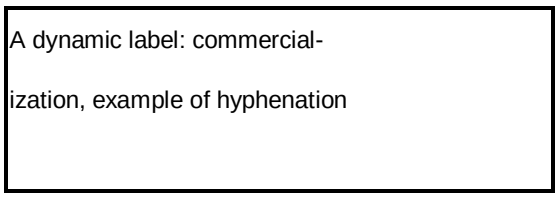




Headline remains stable, scrolling rest of label No headline, display rest of label

3*2 x 4 character display*





Headline remains stable, display rest of label No headline, display rest of label

3.5.7 ITTS text

The Interactive text transmission system (ITTS) provides the mechanism for encoding sound associated data on pre-recorded media and for the transport of such data across equipment interfaces. International standard IEC 61866 [25] defines the higher layers of ITTS i.e. those system characteristics which are independent of the recording or interconnection medium. ITTS was developed to provide the music software industry with a means to include audio-related textual information on the recording medium. For example, on certain CD-audio discs additional textual information is recorded in the subcode R-W channels that can be displayed on a screen.

This additional information can comprise:

- the album title;
- the name(s) of the performing artist(s);
- the name of the track plus a full track list;

- song lyrics or libretto;
- sponsor and station logos;
- etc.

ITTS text can be carried either into the X-PAD (see 3.2.4.2.2) or in a separate data channel in the MSC. Given a certain channel capacity, the service provider has to find a balance between the amount of information he wants to offer to his audience and the time that a consumer has to wait for the information he is presently interested in. Lyrics and libretto lines should appear on the display just before the corresponding audio is heard. This is particularly important in systems with a limited capacity such as the PAD. In general, Dynamic label (see 3.5.6) can a better solution for providing textual information while MOT (see [14]) is to be preferred for providing logos and CD covers or the like.

3.5.8 Closed user-group Packet and Stream channels

3.5.8.1 Introduction

3.5.8.1.1 Purpose of the feature

The Closed user-group packet channel and the closed user-group stream channel are designed to carry new Services in the X-PAD. Such Services can be closely related to the audio signal and are strictly under the control of the Service provider.

3.5.8.1.2 End user

The receiver, the listener and other end-users via dedicated DAB receivers.

3.5.8.1.3 Provider

The Service provider (Programme service provider).

3.5.8.2 Description

3.5.8.2.1 Closed user-group packet channel

The Closed user-group packet channel feature is encoded in Application types 8 and 9. Application type 8 signals when a new packet starts (see 7.4.3 in [1]); it contains in its data field all or part of a packet. When more than one audio frame is required to carry the packet, the following parts of the packet are signalled by application type 9. The different parts of a packet shall be transmitted consecutively but not necessary in consecutive frames. All the contributions to one packet shall be transmitted before another can begin. Whole packets, with different addresses, can be transmitted one after the other. The structure of the packets (see 3.2.3) conforms to the description in 5.3.2 and 5.3.3 in [1]. The Packet mode can be used without restriction except that it is not necessary to include an integral number of packets per audio frame. Different packet addresses, different packet sizes (up to 4) can be used. The packet transport level is also used (5.3.3 in [1]). Each packet has its own CRC. The data can be scrambled according to Configuration 3 in 9.1.4.1 in [1] and Configuration 2 and 3 in 9.1.4.3 in [1]. In this case all the access conditions and signalling are carried within the Data group of the Packet mode.

A packet can be transmitted in one or several audio frames:

- When transmitted in one audio frame, the application data field size is 24 bytes or 48 bytes according to the normalized sizes of the packet;
- When transmitted over several audio frames, all the frames (except the last) are filled with useful packet data. The last frame contains the last part of the packet and, if necessary, padding bytes to fill up the application data field.

3.5.8.2.2 Closed user-group stream channel

Application type 32 is used to identify the beginning of the transmission of a block of data. For the remaining parts, if any, Application type 33 is used (see [1], 7.4.3).

3.5.8.3 Operational aspects of broadcasting

The Closed user group packet channel is optional. When implemented by the Service provider, this mechanism shall respect rules and syntaxes defined in 5.3.2, 5.3.3, 7.4.3, 7.4.5.5 in [1]. In case of scrambling the mechanism shall respect the rules and syntaxes defined in 9.1.4.1, 9.1.4.3, 9.2.3, 9.3.2.1, 9.3.2.3 in [1]. The Closed user group stream channel is optional. When implemented by the Service provider, this mechanism shall respect rules and syntax defined in 7.4.3, 7.4.5.6 in [1]. This mechanism can be used to transfer files, videotex, still picture... It is up to the programme provider to organize and prioritize the insertion of data at the source in relation with the other features.

3.5.8.4 Receivers Implementation Aspects

3.5.8.4.1 Functional Minimum Requirements

Basic receivers shall be able to decode "Closed user group packet/stream channel" Application type and ignore the corresponding data field. The content of the Closed user group packet/stream channel is not specified, so specific devices are required to process the data.

3.5.8.4.2 Recommendations on Implementation and Presentation

It depends on the applications. These features can carry information that is related to the Programme service. Consequently, dedicated receivers shall process the data as soon as they are received. As data are carried in the X-PAD, it is recommended that the packet size is limited to 24 bytes.

3.6 Service Information

Service Information (SI) provides supplementary information about Services, both Audio programme and Data, as well as information about Ensembles and miscellaneous features. A brief description of the SI features has been given in 5.6 in TR 101 496-1 [13] and a summary is given in table 5.10.1 in TR 101 496-1 [13]. In this clause, the features are described in approximately the order in which they appear in the basic DAB standard [1]. The coding of these features in the Fast Information Channel (FIC) is given by reference to their FIG type and Extension (see 3.2.1). FIGs 0 and 1 are used to encode the SI. The allocation of the FIGs 0 and 1 is given in table 3.6.1, together with the use of the C/N, OE and P/D flags (see columns 3, 4, and 5) which are carried in the first byte of the FIG data field (see 3.2.1 and [1], 5.2.2). When these flags are not used, they are set to "0" and reserved for future use of the Type 0 or Type 1 field, as the case may be. Also, certain features can be transported in the Auxiliary Information Channel (AIC within the MSC) using a re-direction mechanism (see 3.6.19 and [1], 5.4). In table 3.6.1, column 6, is an indication of the transport options. The recommended data repetition rates are summarized in column 7 of the table and column 8 gives an indication of the FIC capacity required to support particular features, making a number of broad assumptions.

Since the first edition of [1] there have been a number of amendments to the coding of some system features and some new functionality has been defined. The following amendments are noted:

- Date/Time and Country codes: these features are split into two FIGs. The Time/Date is retained in FIG 10 whilst Country codes and local time offsets are encodes in FIG 9 (see 3.6.3).
- Programme Type: a language field is added. There are 32 programme type categories defined for the European international table (although two of these are not available for DAB) (see 3.6.5).
- Announcements: coding fields are re-ordered, A "new" flag is added and Region codes added to the signalling for Other Ensemble and FM announcements. Six announcement types are defined (see 3.6.8).
- Frequency Information (FI): the transmission mode is signalled. The frequencies associated with DAB services are signalled indirectly using the Other Ensembles services feature (see 3.6.10).
- Labels are defined for Data services separately and for Service component labels (see 3.6.13).
- Service linking: "Soft" links are distinguished from "Hard links". Non-DAB services are listed separately (see 3.6.14).
- Cross-referencing of FM and AM services is explicitly described (see 3.6.18).

Table 3.6.1: Fast Information Group (FIG) Type allocation

FIG Type/ Ext	Description	C/N	OE	P/D	Trpt	Recom data rate	% FIC capacity
FIG 0/5	SERVICE COMPONENT LANGUAGE	Rfu	Rfu	Rfu	FIC	A/B	
FIG 0/6	SERVICE LINKING INFORMATION	SIV	OE	P/D	F/aic	S-B L-D	
FIG 0/9	COUNTRY, LTO & INTERNATIONAL TABLE	SIV	Rfu	P/D	F/aic	S-B L-C	S-0.1
FIG 0/10	DATE & TIME	Rfu	Rfu	Rfu	FIC*	B/C	
FIG 0/11	REGION DEFINITION	SIV	Rfu	Rfu	f/AIC	E	0.1
FIG 0/12	PROGRAMME TYPE PREVIEW	Rfu	OE	Rfu	f/AIC	C	0.1
FIG 0/13	USER APPLICATION INFORMATION	Rfu	Rfu	P/D	FIC	B	
FIG 0/14	Rfu						
FIG 0/15	Rfu						
FIG 0/16	PROGRAMME NUMBER (PNum)	Rfu	OE	Rfu	F/aic$_0$ f/AIC$_1$	A$^{\$}$/B$_0$ A$^{\$}$/C$_1$	~1.0/sv
FIG 0/17	PROGRAMME TYPE (PTy) [STATIC & DYNAMIC]	Rfu	OE	Rfu	F/aic$_0$ f/AIC$_1$	A$^{\$}$/B$_0$ A$^{\$}$/C$_1$	~2.0/sv
FIG 0/18	ANNOUNCEMENT SUPPORT	SIV	Rfu	Rfu	f/AIC	B	0.2/sv
FIG 0/19	ANNOUNCEMENT SWITCHING	Rfu	Rfu	Rfu	FIC	A/B	0.1
FIG 0/20	SERVICE TRIGGER	Rfu	Rfu	Rfu	FIC*	1/min	
FIG 0/21	FREQUENCY INFORMATION (FI)	SIV	OE	Rfu	f/AIC	E	FM-2.0 OE-0.3
FIG 0/22	TRANSMITTER IDENTIFICATION DATABASE	SIV	Rfu	Rfu	f/AIC	E	
FIG 0/23	LOCAL SERVICE AREA	SIV	OE	P/D	F/aic	B	
FIG 0/24	OTHER ENSEMBLES SERVICES	SIV	OE	P/D	f/AIC	C$_0$ D$_1$	small
FIG 0/25	OTHER ENSEMBLES ANNOUNCEMENT SUPPORT	SIV	Rfu	Rfu	f/AIC	B	3.0
FIG 0/26	OTHER ENSEMBLES ANNOUNCEMENT SWITCHING	Rfu	Rfu	Rfu	FIC	A/B	small
FIG 0/27	FM SERVICES ANNOUNCEMENT SUPPORT	SIV	Rfu	Rfu	f/AIC	B	3.0
FIG 0/28	FM SERVICES ANNOUNCEMENT SWITCHING	Rfu	Rfu	Rfu	FIC	A/B	small
FIG 0/29	SATELLITE HANDOVER INFORMATION	Rfu	Rfu	Rfu	FIC*	A/B?	
FIG 0/30	SATELLITE DATABASE	SIV	OE	Rfu	AIC	E	
FIG 0/31	FIC RE-DIRECTION	Rfu	Rfu	Rfu	FIC*	B	
FIG 1/0	ENSEMBLE LABEL	n/a	OE	n/a	F/aic	B$_0$ D$_1$	0.6
FIG 1/1	PROGRAMME SERVICE LABEL	n/a	OE	n/a	F/aic	B$_0$ D$_1$	0.6/sv
FIG 1/2	PROGRAMME TYPE DOWNLOADING	n/a	Rfu	n/a	AIC	C	
FIG 1/3	REGION LABEL	n/a	Rfu	n/a	f/AIC	C	
FIG 1/4	SERVICE COMPONENT LABEL	n/a	OE	n/a	F/aic	B$_0$ D$_1$	
FIG 1/5	DATA SERVICE LABEL	n/a	OE	n/a	F/aic	B$_0$ D$_1$	
FIG 1/6-1/7	Rfu						

Key: Rfu = reserved for future use; SIV = SI version; OE = Other Ensembles; n/a = not applicable, S- = "short form", "L-" - "long form". Rates: A = 10/sec; B = 1/sec; C = 1/10 sec, D = less than 1/10 sec; E = all in 2 min. A$^{\$}$ = rate increased to A at programme junctions FIC* = FIC by ETS; FIC = recommended FIC full rate; F/aic = more in FIC, less in AIC; f/AIC = less in FIC, more in AIC; AIC = AIC only..A$_0$ B$_1$ = A for OE="0" & B for OE="1" etc. sv = service.

3.6.1 Alarm flag

3.6.1.1 Introduction

3.6.1.2 Purpose of the feature

The Alarm flag, valid within one Ensemble, provides a mechanism for the receiver to identify whether any of the Services, contained within the Ensemble, support alarm announcements. Service providers can use this feature for signalling announcements which can be made, under exceptional circumstances, to give a warning of events causing danger of a general nature. The Alarm feature can be implemented regardless of the *full* implementation of the Announcements feature.

3.6.1.3 End user of the feature

The receiver.

3.6.1.4 Provider of the feature

The Ensemble provider in collaboration with Service providers.

3.6.1.5 Involvement of other parties

None.

3.6.1.6 Description

The Alarm flag feature is based on a single-bit flag carried in FIG (0/0) Ensemble information field (see 6.4 in [1]). When the flag is set to "1", the feature is enabled. When the flag is set to "0" the alarm signalling cannot be relied upon. The Announcement type "Alarm" is used to support alarm messages. The "Alarm" announcement is used by a Service provider to signal an alarm message using an Audio service component in a particular sub-channel. This is different from the implementation in RDS [22] where the Programme Type code 31 is used.

3.6.1.7 Mandatory requirements

3.6.1.7.1 For broadcasting

The Ensemble provider shall enable the Alarm flag, carried in FIG (0/0) if at least one Service provider is supporting alarm announcements in the Ensemble.

3.6.1.7.2 For receiving

When the receiver recognizes a raised Alarm flag, it shall be ready to respond to an alarm announcement.

3.6.1.8 Operational aspects of broadcasting

3.6.1.8.1 Functional minimum requirements

The Alarm flag is transmitted in FIG 0/0.

3.6.1.8.2 Inter-relations with other features

The Alarm flag depends on the Announcements feature (see 3.6.8), which in turn can depend upon the Regional Identifier (see 3.6.15).

3.6.1.8.3 Preferred transport mechanisms and alternatives

The Alarm flag shall be carried within the Ensemble information in FIG 0/0.

3.6.1.8.4 Recommendations on contents and real-time aspects

The Alarm flag has no real time constraints.

3.6.1.8.5 Default contents in the event of failing service

The Alarm flag shall default to "reset" i.e. "0".

3.6.1.9 Receiver implementation aspects

3.6.1.9.1 Functional minimum requirements

The receiver shall check the Alarm flag, contained within the Ensemble information in FIG 0/0. If the Alarm flag is raised, the receiver shall monitor the Announcements information, contained in FIG 0/19, of all Services carried in the Ensemble (see 3.6.8).

3.6.2 Service component language

3.6.2.1 Introduction

3.6.2.1.1 Purpose of the feature

The Service component language feature is intended to identify the spoken language associated with the audio content of a Service component. The Service component language feature can also be used to identify the language associated with the content of a data Service component. This information can be used either for user-selection of a Service or Service component by dint of a particular language or simply to display the language as a simple text description.

3.6.2.1.2 End user of the feature

The receiver.

3.6.2.1.3 Provider of the feature

The Service provider.

3.6.2.1.4 Involvement of other parties

No other party is involved.

3.6.2.1.5 Description

The language code is derived from tables 9 or 10 in TS 101 756 [20]). The Service component language feature is encoded in FIG 0/5 (see 8.1.2 in [1]). Since FIG 0/5 does not feature the OE functionality the language of a service component in another Ensemble cannot be signalled. It also does not feature the C/N functionality which means that it is intended to be used dynamically.

3.6.2.2 Mandatory requirements

The Service component language feature is optional.

3.6.2.3 Operational aspects of broadcasting

3.6.2.3.1 Functional minimum requirements

When implemented, the Service provider shall allocate a language description which best fits the audio content of the Service component. The FIG 0/5 shall be transmitted at repetition rate A/B.

3.6.2.3.2 Inter-relations with other features

The Service component language feature is independent of other features. It is important to notice the (subtle) difference between SC language and the PTy language (see 3.6.5). Whereas the SC language can be used to signal the language of any service component within the ensemble, being primary or secondary, being audio or data, the PTy language (see 3.6.5.1.5) is intended to be used in combination with the programme types, and it signals the language of the primary audio component of a service (in addition, one language can be signalled for the secondary service component(s)) Unlike SC Language, the PTy language can be used for services in other ensembles. Whenever both SC language and PTy language is implemented the language fields should be consistent i.e. SC language shall be equal to PTy language (see 3.6.5.3.3). In case of static PTy language, the Service component language should also be static. When the service provider has a service with programmes targeted to different language audience then he should signal the language dynamically. If he has no means for dynamic signalling, static signalling is allowed on condition to set the PTy language equal to "0". The Service component language is in this case not transmitted. (see 3.6.5.3.3).

3.6.2.3.3 Preferred transport mechanisms and alternatives

When implemented, the Service component language feature shall be carried in the FIC in FIG 0/5.

3.6.2.4 Receiver implementation aspects

3.6.2.4.1 Functional minimum requirements

There are two main ways in which the Service Component language feature can be implemented. The first is for Service or Service component selection by language and the second is for display of the language associated with the user-selected Service or Service component. In both cases the receiver shall process all FIGs 0/5 to extract the language information for each Service Component. In principle, there are no differences between the way this information is handled in mobile, stationary or other special purpose receivers.

3.6.2.4.2 Inter-relations with other features

A language filter in the receiver, when present, can be based on SC language to allow service selection by dint of language. A language filter can also be based on PTy language as explained in 3.6.5.4.2. PTy WATCH should be based on PTy language, not on SC language.

3.6.2.4.3 Recommendations on implementation and presentation

For Service selection by language, different scenarios can be considered. Firstly, when carrying out a service search operation, the receiver could give priority to Services containing components with a chosen language attribute. Secondly, if a Service contains several audio components in different languages, they should be identifiable for selection by the listener or made accessible by repeated selection of the service button. Thirdly, the pre-set buttons could store the Service component language information, rather than the SId, which is required for conventional service selection. For receivers which do not implement the service selection by language, the language description could be displayed as well as or instead of the Service label (see 3.6.13) or the Service component label (see 3.6.13).

3.6.2.4.4 Fall-back in the event of failing service

If the language feature is invoked and no Service component language information can be received the receiver should indicate this to the listener.

3.6.3 Date and Time

3.6.3.1 Introduction

3.6.3.1.1 Purpose of the feature

The Date and Time information is intended to provide an accurate time stamp for DAB broadcasts. The time and/or date can be displayed in the receiver. Together with the Local time offset, provided in FIG (0/9) (see 3.6.22) an ensemble/service related time is specified. Additionally, the date and time information can be used to support the Service Component Trigger (see 3.6.9) and Programme Number (see 3.6.4) feature.

3.6.3.1.1.2 End user of the feature

The receiver and listener.

3.6.3.1.1.3 Provider of the feature

The Ensemble provider.

3.6.3.1.1.4 Involvement of other parties

The national time-keeping authority: possibly the GPS operator.

3.6.3.1.1.5 Description

The date and time information is encoded in the Modified Julian Date (MJD) and Co-ordinated Universal Time (UTC) formats respectively. This approach, which is in accordance with ITU-R Recommendation TF.457-1 [28] and ITU-R Recommendation TF.460-4 [29], allows time interval calculations to be made independent of time zones and summer-time discontinuities. A separate flag bit (LSI) is used to signal that the current day contains a "leap second" which is applied by international agreement. The Confidence Indicator (Conf.Ind.) flag is set to 1, when the timing information is within an agreed tolerance - see 3.6.3.3.5. The time information can be provided in two different resolution levels. The standard resolution allows the time to be expressed in one-minute intervals whilst the alternative resolution level allows timing to be expressed in millisecond intervals. The date and time information is encoded in the Date and Time feature in FIG 0/10 (see 8.1.3.1 in [1].

3.6.3.2 Mandatory requirements

3.6.3.2.1 For broadcasting

The provision of Date and Time information is optional but is necessary to support a number of features (see 3.6.3.3.3).

3.6.3.2.2 For receiving

Response to the date and time information is optional. When implemented, the date and time information requires the appropriate Modified Julian Date (MJD) and Co-ordinated Universal Time (UTC) decoders [22].

3.6.3.3 Operational aspects of broadcasting

3.6.3.3.1 Functional minimum requirements

When transmitted, the time and date shall be accurate (see 3.6.3.2.1): otherwise the time and date fields shall all be set to ones. When transmitted, the time and date should be accurate to at least ±50 ms. For time information transmitted to the 1 ms resolution, the accuracy shall be increased to ±1 ms.

3.6.3.3.2 Optional extensions

The time can be transmitted in one of two resolutions, either to one-minute or to millisecond resolution. The latter uses marginally more data capacity and is intended for specialist time observation, using special receivers, rather than for commercial receiver time displays. The higher resolution option can pose an implementation problem of fixing the time reference for the clock.

3.6.3.3.3 Inter-relations with other features

The date and time information is required in connection with the Service Component Trigger feature and can be required in connection with the Programme Number and Paging features. Furthermore, it defines a time reference for some protocols and user applications (for example MOT or TMC). To derive the local time associated with the service (respectively ensemble) the service (respectively ensemble) LTO is needed.

3.6.3.3.4 Preferred transport mechanisms and alternatives

The date and time information shall be transmitted in the FIC using FIG 0/10.

3.6.3.3.5 Recommendations on contents and real-time aspects

The time and data information shall be derived from a responsible authority. The time of transmission of the start of the Null symbol in the Synchronization channel shall serve as the reference for the time information (see [1], 8.1.3 and 14.3.3). In order to compensate for the processing delay through the DAB transmission chain, the time information should be generated in advance so that the time is accurate at the reference point (the point, where the first ground fall of the reference time occurs).

3.6.3.3.6 Default contents in the event of failing service

If an accurate time cannot be transmitted, the time and data fields shall all be set to ones or FIG (0/10) shall not be transmitted.

3.6.3.4 Receiver implementation aspects

3.6.3.4.1 Functional minimum requirements

When the date and time information is processed the receiver would normally provide an accurate free-running clock and synchronize this to time information, when available. Conversion between MJD, UTC and various calendar formats (for example, year-month-day, year-week number-day of week) can be accomplished in the receiver (see reference [22], annex G). Conversion to the correct local time can be performed in the receiver using the UTC and Local Time Offset (LTO) information (see 3.6.22). There are no differences between the way this information is handled in mobile, stationary or other special purpose receivers. The effect of processing delays shall be taken into account.

3.6.3.4.2 Optional extensions and alternatives

The time can be transmitted in one of two resolutions, either to one-minute or to millisecond resolution.

3.6.3.4.3 Inter-relations with other features

The date and time information is required in connection with the Service Component Trigger feature, the Programme number feature and as time reference for some protocols and user applications e.g. MOT [14] or TMC [8].

3.6.3.4.4 Recommendations on implementation and presentation

The date and time information should be used to synchronize a locally-generated clock (an indication to the listener that the date and time information feature is behaving in this way would be useful). The local time and/or date can be displayed by direct listener request, for example as an optional mode for the display used for other functions, such as the Service label. Alternatively, it can be displayed automatically whilst the receiver is performing some other function, such as service searching which might necessitate a delay, and there is no other information which could usefully be displayed. Because the receiver may acquire time information relating to adjacent time zones, the listener shall be the arbitrator of the local time offset to be current in the receiver. To this end, a time display shall only be updated by direct listener action and not automatically. This may require the possibility that the LTO may be pre-set by the listener, so that the respective elements in the received UTC coding can be adjusted automatically.

3.6.3.4.5 Fall-back in the event of failing service

If and when the date and time information cannot be received, the time should revert to a locally-generated clock. It can be useful to indicate to the listener that the clock is no longer synchronized to the received signal.

3.6.4 Programme Number (PNum)

3.6.4.1 Introduction

The Programme Number feature allows programmes to be uniquely labelled. The label contains information about the nominal start time for a programme. It is also possible to signal interruptions, continuation in other services or shifted starting times for programmes. The use of the PNum feature is similar to "Programme Item Number (PIN)" in RDS [22].

3.6.4.1.1 Purpose of the feature

By using a receiver supporting the PNum feature, the listener can acquire any specific programme, either for immediate listening or for recording.

3.6.4.1.2 End user of the feature

The receiver and the listener. The service provider can use the feature for archive purposes.

3.6.4.1.3 Provider of the feature

The service provider.

3.6.4.1.4 Other parties involved

For some network configurations the ensemble provider can become involved.

3.6.4.1.5 Description

The Programme Number field contained in FIG 0/16 consists of an SId defining the service and a 16 bit PNum code which contains the date of the month, the hour and the minute for the nominal start time (local time) of the programme according to figure 3.6.1.

b15 b11	b10 b6	B5 b0
date	hour	minute

Figure 3.6.1: The structure of the PNum code

When a new programme replaces the original one after the publication of the programme schedule, the PNum code for the new programme shall be set to a new unique start time which differs from the nominal start time of the original programme. It is recommended to use the nominal start time of the original programme minus 1 minute (these changes shall of course be indicated in revised versions of the programme schedule published later). If there is a further change, the PNum code for the newest programme can be set to the nominal start time of the original programme minus 2 minutes, etc.

The next byte contains a flag field where a continuity and an update flag is defined. The continuity flag indicates that the programme will be resumed within 60 minutes. When the update flag is raised it signals that a "New SId" and a "New PNum" which gives information concerning about when and where the programme is continued or moved follow the flag field.

A number of new "New PNum" codes starting with date 00 is used for special purposes. Unplanned interruptions of a programme (e.g. a traffic messages) should be signalled by setting the PNum code to 'Date=0', "Hour=0" and "Minutes=2". The interruption shall not exceed 15 minutes. The update and continuity flags should in this case be set to '0'.

When a programme is deleted, the original SId and PNum codes should be transmitted together with the update flag set to '1' and in conjunction with a "New PNum" code which should be set to 'Date=0', "Hour=0" and "Minute=1".

If a non-scheduled programme is transmitted during an intermission between two programmes (e.g. a pause programme) the PNum code should be set to 'Date=0', "Hour=0" and "Minute=1". The update and continuity flags should in this case be set to '0'.

In the event of failing service or if meaningful PNum information is lacking, the PNum code should be set to 'Date=0', "Hour=0" and 'Minute=0'. The update and continuity flags are in this case set to '0'. Annex B illustrates the use of Pnum in a programme schedule.

3.6.4.2 Mandatory requirements

The use of the PNum feature is optional both for the service provider and in the receiver.

3.6.4.3 Operational aspects of broadcasting

3.6.4.3.1 Functional minimum requirements

Each programme should be provided with relevant PNum information according to the published programme schedule. If relevant PNum information is lacking due to changes in the schedule or other reasons, the PNum code 'Date=0', "Hour=0" and 'Minute=0' should be transmitted.

3.6.4.3.2 Optional extensions

To give the end user the possibility to use the feature even when late changes in the schedule are made, complete continuation and update information should be transmitted. More than one PNum field could then be sent in parallel at the same time, one for the programme transmitted at the moment and the other one either to direct the original programme to a new transmission time or to delete it (see annex B). A further enhancement could be to send complete update information concerning the next day at a certain time, for example, at midnight making it possible for advanced receivers to access the information. Such update information can in the future also be contained in electronic programme guides (EPG). Such solutions can also solve the much-discussed problem how to handle the unusual situation when a programme is transmitted before its scheduled time.

3.6.4.3.2.1 OE PNum and FM PIN

The PNum/PIN codes that apply to other ensembles and FM/AM services can also be signalled. In this case, the OE flag in FIG type 0 data field shall be set to 1. Observe that LTO can only be signalled in the tuned ensemble. In the case of FM PIN, the SId field in FIG 0/16 is used to signal the PI code of the RDS service or a "dummy" code using the same format. The recommended rate for transmitting OE PNum information and FM PIN is relatively slow. For a mobile receiver, up to about a minute should be allowed for the full choice of information about the other information to be gathered. If the data capacity of the transmission channel permits, a faster transmission rate will benefit the listener by reducing the receiver response time. The number of other ensembles to cross-reference depends on the DAB service area. Considering for example the London area and assuming that there are five other ensembles, then the OE information requires a data capacity of less than 2 % of the FIC capacity.

3.6.4.3.3 Inter-relations with other features

The PNum feature is dependent upon the Service Identifier (SId), the Extended Country Code (ECC), FIG 0/9, the Other Ensemble feature (FIG 0/25), and the Frequency Information feature (FIG 0/21).

3.6.4.3.4 Transport mechanism

It is recommended that the PNum information is carried in the FIC but it can also be directed to the AIC.

3.6.4.3.5 Recommendations on contents and real time aspects

The PNum codes shall be transmitted according to the times presented in the programme schedule. PNum code "Date=0", "Hour=0" and "Minute=0" shall be transmitted if, for technical or other reasons, relevant PNum information is lacking. The PNum information should be transmitted at a minimum repetition rate of B. At programme boundaries it should be transmitted according to repetition rate A during the first 2 seconds. When a programme is to be continued after a planned intermission, PNum continuity information should be transmitted at least 1 minute before the former part of the programme ends at repetition rate B.

3.6.4.3.6 Default contents in case of failing service

The PNum code 'Date=0', "Hour=0" and 'Minute=0' shall be transmitted in case of failing service.

3.6.4.4 Receiver implementation aspects

The feature is mainly intended for audio receivers with recording facilities but can be implemented for any purpose where the end user wants to watch for a programme start, for example, to wake up listeners in the morning with a specific programme.

3.6.4.4.1 Functional minimum requirements

The receiver should be able to interpret the PNum field and take action when a pre-programmed PNum code is received, for example, to switch into a recording mode. When receiving an interrupt code or a continuation code without reference, the receiver should operate in standby mode at least during 60 minutes and continue recording if the pre-programmed PNum code returns.

3.6.4.4.2 Optional extensions and alternatives

An advanced receiver may be able to handle different time zones (LTO in FIG 0/9).

3.6.4.4.3 Recommendations on implementation and presentation

It must be easy for the listener to programme the receiver to record a certain programme. There are many ways to solve this problem and just a few possible solutions are mentioned here:

- Manual setting of time and date.
- Interpreting bar codes in a paper presenting the programme schedules.
- Marking the desired programme with a cursor on a display which presents the programme schedule.
- Some other future method (e.g. EPG).

3.6.4.4.4 Fall back in the event of failing service

If a PNum code indicating 'Day=0', "Hour=0" and 'Minute=0' (failing service) is transmitted or if the code is not readable, the receiver shall fall back to time-controlled recording using the internal clock.

3.6.4.4.5 Hints and remarks

Normally, it is not allowed to transmit a programme before the announced scheduled time, but as this might happen, e.g. when a sport event holds earlier, it is recommended to set the receiver to stand by mode at least 1 hour before the nominal scheduled time for the programme to be recorded (see also 3.6.4.3.2).

3.6.5 Programme Type (PTy)

3.6.5.1 Introduction

3.6.5.1.1 Purpose of the feature

The Programme Type (PTy) feature allows programme contents to be categorized according to the intended audience. The categorization is achieved by assigning codes to a corresponding label describing the programme contents .There are different possibilities for using the feature. The simplest is to display the Programme Type label. However, the feature is best exploited for Programme Service selection. One approach is to search for a programme of a specific category by letting the receiver scan or search through available Programme Services. Another approach is to let the listener select among the PTys that are available at a certain moment. Still another approach is to tell the receiver to watch for programmes marked with the desired PTy code while listening to another Service or another source (e.g. CD, MD). By programming the PTys for one' s favourite programmes into the receiver it is even possible to store the individual listening profile.

3.6.5.1.2 End user of the feature

The receiver and the listener.

3.6.5.1.3 Provider of the feature

The Service provider.

3.6.5.1.4 Involvement of other parties

For some network configurations the Ensemble provider may become involved.

3.6.5.1.5 Description

The Programme Type feature is encoded in FIG (0/17) (see 8.1.5 in [1]). The assignment of Programme Type codes, by a Service provider, enables the listener to select Services by virtue of the desired Programme Type and language of the audio. For example, "SPORT" in "SWEDISH" might be chosen rather than the Service description, identified by a label such as "Radio One". In concept, the feature is similar to the PTY facility provided by RDS on FM services. However, the DAB feature is adapted to overcome some of the coding restrictions which has made the RDS feature difficult to implement to satisfy all users. The DAB feature includes codes for more categories than are available for use with RDS and more than one code can be assigned at a time. (see TS 101 756 [20]). This enables programmes to be more accurately described and considerably reduces the need to use code "0" (meaning "No Programme Type").

3.6.5.1.5.1 PTy code tables

The characterization of programme content is treated in two levels which gives rise to "coarse" codes and "fine" codes. The range of coarse code categories is expected to allow all types of programme content to be covered. The "fine" codes allow a more detailed characterization of a coarse code category. For example "Sport" might be further characterized as "Football", "Hockey", "Skiing" etc. Therefore, each fine code is associated with a coarse code. Whenever a fine code is used, the associated coarse code is also sent, in order to maintain compatibility with receivers which may respond only to coarse codes. The associated coarse code allows a receiver to default to searching at a coarser level if no fine code can be found.

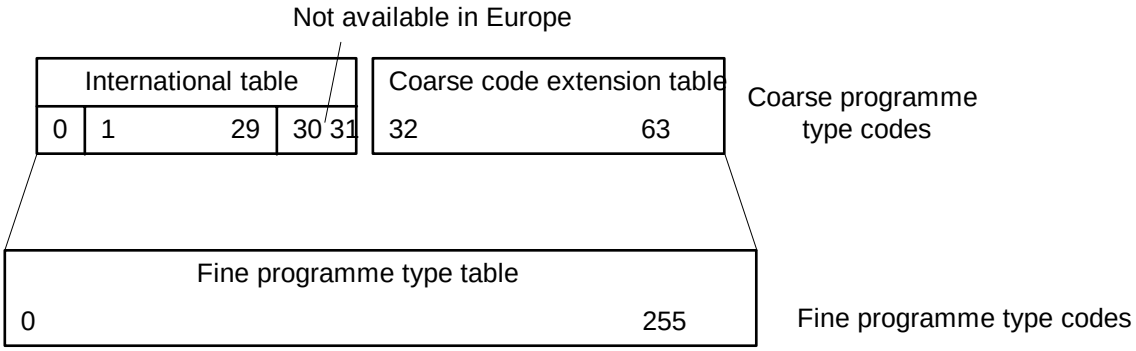


Figure 3.6.2: Structure of the available Programme Type codes

A maximum number of 64 coarse codes (two of these, code 30 and 31, are not available in Europe) and 256 fine codes are available. The number of fine codes associated with each coarse code may vary for each coarse code, but the total number of fine codes shall not exceed 256. Each fine code can only be associated with one coarse code. To codes 30 and 31 no fine code may be associated.

The structure of the available Programme Type codes is shown in figure 3.6.2. Different levels of implementation depend on the total number of codes made available for selection. The breadth of each coarse code category means that the majority of coarse codes are expected to be agreed internationally (see TS 101 756 [20]). The first 32 coarse codes comprise the currently accepted "International Table". Some fine codes can also be agreed internationally, for example "Football" but others are relevant only within a national region, for example "Cricket", "Bavarian chants", "Pelote basque" or "Dojgk". For coarse codes in the range 32 to 63 and all fine codes, the PTy downloading mechanism (see 3.6.6) provides the means for their "over-air" definition by linking the codes to a displayable label (the associated coarse code is declared at the same time). Also, this means that the label associated with a code may be different country by country.

Each Programme Type code definition is valid within a certain geographical area. For those codes which can be agreed internationally, the International Table Identifier (sent in FIG 0/9) specifies the agreed set. Two tables are currently defined for Europe and North America respectively. The use of different International PTy tables within one Ensemble is not allowed. In Europe only Int. table 00000001 shall be used. For those codes which can be agreed nationally, the down-loading mechanism allows the country, within which the code is valid, to be specified using the optional Extended Country Code (ECC) and Country Id parameters. The table below illustrates the relation between fixed PTy codes, PTy codes defined by downloading, International PTy codes and National PTy codes:

Table 3.6.5A: categories of PTy codes

PTY code		Definition of PTy code	Agreement of PTY code
Resolution	Number		
coarse	0 to 29	fixed	International
coarse	30 to 31	not used for DAB in Europe	not used for DAB in Europe
coarse	32 to X	defined by downloading	International
coarse	(X+1) to 63	defined by downloading	National
fine	0 to 255	defined by downloading	International and National

Remarks:

1) In table 3.6.5A the value of X is not fixed. The total sum of the international and national codes defined by downloading is 32.

2) "Defined by downloading " means that the PTy downloading mechanism (see 3.6.6) is required while "fixed" means that these codes are basic PTy codes belonging to an international table which can be stored in the memory of a receiver.

3) "International" means that the PTy code is unique in the area defined by the International Table Identifier in FIG 0/9 while "National" means that the PTy code is unique in the country defined by the Country Id and ECC.

4) The codes are signalled to be national or international by means of the PTy downloading mechanism which is also used to link fine codes to a coarse code.

5) Since national PTy codes can have a different meaning in different countries some restrictions are applicable when using nationally agreed PTy codes in an ensemble. A service cannot be given a national PTy code from another country. Signalling national PTy codes for services in a current ensemble (OE flag = 0) is always allowed, on condition to give their definition with the PTy downloading feature of FIG 1/2. If the current ensemble is an International ensemble (i.e. an ensemble containing services having different CountryId/ECC) several national PTy code tables can co-exist in the ensemble on condition to give the definition of the national PTy codes with the PTy downloading feature and to signal the language in FIG 0/17. Signalling national PTy codes for services in another ensemble (OE flag = 1) is never allowed even if the other ensemble is located in the same country as the current ensemble and even if their definition would be given with the PTy downloading feature.

3.6.5.1.5.2 Static and Dynamic PTy operation

There are two modes in which the Service provider can signal Programme Types. Firstly, the Programme Type feature can be operated in a static mode which means that Programme Type codes (as well as the language, if present) are assigned to a Service and remain unchanged for a long period. These effectively describe the Programme Service "flavour" or "service type". The PTy (as well as the language, if present) in this case does not necessarily reflect the actual current on-air programme, but rather the format or genre, of the Service as a whole. The listener can request the receiver to SEARCH for a Service carrying such a description or can SELECT among the particular types that are currently available. Repetition rate A/B is recommended for Static PTys.

Secondly, the PTy feature can be operated in a dynamic mode which means that the Service Provider switches the PTys when the programme content changes, for example from "News" to "Current Affairs" or from "News" in "Swedish" to "News" in "Finnish". This permits the receiver to operate in the WATCH mode as well as in SEARCH or SELECTION mode.

Repetition rate A/B is recommended throughout the duration of a programme. At the programme boundaries, the PTy codes should be transmitted according to repetition rate A during the first 2 seconds. A static/dynamic flag in FIG 0/17 is used to indicate the mode.

The S/D flag applies to all PTy codes specified in the Programme type field, i.e. also to the fine codes. Therefore up to eight PTy codes can be in use simultaneously: four (static) describing the Service, and four (dynamic) describing the current item.

3.6.5.1.5.3 Signalling programme types of a service

There are in FIG 0/17 three coding fields for programme types:

- **The Int.code field** specifies the "basic" PTy category of the service. It contains a coarse code in the range "0" to "31" ("0" to "29" in Europe). This code is taken from the fixed international table specified in FIG 0/9 (see 3.6.3 and TS 101 756 [20]). For Europe this is the RDS PTY table specified in CENELEC EN 50067.

- **The coarse code field** is optional and can contain one extra coarse code that can be chosen from the full range of 64 codes. The code is either taken from the fixed international table or from an international or a national table that is downloaded in the ensemble. The coding range of the Int code field is restricted to signal compatibility with RDS. If no appropriate entry could be found in the fixed international table, the value "0" shall be signalled in the Int code field. Another code in the range "32" to "63" can then be given in the Coarse code field.

- **The fine code field** In FIG 0/17 is optional and can contain up to two fine codes, i.e. there can be 0, 1 or 2 fine codes assigned to a service. Whenever a fine code is signalled, the corresponding coarse code shall be signalled as well, for compatibility reasons.

  When there are two coarse codes and two fine codes, the fine codes can either be related one to each coarse code (Int.code and coarse code field, see figure 3.6.3 case h) or to the same coarse code, either the one signalled in the Int.code field (see figure 3.6.3 case f) or the one signalled in the coarse code field (see figure 3.6.3 case g).

Fig 3.6.3 (a) to (h) illustrates the combination of codes which can be assigned to a Programme Service. Whenever a fine code is used, the link with the associated coarse code is shown.

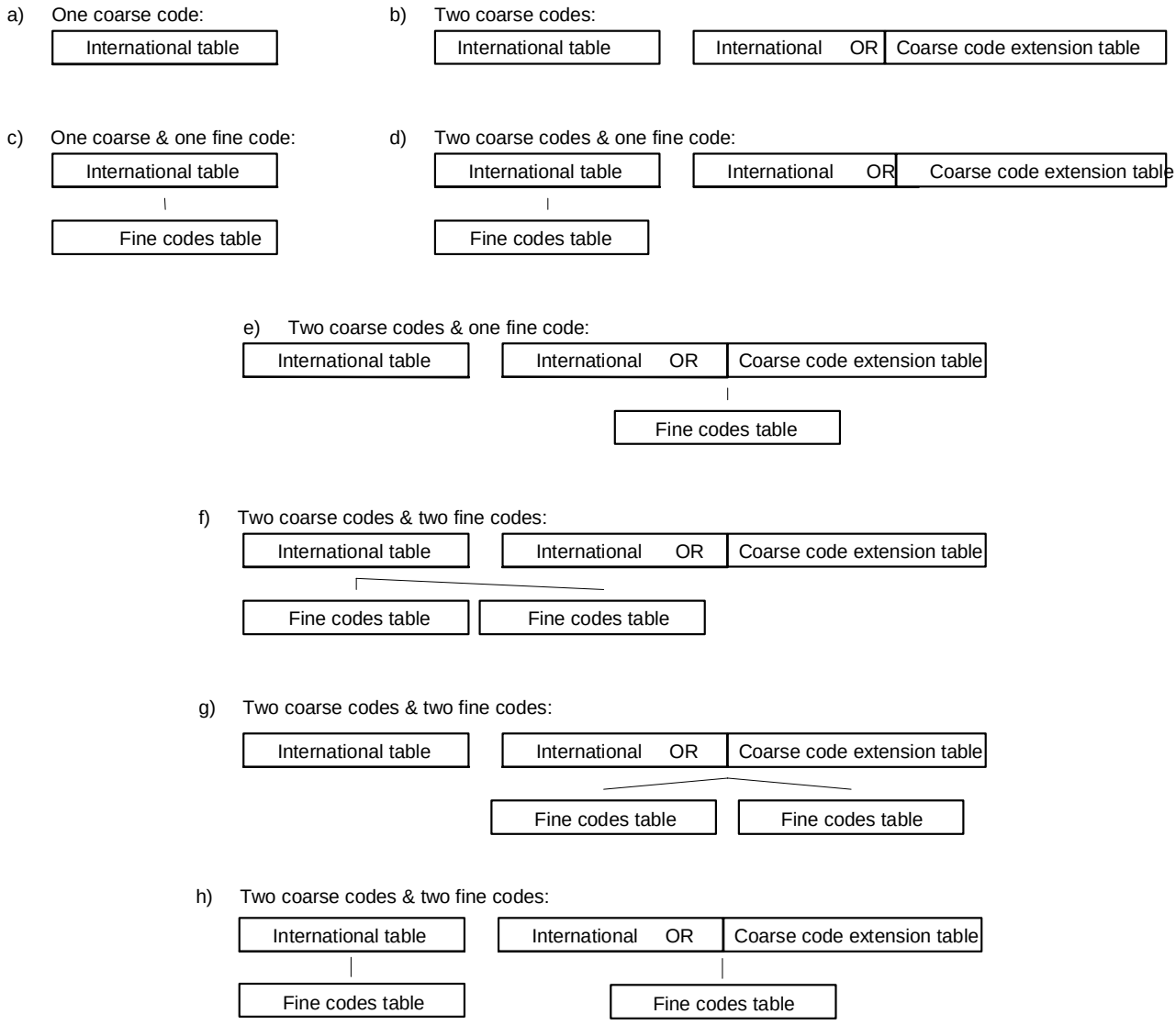


Figure 3.6.3: Possible combinations of PTy coarse and fine codes

3.6.5.1.5.4 Examples:

Suppose that there is an international agreement for coarse code 32 = MEDICAL and coarse code 33 = BAROQUE MUSIC. As well as for the fine codes "134" = "VIOLIN MUSIC" and fine code "247" = "BOUZOUKI MUSIC". Fine code "134" is associated with coarse code "14" (Serious classical) and fine code "247" to coarse code "26" (National music).

All this information is signalled in the ensemble by means of the PTy downloading feature of FIG 1/2 (see 3.6.6.1.5).

A "MEDICAL" programme can then be signalled by putting value "02" (Current affairs) or "03" (Information) or "0" (No programme type) in the Int.code field and value "32" in the coarse code field of FIG 0/17, depending on which code from the fixed international table reflects best the content of the programme.

Signalling "14"(Serious Classical) in the Int.code field and " 33" in the coarse code field can signal a "BAROQUE MUSIC" programme. Putting value "14" (Serious classical) in the Int.Code field and value" 134" in the fine code field can then signal a programme with VIOLIN MUSIC. The coarse code field can but need not be used.

A programme with BOUZOUKI MUSIC can be signalled by putting code "26" in the Int.code field and code "247" in the fine code field of FIG 0/17. The coarse code field can but need not be used. It would for example be possible to put code "15"(Other music) in the Int.code field and code "26" in the coarse code field (or vice-versa).

3.6.5.1.5.5 Compatibility with RDS

To ensure compatibility with RDS, it is required that in case of simulcast the Int.code in DAB shall be equal to the PTY code of the corresponding RDS service. This is also the code to be used in case of fallback. Also, when in RDS PTYN is used, it should be equal to at least one of the PTy fine codes in DAB (see table 3.6.5B).

Table 3.6.5B: Compatibility between DAB PTy and RDS PTY codes

RDS		DAB			
PTy code	**PTYN**	**PTy Int.code**	**PTy coarse code**	**PTy fine codes**	
SPORT	TENNIS	SPORT	INFO	TENNIS	WIMBLEDON
POP	SIXTIES	POP	GOLD	SIXTIES	THE BEATLES
CLASSICS	VERDI	CLASSICS	OPERA	VERDI	PAVAROTTI

3.6.5.1.5.6 PTy in relation to secondary service components

PTy codes are basically assigned to a service. Since a service can comprise several secondary audio and/or data service components as well as the primary audio service component, the PTy codes assigned to the service basically apply to the primary component. Secondary audio service components, if available, should be of the same 'type' as the primary component. Secondary data service components on the other hand can be of the same or of a different type.

EXAMPLE 1: Service = BBC SPORT; PTy Int.code = SPORT; PTy fine codes = TENNIS, WIMBLEDON

The primary audio service component of the Service could be a report of a match played at Centre Court. The first secondary audio service component could be a report from Court 1 and the second secondary audio service component could be a report from Court 2. The 3rd secondary (data) service component could be a picture of the tennis players with their scores of previous games. The 4th secondary data service component could be a Slideshow.

EXAMPLE 2: Service = BBC SPORT; PTy Int.code = SPORT; PTy fine codes = FOOTBALL, CRICKET

The primary audio service component of the service is a football match. At the same time there is a secondary audio service component transmitting a cricket match.

In both examples the P/S flag in FIG 0/17 shall be set to "primary" because the P/S flag only relates to the PTy language, see below.

3.6.5.1.5.7 PTy Language

In order to allow broadcasters to offer the listeners a full range of Programme Type codes also for programmes broadcast in multi-lingual ensembles, FIG 0/17 comprises an optional Language field. The language can be signalled directly along with the PTy code. This means that a "Sports" AND "Football" programme in "Swedish" or a "Sports" AND "Basketball" programme in "Finnish" could be selected in the receiver.

For certain Programme Types (e.g. NEWS) the language can be a more important criterion for the listener than PTy. In this case the receiver needs to evaluate the Language field in FIG 0/17. Some listeners could benefit from having the possibility of listening to a programme in one language with the receiver watching for a programme in a different language.

PTy codes are basically assigned to a service. Secondary audio service components, if available, should be of the same 'type' as the primary component, but they can or can not be given in the same language. In general, one language code can be assigned to a service, regardless of how many secondary components there are. The language therefore applies to the primary component, which is signalled by the P/S flag in FIG 0/17 being set to "primary". There is one situation when the language of a secondary component can be signalled. This is when the service comprises exactly two audio components, one primary and one secondary, and these two components have the same programme type but in different languages.

EXAMPLE: A NEWS bulletin is simultaneously broadcast in two languages: in Swedish on the primary service component of the service and in Finish on a secondary audio service component of the same service. Table 3.6.5C shows the coding in the first and second PTy field in FIG 0/17.

Table 3.6.5C: Coding example for PTy language

Parameter	1st PTy field in FIG 0/17	2nd PTy field in FIG 0/.17
SId	E212	E212
S/D	1 (Dynamic PTy)	1 (Dynamic PTy)
P/S	0 (language refers to the primary serv. component	1 (language refers to a secondary serv. component
L-Flag	1 (language field present)	1 (language field present)
CC flag	0 (coarse code absent)	0 (coarse code absent)
NFC	0 (no fine codes)	0 (no fine codes)
Language field	28hex (Swedish)	27hex (Finnish)
Int.code	00001 (NEWS)	00001 (NEWS)

The P/S flag only refers to the PTy language, not to the coarse or fine codes, these latter apply to the Service. If there is more than one secondary audio service component in a service, the language of these cannot be signalled. And therefore, only the primary component can be found through a PTy search or watch.

NOTE: If no language is signalled (language field absent, L flag = 0), then the P/S flag is meaningless and should be set to "0".

3.6.5.2 Mandatory requirements

The use of the PTy feature is optional, both for the Service provider and the receiver. However when PTy preview information (see 3.6.7) is given for a service in another ensemble it is mandatory to transmit the corresponding FIG 0/17 as soon as the programme with the previewed code in that other ensemble starts.

3.6.5.3 Operational aspects of broadcasting

3.6.5.3.1 Functional minimum requirements

The minimum implementation requires that one coarse code, from the international table be assigned.

3.6.5.3.2 Optional extensions

The multilevel structure of the Programme Type table makes it possible to consider at least three stages of implementation regarding the number of codes in use.

a) the fixed international set of 32 codes only;

b) all 64 coarse codes;

c) all codes (coarse codes and fine codes).

In the case of (b) and (c) it is mandatory to broadcast the Programme Type downloading information covering all applied Programme Types using FIG 1/2 (see 3.6.6.3.1).

3.6.5.3.2.1 OE PTy and FM PTY

The PTy codes that apply to other ensembles and FM/AM services can also be signalled. In this case the OE flag in FIG type 0 data field shall be set to 1. In case of FM PTy, the SId field in FIG 0/17 is used to signal the PI code of the RDS service or a "dummy" code using the same format. The P/S flag is reset. The Int.code is used to signal the RDS PTY code. The S/D flag, CC flag, L-flag and the NFC field remain the same as in DAB. The Coarse code and Fine code fields can remain the same as in DAB though it should be realized that the FM receiver can't test them. In case of OE PTy only international PTy codes can be signalled. Signalling national PTy codes for services in another ensemble is never allowed even if the other ensemble is located in the same country as the current ensemble (see remark n°5 in 3.6.5.1.5.1). The recommended rate for transmitting OE PTy information and FM PTy is relatively slow. For a mobile receiver, up to a minute or so should be allowed for the full choice of information about the other information to be gathered. If the data capacity of the transmission channel permits, a faster transmission rate will benefit the listener by reducing the receiver response time. The number of other ensembles to cross-reference depends on the DAB service area. Considering for example the London area and assuming that there are five other ensembles, then the OE information requires a data capacity of less than 2 % of the FIC capacity.

3.6.5.3.3 Inter-relations with other features

The Programme Type feature is dependent upon the Service Identifier (SId), The Extended Country Code (ECC), the International table identifier carried in the Country, LTO and International table feature (FIG 0/9). The Programme Type downloading feature (FIG 1/2), the Programme Type preview feature (FIG 0/12), the Other Ensembles feature (FIG 0/25), and the Frequency Information feature (FIG 0/21) can be used for further enhancement of the feature. Whereas the language field in FIG 0/17 can be used to signal the language of the primary service component (or a maximum of one secondary service component) of an audio service, the Service component language can be used to signal the language of any service component in the ensemble, being primary or secondary, being audio or data (see 3.6.2.3.2). Whenever the PTys are operated dynamically and both the language field in FIG 0/17 and the Service Component Language in FIG 0/5 is transmitted, the information should be consistent. The language indicated in FIG 0/17 with P/S flag set to "primary" shall be the same as the language signalled in FIG 0/5 for the primary component. A language in FIG 0/17 signalled for a secondary component shall be the same as the language signalled in FIG 0/5 for the same component. When the PTys (including the language field) are operated statically, the Service component language should also be static and equal to the PTy language. When the service provider has a service with programmes with different language audience targets then he should signal the language dynamically. If he has no means for dynamic signalling, static signalling is allowed on condition to set the language field in FIG 0/17 equal to "0".

3.6.5.3.4 Preferred transport mechanism and OE & FI alternatives

It is recommended that the Programme Type information be carried in the FIC using FIG 0/17. When in FIG 0/17 the OE flag = 0 i.e. for PTy information applying to the current ensemble, the information may be carried in both the FIC and AIC though the data repetition rate in the FIC can be reduced. When in FIG 0/17, the OE flag = 1 i.e. for PTy information applying to Other Ensembles the PTy information may be entirely carried in the AIC.

3.6.5.3.5 Recommendations on contents and real time aspects

The Programme Type codes should reflect the contents of the programme according to the intended audience (static mode) or the programme currently broadcast (dynamic mode) and should be chosen with the listener in mind. The allocation of codes does not necessarily have to follow the true programme content.

For example, a programme containing sport interspersed with pop music might be classified as "SPORT" because the listener, interested in sport, would tolerate the musical interludes. It should not be classified as "POP MUSIC" at any time during the programme because the listener would not tolerate pop music interrupted by sport! Broadcasters operating more than one service should bear in mind the interaction between services when allocating PTy codes. For example at a certain moment more than one service may start with a SPORT programme. The broadcaster should decide whether it is appropriate for these services to be signalled as SPORT simultaneously, or whether only one service at a time should be designated as the SPORT service for the benefit of receivers in WATCH mode.

Also the language codes should be chosen considering the intended audience of a programme,. The language code will normally signal the spoken language, i.e. the language of the commentator. If a German service is broadcasting live from an opera house in Italy, the language of the singer could be Italian, but the commentator would speak German. The language signalled in FIG 0/17 should be German, reflecting the language of the intended audience. In the same way, a French service playing a pop song in English, would not change the language code from French to English since the piece of music is just a part of a programme directed to the audience in France.

The Programme Type code "0" ("No Programme Type or Undefined) should be set only if the programme cannot be classified using one of the categories defined in the international set. This should be a rare occurrence, if the full range is available. However, the code "0" may be used more often when it is inappropriate or undesired to send a code, for example, during programme pauses or during advertising breaks.

PTy codes should be transmitted at least once a second and preferably up to ten times per second. This faster rate should be used especially at programme boundaries for the first two seconds. Assuming that eight services are signalled in a national DAB ensemble and that two PTy codes are assigned to each service, the transmission of the Dynamic PTy information requires a data capacity of about 6,4 % of the FIC capacity.

3.6.5.3.6 Default contents in the event of failing service

The Programme type code "0" shall be transmitted in the event that the dynamic operation of codes fails. In the event of a failing service, the Programme Type information should not be transmitted.

3.6.5.4 Receiver implementation aspects

The feature is intended for all types of audio receivers.

3.6.5.4.1 Functional minimum requirements

The receiver should be able to interpret and handle at least one of the coarse codes from the international set with the exception of codes 30 and 31 which shall be ignored by the receiver in Europe. A receiver can display the Programme type label stored in the receiver, either in a 16- or 8- character format. As explained in 3.6.5.4.4 there can be cases (e.g. in multi-lingual ensembles) where it is essential for the receiver to have a language filter, based on PTy language.

3.6.5.4.2 Optional extensions and alternatives

It is recommended that the receiver should provide PTy SEARCH, PTy SELECTION and PTy WATCH modes (see 3.6.5.4.4)

a) PTy SEARCH mode: A listener asks the receiver to try to find a particular PTy code from those that are theoretically possible. This is the mode most often provided on RDS receivers, but on its own (i.e. without SELECTION or WATCH modes, described below) is not generally recommended as it leads often to listener dissatisfaction. In the search mode, the receiver looks for codes which are available NOW.

b) PTy SELECTION mode: A listener is requesting the receiver to inform him what PTy codes are actually available on air at that moment and then chooses by selecting from those PTy codes that the receiver has determined.

c) PTy WATCH (or STANDBY) mode: This mode allows the listener to program the receiver to standby or watch for a particular PTy category to become available later.

Receivers shall only use PTy codes where the dynamic indicator is set to "dynamic" for WATCH mode, but can use either PTys indicating either Dynamic or Static for SEARCH or SELECTION modes. Further implementation stages require the receiver to store and evaluate the Programme type codes from the extended coarse code set "32 to 63" and fine codes "0 to 255" together with their Programme Type labels. This implies the use of the Programme Type downloading feature (see 3.6.6). PTy WATCH/SEARCH for a national PTy code need to be based on PTy + CountryId + ECC while PTy WATCH/SEARCH for an international PTy code can be done based on the PTy code alone.

3.6.5.4.2.1 OE PTy and FM PTY

When the OE flag is set, the services are found by using the FI (see 3.6.10) to retune to the other ensemble or FM service. The search or watch functions are then extended to include PTy codes signalled in other ensembles or FM services. However, the rate at which the information is transmitted for these cases is considerably less than for the tuned ensemble. For a mobile receiver, up to a minute or so should be allowed for all the information to be gathered.

3.6.5.4.2.2 PTy in relation to secondary service components

It is important to notice that in case of PTy SEARCH, when successful, the receiver will find a service i.e. the receiver will automatically default to the primary service component of that service. In the example given in 3.6.5.1.5 a PTy SEARCH for WIMBLEDON or TENNIS or for SPORT will yield the service BBC SPORT and the receiver, defaulting to the primary service component, will reproduce the report from Centre court. Secondary service components, when available, can be signalled by the receiver to the listener so that the user by toggling a switch could "step through" the different available secondary service components and find out from the service component label (see 3.6.13) its content.

3.6.5.4.2.3 PTy Language

In some countries or in multi-lingual ensembles it is essential for the receiver to have a language filter based on the Language field in FIG 0/17. Whenever a PTy SEARCH or PTy WATCH is requested, the receiver evaluates the language field in FIG 0/17. The PTy SEARCH/WATCH is then restricted to PTys with a particular language. In general, when a service comprises besides of the primary service component also secondary service components a WATCH will basically yield the primary service component.

EXAMPLE 1: A Service with PTy = SPORT has a primary service component transmitting a report of a FOOTBALL match and at the same time a secondary service component transmitting a report of a BASKET BALL match. A SEEK/WATCH for SPORT will yield the report of the FOOTBALL match.

However, if the service contains one (and not more than one) secondary service component in a different language a watch for the (common) PTy will yield the component in the desired language if the receiver has a language filter based on PTy language.

EXAMPLE 2: A Swedish service with PTy = SPORT has a primary service component transmitting a report of a FOOTBALL match in SWEDISH and at the same time a secondary service component reporting from the same match in Finnish. A WATCH for "SPORT" in "FINNISH" will yield directly the Finnish report.

The listener can choose whether the language filter is in operation or not. Unless specifically requested otherwise by the listener, the Service component offered as a result of the WATCH mode, should be in the same language as the original Service selected by the listener.

In countries where there is a range of programmes in minority languages, a receiver without a language filter will not work as expected by the majority of listeners speaking the majority language. A search or watch for "news" could result in a programme in a language which the listener does not understand.

3.6.5.4.3 Interrelations with other features

The PTy preview feature (see 3.6.7) provides additional information to signal which codes are likely to be used later. Armed with this information, the listener can make an informed selection by PTy. If the chosen type is not currently available, but is expected to be shortly, the receiver can operate in a "watch" mode and switch to the chosen Programme Type when it becomes available.

The PTy downloading feature (see 3.6.6) allows new codes to be defined "over the air". All coarse codes and fine codes can be defined or re-labelled by implementing this feature. A 16-character label is provided for each PTy description and this can be in one or more languages.

The PTys which are used in other ensembles and FM/AM services can be signalled using the OE flag carried in the FIG sub-header. This allows a receiver to build up a more comprehensive list of the types available. The full benefit to the listener can only be realized if there is a widespread implementation of the feature covering all available services. The extent to which different broadcasters are prepared to support this objective can vary from one country to another. When the OE flag is set, the services are found by using the FI (see 3.6.10) to retune to the other ensemble or FM service.

3.6.5.4.4 Recommendations on implementation and presentation

It is recommended that receivers implement not only "SEARCH", but also "SELECTION" and "WATCH" modes. It is also recommended to implement a language filter based on the interpretation of the language field.

a) SEARCH MODE: The listener enters a PTy code by scrolling through the list of PTy categories that are theoretically possible. This means that all the PTy information received is relevant even if some broadcasters are operating in the dynamic mode. The receiver then SEARCHES each ensemble available to see if the required PTy code is being broadcast at that time.

   The search time depends on the range of services that are checked outside the ensemble. Services within the tuned ensemble are found quickly. Services that are cross-referenced in other ensembles (including FM/AM services) are also directly accessible although a slightly longer delay results from the need to re-tune to the other service source. In some countries, many of the available ensembles can be cross-referenced and most of the PTy information could be recovered in this way. The slowest method is to scan the known DAB frequency bands, tuning to each ensemble in turn. It can be appropriate to display a suitable "PTy Searching" warning to the listener.

   In the search mode, the receiver:

   - can scan all available DAB Ensembles. During this operation, the audio can be muted;
   - shall address all codes regardless of the state of the "S/D" flag and regardless of whether the codes are coarse or fine;

- shall unconditionally switch to the relevant Service if a match to a desired code is found;
- shall not return automatically to the previously selected Service;
- shall indicate when no match is found.

Possible implementation stages:

- International (EBU) set only (0 - 29)
- Full coarse set (0 - 63)

b) SELECTION MODE: The listener makes a programme selection by selecting from those PTy codes that the receiver has determined to be actually available at present. This is achieved by the receiver examining the information contained within the FIC of the current ensemble and also within the Other Ensembles cross-reference information. The receiver should use both PTy static and dynamic codes. For the OE information it may be necessary for the receiver to use the TII information to check which Other Ensembles are actually available at the current location. On a receiver with a large display, the available PTy codes can be shown at once so that the listener is able to make an instant selection, on other receivers the PTy categories available could be presented sequentially.

In the SELECTION mode the receiver:

- can present all PTys that are available for selection by the listener;
- shall address all codes regardless of the state of the "S/D" flag and regardless of whether the codes are coarse or fine;
- shall unconditionally switch to the relevant Service selected by the listener.

Possible implementation stages

- International (EBU) set only (0- 29)
- Full coarse code set (0 -63)
- Fine Codes

c) WATCH MODE: the receiver stands-by and watches out for a PTy code that is not on air at present but will become so later. When it does, the receiver can switch to that audio component. This is useful not only for watching out for programmes which can occur regularly, but also for programmes that occur infrequently, and hence are likely to be missed otherwise. It is possible to program the receiver to Standby for more than one PTy code at any time. In the WATCH mode the receiver checks only for dynamically operated codes by looking at the downloading information or the PTy preview feature. The latter allows the receiver to know in advance those PTy categories that will become available soon.

In the WATCH mode, the receiver:

- can make an initial search as described for the search mode;
- shall continuously search within the confines of the tuned Ensemble and the Other Ensembles' information included with it. This prevents the audio being muted for single front-ended receivers;
- To prevent a receiver "standing by" for ever on a service which does not have the ability to control data dynamically, receivers should examine the PTy static/dynamic flag before standing-by. The receiver shall address only dynamically switched codes (S/D = 1). If the S/D flag is not set (= 0) this indicates that the broadcaster does not change PTy codes, so standing-by is meaningless. If a match to a desired code is found the receiver offers the relevant Service.
- If it can be positively established that a particular chosen code may come later, the receiver confirms this to the listener and begins to watch for the code. If no positive information is available, the receiver can inform the listener about this and allow him to let the receiver watch regardless.
- shall offer the relevant Service component if a match to a desired code and language is found (re-tuning to a different Ensemble if necessary). For each programme service offered in the watch mode, the listener should be able to choose further whether to accept that programme Service or to allow the receiver to continue to watch for further programmes services of the same type

—when the selected programme of the chosen type finishes, the receiver can either return to the previously selected programme service/audio source or remain in the watch mode until the listener cancels the selection.

Possible implementation stages:

- International (EBU) set only (0 - 29)
- Full coarse set (0 - 63)
- Fine codes
- PTy preview

It is valuable for the listener to see a displayed label of the selected Programme Type description so that his choice is confirmed and so that, if the codes are switched dynamically, he may recognize that his choice is no longer available on that Service.

It is important that the use of "vectored" PTys in WATCH mode is done in a careful way. Not all PTy codes are suitable for WATCH mode. Moreover the listener is mostly not aware of the difference between dynamic PTys and Announcement types (see 3.6.8) e.g. the (subtle) differences between a "News flash" (Announcement type) which is basically dynamic and unscheduled and "News" (PTy code 1) which is mostly scheduled i.e. according to a certain PNum (see 3.6.4); between "Area weather flash" (Announcement type) and "Weather" (PTy code 16); between "Transport flash" (Announcement type) and "Travel" (PTy code 22).

In case of NEWS and WEATHER the Announcement feature (3.6.8) shall be used for (short) vectored interrupts of the currently selected service (audio source) while dynamic PTy shall be used for Programme selection, search and watch by finding a match to the desired programme (see annex C). It is important to realize that in case of Announcements the listener has the advantage of cluster operation, regional filtering and the "new" flag while in case of dynamic PTy he has the advantage of language filtering.

The transmission of the Programme Type preview feature (see 3.6.7) allows the receiver to deduce which Programme Type codes are likely to be broadcast in the next two hours. This information can be used to assure the listener whether a watch request is likely to succeed or not. The listener can choose to ignore such feedback, but at least there would be no question of the listener believing that his receiver is malfunctioning if the watch operation fails. If the chosen type is not currently available, but is expected to be shortly, the receiver can operate in a watch mode and switch to the chosen Programme Type when it becomes available.

Receiver manufacturers could produce a particularly attractive PTy implementation by combining the three modes into a single routine:

EXAMPLE: A listener asks to find a Sports programme.

The receiver SEARCHES for PTy code 04 (SPORT). It is currently unavailable, so the receiver automatically goes into the STAND-BY mode. The receiver then offers the listener the SELECTION of categories currently available.

If the fine codes are implemented and a fine code is requested by the listener, the receiver begins to SEARCH for that code. If the SEARCH is unsuccessful, the receiver can give the listener a choice, for example, to move to the WATCH mode or to SEARCH for the associated coarse code. If the listener opts for WATCH mode, the receiver should only consider the fine code requested and to then ignore the associated coarse code.

3.6.5.4.5 Fall back in the event of failing service

If the PTy information (FIG 0/17) is no longer transmitted, following an acknowledged request to watch for a particular code, the receiver should indicate this (on the display). When the watched service is simulcast on FM, the receiver could switch to the equivalent RDS service by using FM PTY and FI.

3.6.5.4.6 Hints and remarks

It is not realistic to have one separate button for each Programme Type category. On the other hand no listener is interested in every PTy. Therefore, the listener can be expected to allocate his favourite Programme Types to a restricted number of buttons.

3.6.6 Programme Type downloading

3.6.6.1 Introduction

3.6.6.1.1 Purpose of the feature

The Programme Type downloading feature allows a receiver to be updated with programme type descriptions, which do not belong to the pre-defined International table of fixed coarse codes or to other codes, which have been internationally agreed. The downloading mechanism applies both to coarse and fine codes. The feature is also used to establish a link between a coarse code and a fine code.

3.6.6.1.2 End user of the feature

The receiver.

3.6.6.1.3 Provider

The Service provider.

3.6.6.1.4 Other parties involved

For some network configurations the Ensemble provider can become involved.

3.6.6.1.5 Description

The Programme Type downloading mechanism allows over-the-air definitions of PTy codes. It can be used to define coarse codes as well as fine codes. Two fine codes can be linked with the same coarse code but each fine code can be linked only with one coarse code. PTy coarse codes in the range 32-63 and PTy Fine codes are redefinable but some of them can be agreed nationally or internationally. The Programme Type downloading information is carried in FIG 1/2 (see [1], 8.1.5.2) and relates the Programme Type code to a 16 character label which describes the programme type.

A Country flag indicates whether the code is defined at an international or national level. When the Country flag = 1 the code is defined at national level. In this case the Extended Country Code (ECC) together with the Country Id (the first 4 bits of the SId) allows the country within which the PTy definition is valid to be specified. When the Country flag = 0 the PTy code is defined at international level within the region defined by the Int.table in FIG 0/9. In this case the last two bytes in FIG 1/2 are absent.

An "International" PTy code means that the PTy + International table is unique while a "National" PTy code means that the PTy + ECC + Country Id is unique. Table 3.6.5A in 3.6.5.1.5 illustrates the relation between fixed PTy codes, PTy codes defined by downloading, International PTy codes and National PTy codes. In this table the value of X is not fixed. The total sum of the international and national codes defined by downloading is 32. The term "fixed" means that these codes are basic PTy codes belonging to an international table (which could be stored in a receiver). The term "defined by downloading" means that the Pty downloading mechanism is required. "International" means that the PTy code is unique in the area defined by the international table identified in FIG 0/9 while "National" means that the PTy code is unique in the country defined by the CountryId and the ECC.

The C/F flag indicates whether a coarse code or a fine code is being defined. The relationship between the coarse and fine codes is conveyed by specifying the corresponding coarse code for each fine code definition.

A Language code indicates the language applying to the 16 character Programme Type label. Unlike in FIG 0/17 (Programme Type, see 3.6.5) and FIG 0/12 (PTy Preview see 3.6.7) where the language field is optional, the language field of the PTy downloading label is mandatory.

The Character field is a 16-byte field that defines the PTy label. It is formed by a string of 16 characters (Character 15 is the left-most character) which are presented in the character fonts identified by the Charset field in the first byte of FIG type 1 data field. From broadcasting side the label is "left adjusted" i.e. if the PTy label comprises less than 16 characters, it is complemented by the necessary "blanks". A character flag field is used to mark the up to 8 characters which should be displayed on receivers having a display of less than 16 characters (3.6.13.6).

3.6.6.2 Mandatory requirements

The Programme Type downloading feature is optional, both for the Service provider and for the receiver. However, when in FIG 0/17 (PTy, see 3.6.5) coarse or fine codes are used which have not been internationally agreed or when PTy preview (see 3.6.7) is given for such codes, PTy downloading becomes mandatory.

3.6.6.3 Operational aspects of broadcasting

3.6.6.3.1 Functional minimum requirements

Preferably the full list of labels, associated with PTy coarse and fine codes used within the ensemble reception area is downloaded continuously. For countries having more than one Country code (In Europe this is the case for Germany) PTy downloading shall be repeated for each Country code. The minimum repetition rate shall be one Programme Type downloading field (FIG 1/2) every 10 seconds. The mixture between internationally and nationally defined codes may vary. The national codes may need to be repeated more frequently in the download cycle to update the receivers in border areas where each country may have its own set of national codes. Recently implemented programme type codes can also need to be inserted more frequently in the download cycle.

3.6.6.3.2 Optional extensions

Besides transmitting definitions for the re-definable codes, the Programme Type downloading feature can also be used to transmit definitions of the fixed international codes at a very low repetition rate. This would make it possible to transmit the PTy labels for the international fixed codes in different languages. A receiver purchased in Sweden could, for example, be pre-programmed to present the labels in English, but after a while the downloading feature would provide the programme type labels in Swedish.

3.6.6.3.3 Inter-relations with other features

The Programme Type downloading feature is closely related to both the Programme Type (see 3.6.5) and Programme Type preview (see 3.6.7) features. The Programme Type downloading feature is also related to, but not dependent upon, the Extended Country Code and International table identifier both carried in FIG 0/9 and the Country Id contained in the first 4 bits of the SId.

The PTy downloading feature allows the use of several national PTy code tables in one international ensemble (current ensemble only i.e. OE flag = 0). Signalling national PTy codes for services in another ensemble (OE flag = 1) is never allowed even if the other ensemble is located in the same country as the current ensemble and even if their definition would be given with the PTy downloading feature (see remark N°5 in 3.6.5.1.5).

3.6.6.3.4 Preferred transport mechanism

Programme Type downloading information is normally carried in the FIC, in FIG 1/2, but can also be carried entirely in the AIC.

3.6.6.3.5 Recommendations on content and real time aspects

Internationally- and most nationally defined codes are seldom redefined. A number of the national codes are set aside for special events and may occasionally be redefined. Once a downloaded PTy code has expired, this code shall not be re-used for a sufficiently long period (e.g. one year), in order not to confuse receivers in which this code may have been preset.

3.6.6.4 Receiver implementation aspect

The feature is intended for all types of audio receivers.

3.6.6.4.1 Functional minimum requirements

A receiver designed to interpret and present the definable programme types contained in the coarse codes 32 to 63 and/or fine codes 0 to 255 shall evaluate FIG 1/2 and be able to store the codes together with the associated Programme Type labels and Country codes.

3.6.6.4.2 Optional extensions and alternatives

An optional feature is to store more than one national set of coarse and fine codes. This would be very useful in border areas. If the receiver can decode and store the code definitions in more than one language, a choice of language could be offered to the listener when displaying PTy options.

3.6.6.4.3 Inter-relations with other features

The Programme Type downloading feature is related to the Programme Type feature and the Extended Country Code together with the Country code contained in the 4 first bits of the SId.

3.6.6.4.4 Fall-back in the event of failing service

The receiver can use previously stored re-definable programme type descriptions. It can also signal when no FIG 1/2 has been received for, say, the last 10 minutes.

3.6.6.4.5 Hints and remarks

The Programme Type downloading feature makes it possible for a receiver to interpret a wide variety of programme types. The listener can then search or watch for broad programme categories not defined in the 32 coarse codes in the currently accepted International Table or for more detailed categories using the fine codes.

If the listener request a programme associated with a "fine" code and if the fine code is not found during a reasonable search process, the receiver could use the associated "coarse" code as an alternative. If the listener chooses the watch mode, the receiver should only check the requested fine code and ignore the associated coarse code.

A downloadable PTy code can change now and then (see 3.6.6.3.5). As there is no change event signalling foreseen in FIG 1/2, the receiver has to continuously monitor FIG 1/2 in order to detect a change.

If many broadcasters implement the Programme Type downloading feature for the internationally set of fixed PTy codes, receivers can utilize this feature to convert the Programme Type labels into another language. A receiver with FRENCH as the preferred language could store the French version of each PTy label and ignore the other languages.

3.6.7 Programme Type preview

3.6.7.1 Introduction

3.6.7.1.1 Purpose of the feature

The Programme Type preview feature allows Ensemble/Service providers, who implement the Programme Type feature using dynamic Programme Type codes (see 3.6.5), to provide a preview of Programme Type codes for programmes which are planned to be broadcast in the next one or two hours in the tuned ensemble as well as in another ensemble. The Programme Type preview feature allows listeners who operate the Programme Type feature in the "watch" mode (see 3.6.5.1.5) to be assured whether the Programme Type codes he has selected will indeed become available or not i.e. that his "watch" request is likely to succeed or not.

3.6.7.1.2 The end user of the feature

The receiver and the listener.

3.6.7.1.3 Provider of the feature

The Ensemble provider in co-operation with the Service provider. The (several) Service providers in the Ensemble inform the Ensemble provider of the PTy preview information for the forthcoming dynamic PTy codes. The Ensemble provider then transmits the PTy preview information for these coming PTy codes over a time window declared by the Service providers.

3.6.7.1.4 Description

The Programme Type preview feature signals to receivers which type of programmes, characterized by the code number of the coarse or fine Programme Type codes, are likely to be broadcast in the next one or two hours.

The PTy preview feature is encoded in FIG (0/12) (see 8.1.5.3 in [1]). This includes the Ensemble Identifier (EId) so that the feature is intended for ensembles (current or other ensemble), not for services neither for FM services.

The 1 bit L Flag indicates whether the language field is present or not. The language field is thus optional and, when present, indicates the language code of the audio to be broadcast. The language field should be consistent with (i.e. the same as) the Service Component Language of FIG 0/5 (See 3.6.2); if present. For each language one FIG 0/12 should be signalled. Language is coded according to TS 101 756 [20].

The 2 bit Flag-field Format (FF) determines whether the following Flag-field contains flags for coarse codes fine codes or both. The Flag-field can be 4, 8, 16 or 24 bytes long, depending on whether Int.codes (codes 0 to 29), Int.codes and coarse codes (codes 32 to 63), Fine codes (128 to 255) or both Coarse and Fine codes (codes 0 to 63 and 0 to 255) are being signalled. The four versions can be mixed in any order. By setting bits "b_i" in the Flag field to "1" the Ensemble/Service provider can signal to receivers that the assigned PTy codes are planned to be transmitted soon.

3.6.7.2 Mandatory requirements

The use of the Programme Type preview feature is optional, for the Ensemble/Service provider and the receiver. Whenever PTy preview information is signalled for another ensemble, the corresponding Programme Type signalling (FIG 0/17) need to be given as soon as the concerned programme starts. When giving a PTy preview of national PTy codes applicable to services in another ensemble also the definition of these codes should be given (by means of the PTy downloading feature FIG 1/2, see 3.6.6) i.e. the PTy label, the link between the fine code and the coarse code, the ECC and Country Id.

3.6.7.3 Operational aspects of broadcasting

3.6.7.3.1 Functional minimum requirements

The Ensemble provider should transmit the Programme Type preview information covering the forthcoming dynamic Programme Types over a time window declared by the Service Provider. The flag, which signals that a certain Programme Type code is to be used, should be reset to "0" as soon as that code is actually transmitted. The exception from this rule is when the same Programme Type code will appear again during the pre-defined time, this will be true for example for "NEWS". When giving a PTy preview of PTy codes applicable to services in the current ensemble, the Int. table (transmitted in FIG 0/9, see 3.6.3) should apply to all services in the ensemble.

When giving a PTy preview of PTy codes applicable to (services in) another ensemble, the Int.table applicable in the current ensemble shall also be applicable in the other ensemble. For each combination of EId/language one FIG 0/12 needs to be sent.

3.6.7.3.2 Restrictions

National PTy codes can have a different meaning in different countries. For example PTy coarse code "57" could mean PIANO MUSIC in Germany, labelled as "KLAVIER MUSIK " and WOMAN's programme in France, labelled as "FEMMES". It is important to realize that:

1) The PTy preview concept is based on signalling PTy codes for an Ensemble, not for a Service in the Ensemble i.e. the receiver initially does not know which service in the Ensemble will (soon) start with a programme having the signalled code.

2) For an unambiguously interpretation of a national PTy code both the Country Id and ECC has to be known. It is the Ensemble ECC which specifies together with the Country Id of the EId the validity of the downloaded PTy code (see 3.6.22.1.5).

3) An (International) Ensemble can contain one or more services having a Country Id and ECC different from the rest of the services in the Ensemble. FIG 0/9 (see 3.6.22) signals besides of the Ensemble ECC also those services in the Ensemble for which the associated ECC differ from that of the Ensemble ECC.

However, since FIG 0/9 has no OE functionality (the OE flag in the FIG subheader is a RFu) the ECC of another Ensemble cannot be signalled from the current Ensemble. Only by (temporarily) tuning to the other Ensemble the ECC of that Ensemble will be known. The consequence of the above is that in some cases a preview of a national PTy code will be ambiguous and should not be done; table 3.6.7 summarizes the conditions under which PTy preview of International and national codes is allowed or not (see annex F for details).

Table 3.6.7: PTy preview restrictions

Ensemble	PTy preview of Int.codes	PTy preview of National codes
Current Ensemble = National Ensemble: all services have same Country Id/ECC	Allowed	Allowed if definition of codes is given with FIG 1/2
Current Ensemble = International terrestrial Ensemble: some services have different Country Id/ECC	allowed, if language is signalled in FIG 0/12	Allowed if agreement to use only one set of national PTy codes; their definition is given with FIG 1/2 and language is signalled in FIG 0/12
Other Ensemble = Ensemble in neighbouring country: all services have same Country Id/ECC	Allowed if same Inter.Table Id as in current ensemble and language is signalled in FIG 0/12	Not allowed
Other Ensemble = International Ensemble in neighbouring country: some services have different Country Id/ECC	Allowed if same Inter.Table Id as in current ensemble and language is signalled in FIG 0/12	Not allowed
Current ensemble = National multi-lingual Ensemble: all services have same Country Id/ECC but some of them have different language	Allowed if Language is signalled in FIG 0/12	Allowed if codes are unique and their definition given with FIG 1/2; language is signalled in FIG 0/12
Other Ensemble = National multi-lingual Ensemble: all services have same Country Id/ECC but some of them have different language	Allowed if same Inter.Table Id as in current ensemble and language is signalled in FIG 0/12	Not allowed

3.6.7.3.3 Interrelations with other features

The Programme Type preview feature is inherently related to the Programme Type feature (see 3.6.5) operated in the dynamic mode, with the PTy downloading feature (see 3.6.6), with the Country, LTO and International Table feature (3.6.22).

3.6.7.3.4 Preferred transport mechanism

The Programme Type preview feature, when applied, is normally carried in the FIC but can also be directed to the AIC in the MSC. When in FIG 0/12 the OE flag is reset i.e. for PTy preview information applying to the tuned ensemble, the information can be carried in both the FIC and the AIC though the data repetition rate in the FIC can be reduced. When the OE flag is set i.e. for PTy preview information applying to other ensembles the information can be entirely carried in the AIC. The ensemble provider needs to rationalize all the programme type contributions from the services carried in the ensemble. Repetition rate C is recommended. Assuming that eight services are signalled in an ensemble, the transmission of the PTy preview information requires a data capacity of about 0,1 % of the FIC capacity

3.6.7.3.5 Recommendations on contents and real time aspects

The Programme Type preview information should be dynamic and kept updated according to the rules set in 3.6.7.3. If the particular Programme Type is no longer expected to be transmitted the appropriate Programme Type preview flag should be reset immediately.

3.6.7.4 Receiver implementation aspects

The Programme Type preview feature is mainly intended for receivers in which the Programme Type feature "watch" mode is implemented.

Some PTy labels such as SPORT are common in many languages; A user may decide to start watching for such a programme based on PTy preview. In order to avoid the customer watching for a programme in a language he does not understand (in case of multi-lingual Ensembles or a preview for another ensemble located in a neighbouring country) a language indication or a language filter based on the language field in FIG 0/12 is strongly recommended.

It is possible that a PTy code preview may be applicable to more than one service. In this case the receiver watching for this dynamic PTy will catch the first service that comes on air. If later another service with the same dynamic PTy code comes on air the receiver can either switch to it or ignore it.

3.6.7.4.1 Functional minimum requirements

The receiver should be able to indicate which Programme Type codes are currently present in the Programme Type preview list or indicate that the list is not available.

3.6.7.4.2 Optional extensions and alternative

An advanced receiver may display to the listener in which Ensemble his programmed Programme Type codes will become available.

3.6.7.4.3 Interrelations with other features.

The Programme Type preview feature is inherently related to the Programme Type feature (see 3.6.5), to the PTy downloading feature (see 3.6.6) and with the Country, LTO and International Table feature (see 3.6.3). Moreover, since the PTy preview codes are given for an Ensemble, not for a Service, the receiver while watching for a particular programme type doesn't know which service (component) in the other ensemble will generate the programme. Therefore the receiver has to be prepared for switching by monitoring FIG 0/21 for getting the frequency of the other ensemble, by monitoring FIG 0/17 (for OE = 1) for getting the start of the watched programme and the SId of the service that will generate the programme and by monitoring FIG 0/2 for getting the sub-channel of the service (component) in the other ensemble.

3.6.8 Announcements

3.6.8.1 Introduction

3.6.8.1.1 Purpose of the feature

The Announcement feature allows a listener to be temporarily re-directed from the current selected audio source to an audio source, which delivers a spoken message in the form of an (short) announcement. This interruption mechanism depends on three selection (filter) criteria.

The first is the kind of information supported by the announcement, for example road traffic information. One type is specifically assigned for public service alarm messages.

The second criterion (based on Clusters) gives the Service provider some control over the services allowed to supply the messages by restricting the message sources to those other services chosen by the Service provider.

The third criterion is optional and signals the region to which a message is targeted. This is important for emulating the inherent regional nature of FM broadcasting when the DAB ensemble operates in a Single Frequency Network.

It is the second and third criteria that distinguish the Announcement feature from the dynamic Programme Type feature (see 3.6.5). Messages may be retrieved either from the tuned ensemble (which is the basic implementation), from other receivable ensembles or from FM (RDS) services. The Announcement feature is restricted to Programme services: the interrupted service shall be a Programme service; the interrupting Service component shall be Audio. However, if the current service contains data components, switching to an announcement from another ensemble or FM may interrupt not only the audio but also the data application. The Announcements feature should be used for (short) vectored interrupts of the currently selected service/audio source, as known from the RDS TA announcement feature (see [22]). After an announcement, the originally selected service/audio source should be restored to the user (listener).

3.6.8.1.2 End user of the feature

The listener, who is enabled to select the kind of announcements he is interested in.

The Service and the Ensemble- provider, who can control the mutual interactions between several of his programmes and can protect them against unwanted interrupts (for example, from a competing broadcaster).

3.6.8.1.3 Provider of the feature

The Service provider.

3.6.8.1.4 Involvement of other parties

The Ensemble provider should regulate Announcement clusters (see 3.6.8.1.5) and these should be unique in an Ensemble coverage area. The definition of the Announcement types is a matter for international agreement for a given table. So far a table (see table 14 in TS 101 756 [20]) containing eleven of the possible sixteen types has been agreed by WorldDAB in Europe.

3.6.8.1.5 Description

3.6.8.1.5.1 Announcement support

The announcement feature is based on the concept of an Announcement Cluster which can be understood as a mailbox. There can be up to 255 different Announcement Clusters in an Ensemble, each of which is uniquely identified within the Ensemble by an 8-bit Cluster Identifier (Cluster Id). Each announcement can be sent to one and only one Announcement Cluster at a time. This can be understood as "posting" the announcement in a mailbox.

For every Service which is allowed to be interrupted by announcements, static Announcement Support information is provided. The Announcement Support information, which is signalled in FIG (0/18), includes a list of Cluster Ids which identify those Announcement Clusters a Service is participating in. Only those mailboxes, which are indicated in the Cluster Id list, are of direct concern to a receiver accessing a particular Service. If an announcement is sent to an Announcement Cluster which is not in the list, it shall not interrupt the Service. Additionally, the Announcement Support information includes 16 Announcement Support (ASu) flags, which indicate the Announcement types which are intended to interrupt the Service. These can be used by the listener to select those announcement types for which he wants the service to be interrupted and to de-select those for which he does not want an interruption.
ClusterId = "00000000" and "11111111" are predefined and should not be signalled in the Announcement Support. They can be used in the Announcement Switching, see below.

3.6.8.1.5.2 Announcement switching

For each message, Announcement Switching Information identifies four parameters and an optional fifth parameter. The Announcement Switching (ASw) flag field indicates the announcement type. The Cluster Id indicates the relevant Announcement Cluster. The Sub-channel indicates the audio source carrying the message. This Sub-channel can be reserved by the Ensemble provider especially for announcements and does not need to be contained in any Service structure. The New flag indicates whether this announcement is a new or a repeated (old) one. The RegionId is an optional parameter to identify the region to which the announcement is targeted.

The switching information is sent at the beginning, during and at the end of an announcement transmission. Its appearance initiates the conditional interruption of a Service by the Service component/Sub-channel that provides the announcement. It is encoded in FIG (0/19). An announcement is clearly identified by a beginning burst of FIG (0/19), with the appropriate ASw flags set and the ending burst of FIG (0/19) with the ASw flags reset to 0 (keeping the same ClusterId and SubChId during the beginning and end burst). Such an announcement cannot be divided in sub-messages and for this time all the announcement fields (Region, ASw, New flag, SubChId) shall be stable. If any of the fields needs to be changed, a new Announcement shall be created.

Cluster Id = "00000000" has a special meaning. It specifies that an ongoing announcement is intended to interrupt the audio service components of the *same* Service (i.e. all Services that have the signalled SubChId included in their Service Organization information can be interrupted by the announcement). This is a shorthand way of signalling an Announcement without actually allocating a Cluster Id. ClusterId = "00000000" switching shall only be used inside an ensemble and not for OE or FM Announcement Switching. Cluster Id = "11111111" indicates that an ongoing announcement is intended for all Programme services in the Ensemble, thus bypassing the normal cluster and ASu-flag filter. This Cluster Id shall be used exclusively for "Alarm" announcements (see also 3.6.1). However, a RegionId can be used to restrict the announcement to a certain geographical area. When an announcement is targeted to a particular geographical region, Regional identification information can be appended to the announcement switching information (see also 3.6.15). Its presence is indicated by the Region flag set to "1". At the end of an announcement (ASw flags set to '0') the RegionId can be omitted. If the RegionId is absent, the Announcement is targeted to the whole Service area.

3.6.8.1.5.3 Extension to other ensembles

An extension of the Announcements feature supports messages from other DAB Ensembles and announcements from FM services. As for the basic feature, it comprises static Announcement Support and dynamic Announcement Switching information.

For each Service, the Other Ensemble Announcement Support information (OEASu) specifies a list of Ensemble Identifiers (EIds) of other Ensembles, which are potential announcement carriers. It includes the ASu flag field which signals the types of announcements carried in all of those listed ensembles. This information, encoded in FIG (0/25), supplements the basic Announcement Support information of FIG (0/18) which is still required for assigning Cluster Ids to a Service.

The Other Ensemble Announcement Switching information (OEASw) provides the real-time switching information for announcements carried in other Ensembles and is encoded in FIG (0/26). It contains the EId of the Ensemble which provides the announcement together with both the Cluster Id in the current Ensemble and the Cluster Id of the other Ensemble. The Cluster Id in the current Ensemble is used, in the same way as for the basic Announcements feature, to determine whether the announcement can cause an interrupt. The Cluster Id of the other Ensemble is used to identify the Sub-channel carrying the Service component which in turn provides the announcement in the other Ensemble.

Region information, associated with both the tuned and other ensemble, can be provided. The RegionId for the current ensemble enables the initial region filter mechanism. The RegionId for the other ensemble allows the correct message to be identified from the basic Switching information carried in the other ensemble. If the RegionId for the current ensemble equals '000000' the Announcement is target to the whole current Ensemble area. The RegionId field for the other ensemble can be left out by setting the Region flag to '0', in this case the Announcement is targeted to the whole other ensemble area.

3.6.8.1.5.4 Extension to FM services

For each Service, the FM services Announcement Support information (FMASu) specifies a list of Programme Identification (PI) codes, which identify those FM (RDS) services that potentially provide traffic announcements corresponding to the DAB announcement types "Road Traffic" or "Transport flash" (equivalent to TP flag in RDS [22]). This information, encoded in FIG (0/27), supplements the basic announcement support information in FIG (0/18) which is still required for assigning Cluster Ids to a Service.

The FM services Announcement Switching (FMASw) provides the real-time switching information for announcements on FM (RDS) services (equivalent to TA flag in RDS [22]). It is encoded in FIG (0/28).

The region information, associated with the tuned ensemble, indicates the region to which the FM Announcement is targeted. In the case of RegionId = '000000' the announcement is targeted to the whole Ensemble coverage area.

3.6.8.1.5.5 Extension to operate the "New" flag

The "New" flag (signalled in the Announcement Switching information) is used by the Service provider to distinguish between a message that is being broadcast for the first time ("new") and a message that is repeated ("old"). Normally, the flag is set to indicate "new". It is only toggled by those Service providers, who provide information on a regular basis and when the same information may remain current for a longer period. The detection of this flag by the receiver, allows the listener (if he wishes) to avoid being interrupted by repeated messages.

3.6.8.2 Mandatory requirements

The Announcements feature is optional for the Service provider, the Ensemble provider, and for the receiver.

3.6.8.3 Operational aspects of broadcasting

3.6.8.3.1 Functional minimum requirements

The Ensemble provider should regulate Announcement clusters. Announcement Support information, encoded in FIG (0/18), shall be provided for all the services that can be interrupted and shall be repeated at repetition rate B. If Announcement Switching is signalled using Cluster Id '00000000' (an Announcement from within the service), Announcement Support information shall also be generated but without listing Cluster Id '00000000' in the Cluster list. Announcement switching information, encoded in FIG (0/19), shall be provided for each message that needs to be signalled. During the first two seconds of an announcement and for a similar period after the end, it shall be repeated at repetition rate A/B. For the remaining time of the announcement repetition rate B shall be used.

3.6.8.3.2 Optional extensions

The Ensemble provider should allocate RegionIds for use within the ensemble. It is helpful if regions are regulated on a national basis so that regions identified in one ensemble can be "mapped" onto regions in other ensembles (see 3.6.15). When announcements need to be directed to more than one region, several Announcement Switching fields, using different RegionIds, can be sent in quick succession. When RegionsIds are not allocated, the Region flag shall be set to "0". If regions are signalled within the announcement switching, it is recommended that region labels be provided to enable a listener to select the announcements by means of the region label.

3.6.8.3.2.1 Announcements from other ensembles

For Other Ensembles announcements, OEASu information, encoded in FIG (0/25), shall be repeated at repetition rate C. When signalling announcements in other ensembles, great care has to be taken to synchronize the information that is transmitted at the start of the message. Therefore, announcement switching information (FIG 0/19) shall be present in the other ensemble (including the start and the end burst) at the time when OEASw is sent in the current ensemble. OEASw information, encoded in FIG (0/26), shall be repeated at repetition rate A/B during the first two seconds of an announcement as well as after the end of the announcement. For the remaining time of the announcement, repetition rate B shall be used. When RegionIds are not allocated for the current ensemble,
RegionId Current Ensemble = "000000" shall be used. When RegionIds are not allocated for the other ensemble, the Region flag shall be set to "0" or the RegionId Other Ensemble = "000000" shall be used.

3.6.8.3.2.2 Announcements from FM

For FM traffic announcements, FMASw information, encoded in FIG (0/27), shall be repeated at repetition rate C. FMASw information, encoded in FIG (0/28), shall be repeated at repetition rate A/B during the first two seconds of an announcement as well as after the end of the announcement. For the remaining time of the announcement repetition rate B shall be used. When signalling announcements on FM, great care has to be taken to synchronize the information that is transmitted at the start of the message. Therefore, a raised TA flag shall be present in the FM service as long as the announcement is going on. When RegionIds are not allocated, the RegionId Current Ensemble = "000000" shall be used.

3.6.8.3.2.3 New flag

The "New" flag is intended for announcements, where messages are repeated on a regular basis. Such repeated messages are indicated as "old" and should be the repetition of the latest available message. When any of the messages are new, the flag is set to "New". The "New" flag is especially well suited for a "cyclic announcement channel", e.g. a sub-channel reserved for the repeated emission of announcements only and possibly not being included in any service description (hidden sub-channel). Only one such cyclic announcement channel is possible for each announcement type of a service for the signalling to work, so a service provider should not provide more than one such channel for a given Announcement type. The region and the cluster filter are applied before the "New" flag is taken care of, so a service provider should take into account that a receiver does not keep memory of different regions or clusters but only of the different Announcement types.

3.6.8.3.3 Inter-relations with other features

If announcements are limited to specific geographical regions, Regional identification information is desirable (see 3.6.15). This is especially true for alarm announcements. However, very important alarm announcements, shall be directed to the whole ensemble area, because receivers without regional alarms will only response to alarm announcements targeted to the whole ensemble area.

The extended announcement feature (OE or FM) requires Frequency Information and Other Ensemble Services of other Ensembles or FM services (see 3.6.10).

Multiplex re-configurations do not affect the Announcement Support information. If a Service is removed from the Ensemble, its Announcement Support information becomes obsolete even though it is not explicitly deleted. The Service Component Language (SCLang) is intended for Service Selection. It is not intended to be used as a language filter for the Announcement feature.

3.6.8.3.4 Preferred transport mechanisms and alternatives

The preferred transport mechanism for Announcement Support and Announcement Switching information is the FIC. Although a part of the information can be re-directed to the AIC, it is strongly recommended that FIG (0/18) and FIG (0/19) are carried entirely in the FIC with their normal repetition rate (see 3.6.19). For the Announcement Switching for Other Ensembles, FIG (0/27), and for FM services, FIG (0/26), it is recommended that they be carried in the FIC with their normal repetition rate.

3.6.8.3.5 Recommendations on contents and real-time aspects

The Announcement Support information is static. Once transmitted, it remains valid until it is explicitly superseded. In order to provide fast access to the Announcement Support information, it is repeated regularly (see 3.6.8.3.1). However, occasional changes of the Announcement Support information can be necessary. In this case the new information supersedes the old. Any change of the Announcement Support information, OEASu or FMASu is indicated by sending a corresponding change event (ASu flags set to zero and the Number of Clusters set to 0 for ASu, the Number of EId set to 0 for OEASu and the Number of PI codes set to 0 for FMASu) (see 3.6.20). If a Service discontinues supporting announcements, a change event should be sent without being followed by new information.

In the Announcement Support information all Announcement Types supported within the current ensemble (e.g. those types for which the ASw can be expected to be given with FIG (0/19)) and all Clusters the Service is participating in (including OE and FM Clusters) should be listed in one FIG (0/18), so only one single Announcements support field per Service is needed within the ensemble. There is no relation from a specific Cluster to a particular ASu flag setting. This information is given within the Announcement Switching information.

If a service is providing alarm announcements, the alarm bit in the Announcement Support Type field (ASu) shall be set to 0, and the ensemble-wide alarm bit in FIG (0/0) shall be set instead.

The Announcement Support Information for Other Ensembles and for FM services is intended to give background information about possible announcement sources. It is not included in the filtering process, which takes place for the Announcement Switching. However, (simple) receivers, even when having implemented OE and FM announcement switching, can only be able to switch to OE or FM announcements when the proper Announcement Support information (OEASu and FMASu) is given.

For the Announcement Support for Other Ensembles the Ensembles providing Announcement Support should be listed by their EId per Announcement Type in one FIG (0/25). The Announcement Types given with the ASu shall be valid for all listed ensembles. So a SId can be included in more than one FIG (0/25) list.

For FMASw the inclusion of a regional Identification is recommended if the coverage area of the ensemble is larger than that of the interrupting FM service.

Concurrent interrupts, i.e. two Service components sending announcements to the same Announcement Cluster at the same time, can occur. No prioritizing rules are given. Therefore, it is recommended to use different Clusters for concurrent interrupts or to signal them one after each other.

During the preparation phase of a multiplex re-configuration (see 3.3.5), Announcement Support information may be sent for Services which are not currently present in the Ensemble but will be present in the next configuration. If sent in advance, the Announcement Support Information of a new Service entering the Ensemble becomes available immediately.

The Announcement switching information is very time critical because switching is expected to take place at a defined point in time. Care has to be taken to synchronize the switching information with the beginning of the spoken announcement, especially if the announcement is given in an other ensemble or on FM (RDS).

3.6.8.4 Receiver implementation aspects

3.6.8.4.1 Functional minimum requirements

The receiver shall process and interpret the Announcement Support and Switching information encoded in FIG (0/18) and FIG (0/19) respectively. The listener's selected service allows the receiver to identify the appropriate Cluster Ids to watch out for. The listener should be offered the choice of announcement type which allows the receiver to further filter messages.

The beginning of a message is clearly identified by a burst of Announcement Switching information, being repeated at least eight times within two seconds. For all received FIGs (0/19), the receiver should compare the Cluster Id and announcement type with those selected by the listener. When both these filter mechanisms are satisfied, the receiver can identify the appropriate Sub-channel in which the message is carried and immediately switch to it. This operation shall be completed within two seconds.

The Announcement Switching information continues to be sent during the message. This allows the receiver to switch over to the message if the listener wants it. A receiver can evaluate the beginning burst of FIG (0/19) to avoid switching to an ongoing announcement.

3.6.8.4.2 Optional extensions and alternatives

The receiver can apply a regional filter based on the local region in which the receiver is currently situated. It could do this by monitoring the TII to determine its position (see 3.6.11) Additionally, the receiver can offer the listener a choice of region (by means of a region label) in the announcement selection. This effectively adds a further filter to the Announcement Switching information checking procedure. The use of region labels permits announcements to be selected from remote regions.

Implementing the other Ensemble announcements feature requires the receiver to process and interpret FIG (0/25) and FIG (0/26). The OE Support information allows the receiver to determine which other ensembles support what kind of messages. Checks can be made to investigate which of these ensembles are receivable. The listener's selected service allows the receiver to identify the appropriate Cluster Id (for the current ensemble) to watch out for. The listener's choice of announcement type and region applies as before. When all these filter mechanisms are satisfied, the receiver can take note of the EId of the other ensemble and (using the FI, see 3.6.10) immediately switch over to it. This other ensemble now becomes (temporarily) the newly current ensemble. The receiver should check the Announcement Switching information in FIG (0/19), using the Cluster Id and RegionId, originally signalled as for the "other ensemble" to identify the appropriate Sub-channel in which the message is carried. The end of the message is signalled by the FIG (0/19) information in that ensemble. When detected, the receiver should immediately return to the original service.

For the FM service announcements the receiver shall process and interpret FIG (0/27) and FIG (0/28). The FM Support information allows the receiver to determine which FM services support traffic information (using their PI codes). Checks can be made to investigate which of these services are receivable. The listener's selected service allows the receiver to identify the appropriate Cluster Id (for the current ensemble) to watch out for. The listener's choice of (the DAB) announcement types "Road traffic" or "Transport Flash" and region applies as before. When all these filter mechanisms are satisfied, the receiver can take note of the PI code of the FM service and (using the FI, see 3.6.10 or RDS processing) immediately switch over to it. The receiver shall only switch to a FM announcement, if both, the FM Announcement Switching Information, FIG (0/28), is received and the corresponding FM service raises its RDS "TA" flag. The announcement should be immediately available. The end of the message is signalled by resetting the "TA" flag signalled by RDS in that FM service. When detected, the receiver should immediately return to the original DAB service.

The receiver response to the "New" flag is expected to be very simple (see 3.6.8.3.2). The initial default should be to ignore the new flag: this ensures that no messages are missed. The option to restrict access to "new" only should be specifically requested by the listener. If the receiver is switched to this "new"-mode, it should accept the first message regardless of its "New" flag. There is no intention for the receiver to keep track of different clusters, different sub-channels and different regions. This would impose a heavy (and variable) burden on the receiver. The receiver only needs to keep track of a single flag setting for each announcement type supported by the service selected by the listener. After changing the service a simple receiver might reset all the information about the new flag of the different announcement types and might operate as if it was just switched on (more sophisticated receivers might reset the new flag information only if they receive announcements with ClusterIds different to those of the previous selected service). This may lead to the repetition of an old message if the announcements are shared by several services (using the same ClusterId). The only danger of this simplistic approach is that some "old" messages may not be heard. This occurs when more than one Service provider operates message updates on different cycle patterns.

For example, suppose that a listener has chosen "Weather flash" messages and he may have just heard a repeat of a message that he had heard earlier. This implies that the Service provider supplying that message is toggling the New flag. Now, suppose that he selects "new" messages only in order to avoid further repeated messages. However, additionally suppose that there is at least one other Service provider operating the New flag when their messages are repeated. There is a chance that the listener may not have heard one or more of these messages before he selected "new" messages only. However, as soon as any one of the other Service providers updates their messages, the danger is removed.

3.6.8.4.3 Inter-relations with other features

The basic Service does not depend on other features. The choice of region depends on the processing of Regional Identification. The extended service involving other ensembles requires the processing of Frequency Information and Other Ensemble Services. Switching over to FM services can use the FI or rely on RDS processing.

The Alarm feature is a special kind of announcement which should not be de-selectable. Receivers which operate in dormant mode (active part when the receiver is switched off) are recommended to decode the Region Id field contained in FIG 0/19 alarm announcements. All receivers can also benefit from decoding the Region Id field. Receivers should only respond to alarm announcements if they are located in the region which is identified by the Region Id field. Therefore, receivers which do not support the region feature shall only respond to alarm announcements targeted to the whole Ensemble area. The reason for this is that broadcasters need to have some control about where an alarm is reproduced (because it is not deselectable in the receiver).

In RDS some dynamic PTYs are handled as announcements. Where these PTYs have an equivalent announcement type (i.e. News and Weather) when simulcasting, the RDS PTYs should be converted to an announcement in DAB. A combined RDS/DAB receiver should take care of presenting these different coding mechanisms in a consistent way. Although Announcements and dynamic PTys are two separate features in DAB, care has to be taken to handle them appropriately and to choose the corresponding feature for each purpose. An example programme schedule is given in annex C. Because PTy and Announcements are two separate features, the dynamic PTy has no special meaning during an Announcement (i.e. the same meaning as if there is no Announcement active).

The Service Component Language feature can be incorporated into the listener's service selection mechanism so that also announcements appear in a particular language. However, no special language filter mechanism is defined for Announcements.

3.6.8.4.4 Recommendations on implementation and presentation

When a service ceases to support announcements a change event is sent without being followed by new information (see 3.6.8.3.5). In order to prevent the receiver waiting in vain for new information the receiver should interpret this change event as the withdrawal of announcement support information. The following example illustrates, how a receiver can decide whether an announcement should interrupt the current Service. The rules implemented in a receiver can differ from those used in this example.

1) IF ClusterId = '11111111' ("Alarm") THEN goto 5 ELSE goto 2.

2) Bitwise AND the ASw flags with a selection mask (based on the ASu flags and defined by the listener and/or the receiver manufacturer). OR the sixteen results. IF result=1 THEN goto 3 ELSE NO INTERRUPT.

3) IF the Cluster Id of the Announcement Switching information is included in the Announcement Support list of Cluster Ids of the Service THEN goto 5 ELSE goto 4.

4) IF the Cluster Ids of the Announcement Switching information equals "00000000" AND the source of the announcement is a Service component of the current Service THEN goto 5 ELSE NO INTERRUPT.

5) IF the Region flag of the Announcement Switching Information is set to 1 THEN goto 6 ELSE goto 7.

6) Check RegionId. IF region is relevant THEN goto 7 ELSE NO INTERRUPT.

7) IF ClusterId = '11111111'("Alarm") THEN INTERRUPT ELSE goto 8.

8) IF the receiver is not in 'New mode' THEN INTERRUPT ELSE goto 9.

9) IF this is the first Announcement (after switching ON the receiver) for this Announcement type THEN INTERRUPT ELSE goto 10.

10) IF the New flag is set THEN INTERRUPT ELSE NO INTERRUPT.

3.6.8.4.5 Fall-back in the event of failing service

If a multiplex re-configuration happens during an announcement, the continuity of the Service component which provides the announcement shall be assured. However, it can happen that the interrupted Service is removed from the Ensemble. In this case, the receiver is assumed to act reasonably at the end of the announcement, for example remain with the interrupting programme.

3.6.8.4.6 Hints and remarks

The announcement feature could prove to be an attractive one for the listener, building upon and extending a similar feature available on RDS. The success for DAB will depend on exploiting the range of announcement types and the region selection filter. This latter facility gives an edge over the RDS implementation because it allows announcements relevant to regions to be selected, for example to acquire traffic messages about one's destination.

Combined DAB/FM receivers are able to gather announcement support information about FM services via both the DAB FM Announcement support feature and the RDS EON feature. In the absence of DAB FM announcement support information, these receivers may attempt to find the equivalent information delivered via RDS so that any FM Announcement switching information (evaluating FIG (0/28) with the appropriate ClusterId) can be interpreted correctly and quickly. (Note: In the case of great and complex networks, the DAB FM Announcement support feature could require a considerable part of the FIC capacity. Therefore, to lower the burden on the FIC, operators can decide to provide no DAB FM Announcement support FIG (0/27).)

3.6.9 Service Component Trigger (SCT)

3.6.9.1 Introduction

3.6.9.1.1 Purpose of the feature

The Service Component Trigger (SCT) feature is for use primarily with Data services. The SCT feature is used to inform a receiver or a group of receivers about the beginning or the end of the transmission of a Service. This is intended to satisfy receivers which respond to time division multiplex services (TDMS) and which are designed for low power consumption.

3.6.9.1.2 User of the feature

This feature is intended for special receivers dedicated to data or multimedia services.

3.6.9.1.3 Provider of the feature

The Ensemble provider shall insert the SCT information as well as the associated Service at the appropriate place in the appropriate Logical frame.

3.6.9.1.4 Involvement of other parties

The Service provider, in order to co-ordinate the transmission of the Service component and the SCT information.

3.6.9.1.5 Description

The Service Component Trigger operates on a single component of a Service. The SCT information (see [1], 8.1.7) comprises the Service component description, a number of Flags (F1, F2, F3 and F5), the Logical Frame Number and other optional fields. The optional fields are Time, Conditional access parameters and the Service user group. When Service components are carried in the Main Service Channel (MSC) or the Fast Information Data Channel (FIDC), the Short form of the Service component description (SubChId or FIDCId) is used (L/S flag = "0"). When Service components are carried in Packet mode, the Long form of the Service component description (SubChId and Packet address) is required (L/S flag = "1"). In its simplest form the SCT information comprises only the Service component description, Flags F1, F2 F3 and the Logical Frame Number (F1 = "0"). F2 signals whether the LFN applies to the beginning or end of service transmission. F3 is used to signal whether the optional Service user group information (defining specific groups of receivers) is present or not. Additional information can be provided (F1 = "1") to signal F5, the Time (using the one-minute resolution) and the Conditional access parameters. The SCT feature is encoded in FIG (0/20).

3.6.9.2 Mandatory requirements

The use of the SCT is optional.

3.6.9.3 Operational aspects of broadcasting

These depend upon the kind of service and the kind of receiver addressed:

a) Broadcasting to receivers processing the FIC or the AIC in continuous manner

- In this case, the SCT can be transmitted in the FIC or in the AIC at any time in order to signal the transmission of a Service (beginning or end). The same SCT can be transmitted several times without any constraint on the transmission time.

b) Broadcasting to low power consuming receivers

- In this case, the ST shall be transmitted in such a way as to take into account the limited FIC processing potential (see 3.6.9.4).

3.6.9.3.1 Functional minimum requirements

When implemented, the Ensemble provider shall insert the ST information at the appropriate place in the appropriate Logical frame.

3.6.9.3.2 Preferred transport mechanisms and alternatives

The SCT shall be carried in the FIC or in the AIC. This choice depends on the target receivers: For receivers which only process the FIC, the SCT information shall be carried in the FIC.

3.6.9.4 Receivers implementation aspects

Figure 3.6.4 illustrates how different groups of low power consuming receivers (i, m and x) can respond over a given time period. The Windows indicate when the receiver is active and when the FIC is processed. Between windows the receivers can ignore the FIC. Time windows for different receiver groups can be staggered and of different duration. The shortest time window shall be one COFDM symbol period. This time period can change from one to several thousand of physical frames. The same SCT can be repeated in the same window or in different windows.

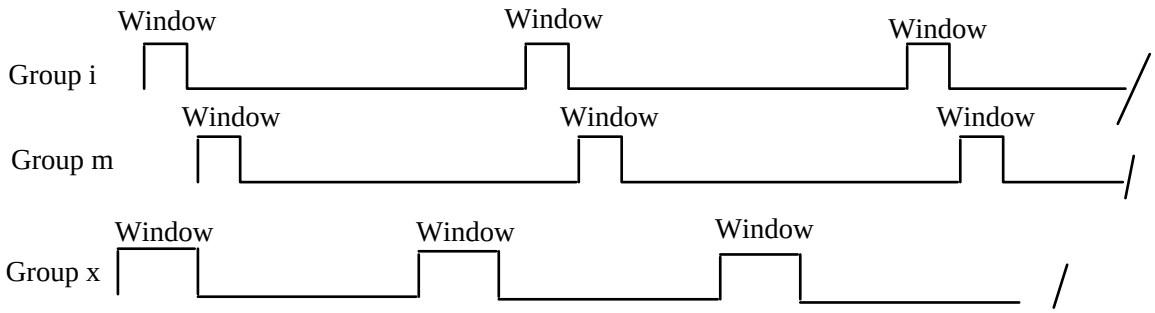


Figure 3.6.4: The time window mechanism

3.6.9.4.1 Functional minimum requirements

When implemented, the receiver shall process FIG (0/20). If the Service is carried in the MSC, the receiver shall also process FIG (0/1) and, if the Service component is carried in Packet mode, also FIG (0/3) accordingly. If in the SCT, the time value is set to "0", or is absent, and if the LFN parameter is set to "1FFF", the transmission of the indicated Service is considered to have just started or ended. The SCT feature can only apply to one Service at a time. When a receiver is a member of a Service user group, signalled in the SCT, and it satisfies the access conditions, it shall look for the Service carried in the MSC in Stream or Packet mode or in the FIDC, at the time indicated by the SCT. There can be a delay between the real time of the reception of the Service and the time indicated in the SCT. For the start of the service, the beginning of the reception of the service shall be later than the time indicated in the SCT. For the end of the service (when signalled) the actual end time shall be later than the real end time.

3.6.10 Frequency Information (FI)

3.6.10.1 Introduction

3.6.10.1.1 Purpose

The Frequency Information (FI) feature is used to provide the receiver with information about the frequencies on which DAB Ensembles, FM and AM Services are broadcast. This information can refer not only to Services carried within the Ensemble the receiver is currently tuned to, but to other Services as well. When used in combination with the Regional identification feature (see 3.6.15), a geographical area filter can be provided to allow the receiver to determine which of the frequencies listed are worth checking in the area where it is situated. The RegionId (see 3.6.15) specifies a region within the coverage area of the current ensemble (a "current ensemble" is characterized by its EId and could possibly be carried on different frequencies within a Multi-Frequency Network (MFN - a number of neighbouring SFNs carrying the same ensemble), whereby a "tuned ensemble" is characterized by its EId and the carrier frequency).

The feature meets several requirements:

- To allow mobile receivers, leaving the coverage area of a DAB transmitter or single frequency network, to re-tune to an alternative frequency (service following). The alternative frequency may apply to an identical DAB Ensemble (same EId, see 3.3.8 for conditions), an Other Ensemble carrying the equivalent primary service component or the equivalent primary audio service component on FM or AM. These service components can be identical (16-bit identifiers for the SId, RDS PI-code or "Dummy" code are identical) or hard-linked (see 3.6.14 for Service Linking). When signalling Other Ensembles which contain equivalent service component(s) the feature "OE services" (FIG 0/24) should also be provided and evaluated. For the hard link (cases Other Ensemble and/or FM/AM) the feature "Service linking" (FIG 0/6) is needed as well.

  Equivalent services are characterized by identical primary service components. Therefore, service following means in fact primary service component following.

- To support receivers finding a primary service component, which is soft-linked to the currently selected one. This could be an appropriate solution if there is no alternative source for the same component. From FIG 0/6 ("Service linking") and, in the case of another Ensemble, from FIG 0/24 ("OE services") the necessary information can be derived.

- To help receivers to access other DAB Ensembles which are available in certain regions. An ensemble scan can be speeded up if all other DAB Ensemble frequencies are signalled to the receiver. FI should be transmitted regardless of whether or not the other Ensemble is receivable in the coverage area of the current ensemble and the Control field should be used to distinguish between other Ensembles in geographically adjacent areas and those further away. In a similar way an easier access to FM/AM service could be supported (information about adjacency cannot be signalled for FM/AM services).

- In combination with the OE/FM Announcements feature (FIGs 0/25 to 0/28), to establish a link between Services (using the Service Identifier, SId) and frequencies needed for Announcement switching (see 3.6.8).

- In conjunction with the OE/FM "PTy Watch" function (FIG 0/17 and FIG 0/12), to allow fast access to services starting to broadcast a programme item of the desired type. Here FIG 0/24 (OE services) can be taken into account (see 3.6.5 and 3.6.7).

- On the basis of the OE/FM "Programme Number (PNum)" (FIG 0/16) switching to and, if desired, recording of a pre-programmed programme item can be enabled. Again FIG 0/24 (OE services) has to be generated/processed in parallel.

3.6.10.1.2 User of the feature

The receiver.

3.6.10.1.3 Provider of the feature

The FI should be kept up to date by Ensemble providers, based on information received from the service providers (i.e. the frequency database itself, information about FM-RDS regionalization, linking of services, local windows and PTYs).

3.6.10.1.4 Involvement of other parties

The regulatory control of Ensemble, FM and AM radio frequencies can involve other Ensemble providers, in co-operation with other Service providers, and national authorities responsible for regulating broadcasting frequencies.

3.6.10.1.5 Description

The Frequency Information feature is assigned to providing radio Frequency Information (FI). If this applies to the whole current ensemble, an individual service or a particular primary service component from the current ensemble, the OE flag shall be set to "0" in the FIG type 0 sub-header (see [1], 5.2.2.1) The Frequency Information feature is also used to provide frequencies of ensembles other than the current ensemble (R&M = "0000" or "0001"), and of FM and AM services which are not identical with a primary programme service component from the current ensemble (R&M = "1000", "1001", "1010" or "1100"). In these cases, the OE flag shall be set to "1" in the FIG type 0 sub-header (see [1], 5.2.2.1). The "Continuity" flag in the FI list header is not used for the latter two cases (AM/FM and OE = 1) and remains set to "0". The FI feature is encoded in FIG (0/21) (see [1], 8.1.8). The OE flag is used for this FIG, the P/D flag is not (reserved for future use (RFu)). Here, the C/N flag signals the Service Information Version (SIV) (see [1], 5.2.2.1). The corresponding "Key", used for CEI purposes (see 3.6.20), consists of the parameters "RegionId", "Id field", and "R&M".

Table 3.6.10A: FI signalling options

	Relation	Case	Id EId	field in PI	FIG 0/21 Dummy	OE Flag	Contin. Flag	Control Field	R&M
Related	DAB to DAB	Identical	EId1			0	x	x	0000
to SId's		EId's	EId1			0	x	x	0001
within	DAB to DAB	Identical	EId2			1	x	x	0000
the		SId's	EId2			1	x	x	0001
tuned	DAB to			PI=SId		0	x		1000
en-	FM+RDS								
semble	DAB to				Dummy	0	x		1001
EId1	FM/AM				= SId	0	x		1010
						0	x		1100
Unre-	DAB to DAB	Other	EId3			1	x	x	0000
lated		Ensemble	EId3			1	x	x	0001
to	DAB to			PI≠SId		1			1000
SId's	FM+RDS								
within	DAB to				Dummy	1			1001
the tuned	FM/AM				≠ SId	1			1010
ensemble						1			1100

EId1: Same Ensemble Identifier as the tuned ensemble (and herewith part of the current ensemble)

EId2: Another Ensemble, consisting of one or more services, that are also present in the current ensemble (same SIds, identical primary service components)

EId3: Another Ensemble, consisting of services, none of which are carried in the current ensemble, but which could be linked to services out of the current ensemble

x: Marked parameter applies to that constellation

3.6.10.1.5.1 Example

The FI feature can be described by the use of the following example, illustrated in figure 3.6.10 (all identifiers in hexadecimal notation except for the decimal RegionIds) and the table 3.6.10A, explaining the setting of different parameters in the FIG 0/21 data field and the interrelation with the FIG 0/24 (OE services) in general. This example mainly refers to the case "(automatic) service following" (see above).

A Single Frequency Network (SFN 1) is located in the centre of the figure and operates on 1 463,232 MHz. It is divided into six Regions (Reg65 to Reg70) and supports Ensemble 1 042, carrying six Services (SIds 1 311 - 1 316). SFN 2, on 1 452,960 MHz, supports the identical Ensemble 1 042 (conditions for same EId: see 3.3.8). SFN 1 and SFN 2 overlap each other and form a Multi-Frequency Network (MFN).

Here, they are synchronized in time and frequency in a way that the criteria for setting the Continuity Flag are fulfilled (see 3.6.10.3.5). SFN 3, on 223,936 MHz, is an Other Ensemble (1 034), which includes Service 1 311, in addition to others. Because the coverage areas of SFN 1 and SFN 3 are not even adjacent to each other, an uninterrupted switching from one to the other is not feasible (Continuity Flag = 0).

In the area between SFN 1 and 3, Service 1 311 cannot be received by DAB, but can be received from FM-RDS transmitters or an AM transmitter (receivable all over the SFN1 area) on different frequencies (conditions for SId = PI and SId = "Dummy" code: see 3.3.1).

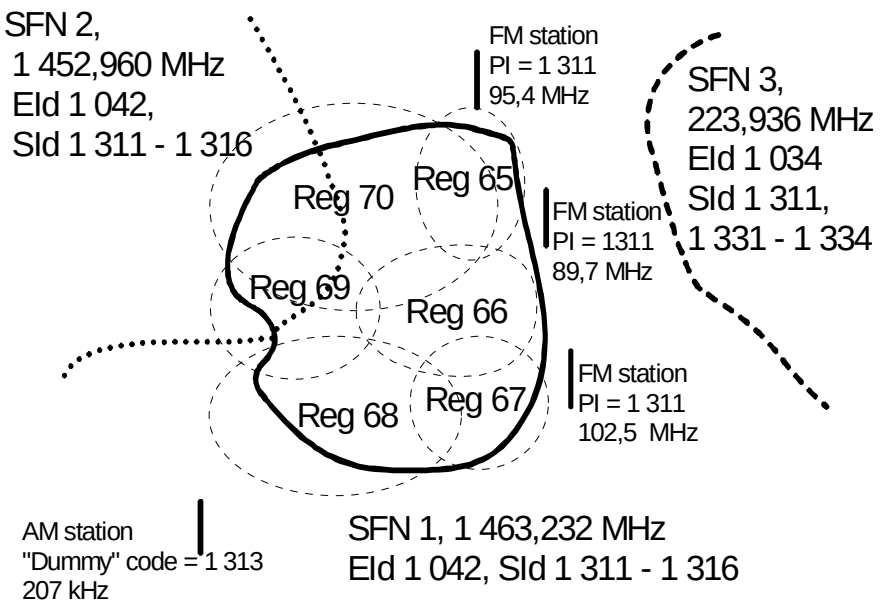


Figure 3.6.10: FI example situation

In this example the FM and AM transmissions are not delayed in a way that the Continuity Flag could be set. Now, the following Frequency Information can be provided to signal the alternative frequency options within the FIC of the Ensemble 1 042 on SFN1:

Table 3.6.10B: Example of provided FI

OE	RegionId	Identifier	Characteristics	Frequency
0	69	EId = 1 042	DAB, adjacent, Mode II, continuity flag = 1	1 452,960 MHz
0	70	EID = 1 042	DAB,adjacent, Mode II, continuity flag = 1	1 452,960 MHz
0	65	PI = 1 311	FM-RDS, continuity flag = 1	95,4 MHz 89,7 MHz
0	66	PI = 1 311	FM-RDS, continuity flag = 1	89,7 MHz 102,5 MHz
0	67	PI = 1 311	FM-RDS, continuity flag = 1	89,7 MHz 102,5 MHz
1	65	EId = 1 034	DAB, not adjacent, Mode I, continuity flag = 0	223,936 MHz
1	66	EId = 1 034	DAB, not adjacent, Mode I, continuity flag = 0	223,936 MHz
1	67	EId = 1 034	DAB, not adjacent, Mode I, continuity flag = 0	223,936 MHz
0	0	Dummy = 1 313	AM, continuity flag = 0	207 kHz

NOTE: "Reg 0" (RegionId, binary = "0000 0000 000") is used to signal "no region specified". This means that the corresponding Frequency Information is valid for the whole coverage area of the ensemble.

If RegionIds are given for FM/AM services, their coverage area should overlap with the corresponding region (part of the current ensemble's coverage area) or should be near to it.

3.6.10.2 Mandatory requirements

The implementation of the FI feature is optional (see 3.6.10.3.3 for consequences).

3.6.10.3 Operational aspects of broadcasting

3.6.10.3.1 Functional minimum requirements

The FI feature should at least provide the information about the frequencies needed for automatic service following, accompanied by the necessary additional information carried in FIGs 0/24 (OE services) and 0/6 (Service linking). For this purpose the signalling of specific regions is useful.

3.6.10.3.2 Optional extensions

The feature can be extended to provide a comprehensive guide to all audio broadcasting networks on DAB, FM and AM which can be received in or near the coverage area of the current Ensemble.

3.6.10.3.3 Interrelations with other features

The FI feature relies on none of the other optional SI features as long as frequencies for the same ensemble (same EId) are listed (a typical example would be an L-band Multi-Frequency Network (MFN)). Often, the "OE services" feature must be co-processed in order to find the corresponding EId for the ensemble that carries the desired service. In addition, the links between services are given with the "Service linking" (FIG 0/6). In general, the Frequency Information is much more effective if the Regional Identification feature (FIGs 0/11 and 0/22) is implemented. This is especially true for MFNs (Multi-Frequency Networks) and SFNs covering larger areas.

FI interrelates intimately with the following FIGs:

- FIG 0/24, OE Services: Here the presence of a certain service in different ensembles is signalled (see 3.6.12).
- FIG 0/6, Service linking information: Hard (alternative service) and soft links (service substitutes) are described there (see 3.6.14).
- FIG 0/23, Local service area: If the R&M value 0001 appears in the FI, this is a warning for the receiver: In the coverage area of the corresponding ensemble local windows are opened. The exact regions of those windows and the services, covering the windows, can be derived from the FIG 0/23 (see 3.6.16).
- FIG 0/17 and 0/12, Programme Type and Programme Type preview: If this information is given for other Ensembles, the corresponding frequencies of these ensembles should be signalled with the FI (see 3.6.5 and 3.6.7).

Other interrelations exist with the following functions:

- OE/FM Announcement support and switching (FIGs 0/25 to 0/28); (see 3.6.8)
- OE/FM Programme Number (FIG 0/16); (see 3.6.4)
- OE/FM/AM Ensemble, Service labels (FIG 1/0, 1/1, 1/5); (see 3.6.13)
- Satellite database (FIGs 0/30); (see 3.6.17)

See also 3.6.10.1.1.

3.6.10.3.4 Preferred transport mechanism and alternatives

The FI required to meet the minimum requirements (see 3.6.10.3.1) should be carried in the FIC. Any extension of FI, beyond this, (see 3.6.10.3.2) may be carried in the FIC if there is sufficient capacity but can also be carried in the Auxiliary Information Channel (SubCh 63, packet address 1 023, see 3.6.19).

3.6.10.3.5 Recommendation for contents and real-time aspects

As soon as the frequency database for particular sublists (FM-RDS frequencies for example, "KEY" RegionId + Id field + R&M) changes, this "Change Event" (see also 3.6.20) should be accompanied by an increased repetition rate of the FIG 0/21 (at least two transmission cycles of that new information at rate D) transporting the new part, making the new data quickly available for the receivers.

Transmitting a complete frequency database requires usually several FIGs of the type 0/21. The receiver is informed about the start and continuation of such a database transmission via the C/N flag, here used as SIV (for details see 3.6.20). Stable Frequency Information should be transmitted with repetition rate E.

Frequency Information can also be given for ensembles and FM-RDS services, currently not on air (i.e. due to service regionalization on FM-RDS). In contrast to that FI for FM/AM services should be withdrawn as soon as the service is no longer available on FM/AM.

In the case of linked services, either FI or the Service Linking Information shall be correct at any time. In general, dynamic changes should be reflected either in FIG 0/21 (Frequency Information), FIG 0/6 (Service Linking Information) or in FIG 0/24 (OE Services).

The providers of FI should be aware that for each "Freq. list" (see 8.1.8 in reference [1]) there is a maximum of two DAB frequencies, seven FM/AM (9 kHz steps) frequencies or three AM (5 kHz steps) frequencies that can be signalled. In order to support receivers in the most efficient way, the providers of FI should subdivide frequency databases by means of RegionIds ≠ "0". For each signalled region only frequencies with a sufficient probability of undisturbed reception should be listed.

3.6.10.3.6 Continuity requirements

Fulfilling the continuity requirements is an important criterion to enable service following to be implemented by a receiver with a quality that is comparable to that achieved by RDS receivers. When set to "1" the Continuity flag tells the receiver that in the case of switching to a DAB ensemble, an uninterrupted reproduction of the selected primary service component(s) is feasible. In the case of switching from DAB to FM or AM, the disturbance of the audio would be of minor significance. Continuity information can be provided for equivalent and hard-linked services. The conditions listed below shall be fulfilled for setting the flag to "1":

1) DAB frequency list (only valid for ensembles covering adjacent areas, see 3.6.10.3.7).

   a) "No transmission mode signalled" is permitted.

   b) The referenced ensembles shall be synchronized in time with the tuned en-semble. This means that NULL symbols of certain corresponding transmission frames of the affected ensembles have to occur at the same time (with the tolerance of $\pm$the Guard Interval duration).

   c) The referenced ensembles shall by synchronized in frequency. So, the following relation applies to the carrier frequencies of the referenced and the tuned ensemble:
      $|f_r - f_c| \leq k \times kHz \pm 10$ Hz
      (f_r= centre frequency of the referenced ensemble, f_c=centre frequency of the tuned ensemble, k= positive integer value ≠ 0)

   d) For all services (except for local ones) present in both the current and the referenced ensembles, the following requirements apply:

      d1) The CU start address, the sub-channel size and error protection profile have to be identical for the primary service component.

      d2) For the primary service component the CA conditions need to be unique and the CIF counter values have to be equal.

      d3) A primary packet mode data service component has to occupy identical packet addresses.

   e) The continuity requirements apply to all frequencies in the "Freq. list".

2) FM (-RDS)/AM freq.list: (only for OE = 0).

The delay between the audio signal of the affected primary DAB programme service component and the audio signals of all listed FM (RDS)/AM services shall not exceed 100 ms.

3.6.10.3.7 Adjacency requirements

"Geographically adjacent area" (bit b_{19} (lsb) = "0" (within the "Control field")) means: The signalled DAB ensemble (centre frequency is given) is receivable somewhere in the signalled region (identified by its corresponding RegionId). "Not geographically adjacent area" (bit b_{19} (lsb) = "1" (within the "ControlField")) means: It is not guaranteed, that the signalled DAB ensemble (centre frequency is given) is receivable some-where in the signalled region (identified by its corresponding RegionId). The coverage areas of ensembles signalled as being adjacent shall overlap significantly with the coverage area of the ensemble that is identified by its EId in the "Id field" contained in the "Header" of the "FI list" (see [1], 8.1.8). If the corresponding ensemble is transmitted on an MFN with the same EId, the adjacency requirement affects all participating SFNs.

3.6.10.4 Receiver implementation aspects

The implementation of this feature depends on the receiver control strategy and is manufacturer dependent. Suitable strategies should be developed especially for automatic and seamless service following. In addition, receivers shall be prepared to find the carrier frequency of the tuned ensemble in the Frequency Information (this case can occur for example when an MFN is fed from one single Ensemble Multiplexer).

3.6.11 Application of Transmitter Identification Information (TII)

3.6.11.1 Introduction

This clause provides an introduction to TII applications in general: details of another application are given elsewhere (see 3.6.21). Some guidance is given to broadcasters about the allocation of TII codes.

3.6.11.2 Purpose of applications

TII-based features offer an opportunity to introduce geographical region filtering of information which is an advantage for Single Frequency Networks (SFNs) and Multi-frequency Networks (MFNs).

3.6.11.3 End user of the applications

The receiver.

3.6.11.4 Provider of the applications

The Ensemble provider and Service providers.

3.6.11.5 Involvement of other parties

The Transmission network provider.

3.6.11.6 Description

In dealing with TII, it is important to understand the difference between the area served by a Single Frequency Network (SFN) and an Ensemble, identified by an EId.

- Single Frequency Network (SFN) coverage area: is the area over which an ensemble is broadcast using one radio frequency channel allocation.

- Ensemble coverage area: is the area over which the ensemble is receivable. If the ensemble is broadcast on one SFN, the ensemble coverage area is the same as the SFN coverage area. If the ensemble is broadcast on several SFNs, (MFN) the ensemble coverage area is the union of the SFN (MFN) coverage areas.

Transmitter Identification Information (TII) can in principle provide an unambiguous identification of each transmitter in an SFN, it is considered mandatory that the uniqueness is extended to cover the Ensemble coverage area. This information is transported within the Null symbol (see TR 101 496-3 [17]) and can be used by a receiver to locate its position. This can be achieved by detecting which transmitters are currently receivable and by recognizing their TII codes.

The TII code identifies a particular transmitter and consists of two numbers, representing the pattern number (7 bits) and the comb number (5 bits) associated with the coding of the TII in the null symbol. The two numbers are signalled as the "Main Identifier (MainId)" and the "Sub-Identifier (SubId)" and can be referred to conveniently by the hexadecimal short-form. For example, the Crystal Palace transmitter in the UK has MainId = "0001011" and SubId = "00001", which can be reduced to "0B, 01". It should be noted that the SubId='0' is not associated with any region it is reserved for use with satellite transmission (see [1], 8.1.9).

Within an ensemble coverage area, up to 1 610 codes (70 MainId patterns for each of 23 SubId combs) are available in transmission modes I, II, and IV, and up to 138 codes (6 MainId patterns for each of 23 SubId combs) in mode III. However, the TII can also be used to define a geographical region in terms of a list of TII codes, representing all the transmitter identifiers belonging to the region. By searching for these identifiers in a TII list the receiver is able to decide automatically, whether or not it is located inside the respective region. Whenever a TII list is inappropriate, for example in a satellite transmission, the length of the TII list is set to zero.

The Regional Identification feature (see 3.6.15) uses a list of TII codes to define a region. This can be used in combination with other SI features to provide different functions:

- the Local service area feature signals the extent of a local service area (see 3.6.16). This information can be used to determine the appropriate local Service (out of several transmitted within the SFN) for the present receiver location;
- the Frequency Information (FI) feature (see 3.6.10) provides a list of frequencies for Ensembles/Services available in particular regions. This information can be used for restricting the list of alternative frequencies corresponding to other Ensembles which carry identical Services;
- the Announcements feature may use a Regional Identifier to define the target area for the announcement (see 3.6.8). By determining the driving direction of a vehicle, the receiver can automatically offer the listener a relevant subset of traffic messages, for example, for his journey;
- the Traffic Message Channel (TMC) can also be targeted at a particular region and relevant messages, for example car-park information, filtered automatically (see also 3.7.2).

The use of the Regional identification information is not restricted to receivers which are able to locate their position. The listener can be offered the choice of geographical area for which he would like to accept announcements or TMC messages. Additional TII location **database** information can be signalled in the SI to provide a cross-reference between the TII codes and the geographical location.

3.6.11.7 Mandatory Requirements

3.6.11.7.1 For broadcasting

Although not mandatory, it is highly recommended that TII is transmitted in the null symbol as a regular part of a DAB signal, especially where regional filtering depends on it, for example, when using the Frequency Information feature for service following.

3.6.11.7.2 For receiving

The implementation of TII-based features is optional.

3.6.11.8 Operational aspects of broadcasting

3.6.11.8.1 Functional minimum requirements

All the information about the various transmitters should be transmitted within 2 minutes (rate E).

3.6.11.8.2 Optional extensions

The TII database information can be transmitted to provide absolute geographical location and relative delay offset information (see 3.6.21). However, the TII database information can also help the receiver to improve the efficiency of detecting TII codes (see 3.6.11.9)

3.6.11.8.3 Inter-relations with other features

The Regional identification feature depends on TII (see 3.6.15). Several other features incorporate Regional codes for targeting particular geographical areas: these include the Local service area feature (see 3.6.16), the Frequency Information (FI) feature (see 3.6.10), and the Announcements feature (see 3.6.8).

3.6.11.8.4 Recommendations on contents and real-time aspects

The MainId (pattern code) should be assigned first to broad geographical areas. Different SubIds (comb values) should then be used to distinguish up to 23 transmitters within each broad area, using conventional frequency planning techniques to avoid mutual interference. With transmission mode I and transmitter spacing of around 60 km, a broad area can extend to a radius in excess of 200 km. Although theoretically the maximum numbers of codes described above can be assigned over each SFN, MFN, it is considered mandatory that the TII codes are not re-used within the Ensemble coverage area. Co-located transmitters can be assigned different TII codes, for example they can be supported by different Ensemble providers. For such a case, the TII database information would allow their common latitude and longitude to be signalled.

3.6.11.8.5 Hints and remarks

As an example, the TII code assigned to the Crystal Palace transmitter, which serves much of London, is Pattern number 0B (hex) and Comb number 01 (hex) and this code is signalled on the mode I national BBC transmission (Note: the pattern and comb number correspond to the MainId and SubId parameters introduced in the TII database coding, see [1], 1. 8.1.9).

From the pattern table (see table 53 in 14.8.1 in [1]), Pattern number 0B corresponds to 11 (decimal) and the pattern mask [ab(p)] is "00110110". This defines which four out of the eight groups of 24 carrier-pairs have active carrier-pairs. In this case, only the third, fourth, sixth, and seventh positions are used. No carriers are generated for the first, second, fifth, and eighth positions.

The Comb number 01 means that the third and fourth carriers are generated in each group of 24 carrier-pairs that is prescribed by the pattern number. The active carrier pattern is repeated for all the four sets of 384 carrier positions in alternate null symbols. There are no active carriers on intervening alternate null symbols. The eight active carriers contained within the null symbols over a two-frame period are illustrated in figure 1. This pattern repeats for ensuing frames. (see [1], 14.8.1 about TII pattern and transmission mode.)

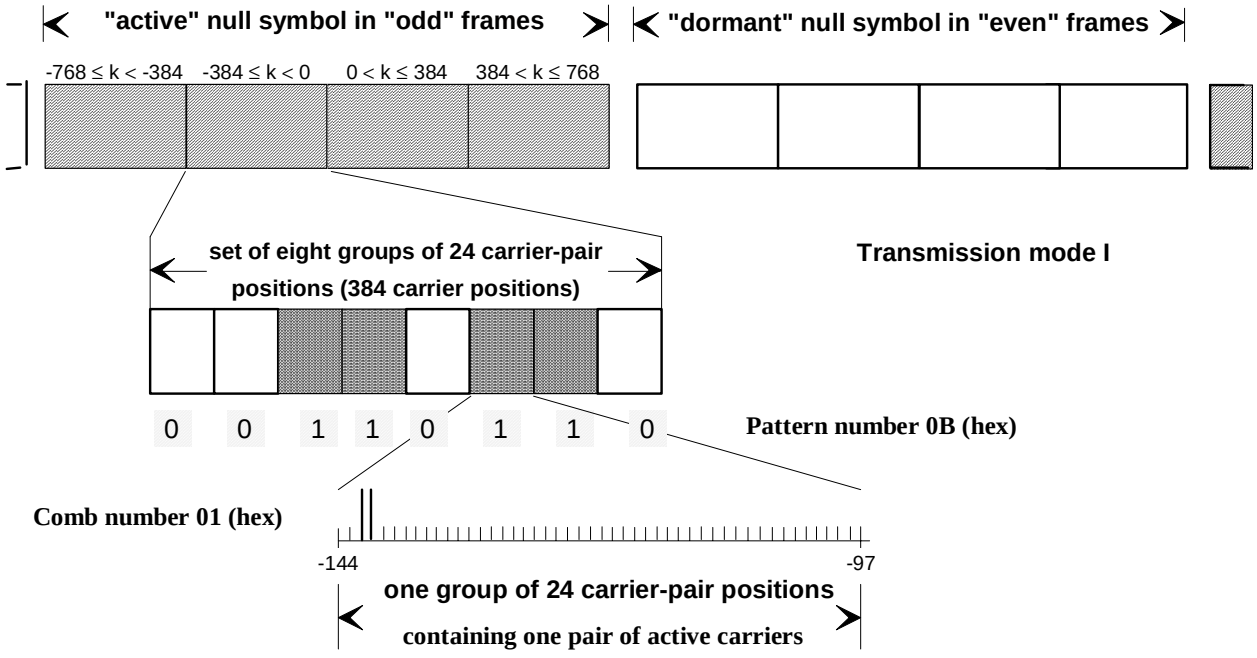


Figure 3.6.11: TII carrier generation for the Crystal Palace transmitter

3.6.11.9 Receiver implementation aspects

3.6.11.9.1 Functional minimum requirements

The TII codes of all transmissions received should be decoded in order to determine the transmitter identities. This information can be used in combination with the Regional identification information (see 3.6.15) to determine the current receiver location in terms of the defined region.

3.6.11.9.2 Optional extensions and alternatives

Further information about the transmitters' precise position and the relative delay of the signal broadcast from each transmitter can additionally be decoded in order to establish the receiver's precise location. It is not yet known how precise the location can be specified by this means (see 3.6.21).

3.6.11.9.3 Inter-relations with other features

See the remarks for broadcasters above.

3.6.11.9.4 Recommendations on implementation and presentation

The TII should be transparent to the user. The user interface for TII is provided through the region-related features.

3.6.11.9.5 Hints and remarks

The receiver derives the MainId and SubId from the TII signal by checking which carriers are switched on in particular positions. This process can be aided by decoding the TII database information (see 3.6.21), which signals precisely which transmitter codes are available in the Ensemble coverage area. This knowledge reduces the number of transmitter code options that the receiver must decide upon. In addition, the database information offers the opportunity to use the time difference, derived from correlating the carrier pairs, for calculating the receiver location more precisely.

3.6.12 Other Ensembles

3.6.12.1 Introduction

Several features are capable of providing information about other DAB Ensembles and the Services carried in them. A list of these is given here, together with references to other parts of these guidelines:

- Service linking (see 3.6.14);
- Ensemble, Service and Service component labels (see 3.6.13);
- Frequency information (see 3.6.10);
- Programme Number (see 3.6.4);
- Programme Type (see 3.6.5);
- Programme Type preview (see 3.6.7);
- Announcements (see 3.6.8);
- Local service area (see 3.6.16);
- Satellite database information (see 3.6.17).
- Although such information is normally carried in the FIC (see 3.2.1), other ensemble information can overflow into the AIC (see 3.6.19). A link between the Service Identifier and the Ensemble identifiers associated with other Ensembles, carrying that Service, is provided by the Other Ensembles' Services feature. Announcement support is dealt with in detail in 3.6.8. All other information about Services in other Ensembles is coded in the FIGs used for the current Ensemble, but with the "OE" flag set to "1" (see [1], 5.2.2). Only the feature signalling Other Ensembles' services is described here.

3.6.12.1.1 Purpose

The Other Ensembles' Services feature provides a link between a Service and those other Ensembles carrying that Service.

3.6.12.1.2 User of the feature

The receiver.

3.6.12.1.3 Provider of the feature

The Ensemble provider.

3.6.12.1.4 Involvement of other parties

Other ensemble providers.

3.6.12.1.5 Description

The Other Ensembles' Services feature provides a link between a Service (identified by its Service Identifier, SId) and other Ensembles (identified by a list of Ensemble Identifiers, EIds) carrying that Service. Services carried in the current Ensemble are distinguished from other Services carried in other Ensembles. In the former case, the OE flag is set to "0" and for other Services it is set to "1". The OE services feature is encoded in FIG (0/24) (see [1], 8.1.10.2).

3.6.12.2 Mandatory requirements

The implementation of the Other Ensembles' Services feature is optional but becomes essential if the frequency information associated with a particular service needs to be signalled.

3.6.12.3 Operational aspects

3.6.12.3.1 Functional minimum requirements

The information does not have to be comprehensive. The information provided should be kept up to date as far as possible. After a multiplex reconfiguration in another Ensemble, however, there can be obsolete information sent for some time. Ensemble providers should ensure that this period is minimized. The information should be transmitted at repetition rate D.

3.6.12.3.2 Optional extensions

In principle, the amount of information provided about other Ensembles is extensive.

3.6.12.3.3 Interrelations with other features

All other information about other Ensembles and their Services (see Introduction) rely on this feature.

3.6.12.3.4 Preferred transport mechanism and alternatives

The Other Ensembles' services information may be carried in the FIC in FIG (0/24). Alternatively, it may be carried in the AIC (see [1], 8.1.12).

3.6.12.3.5 Recommendation for contents and real-time aspects

There are no real time requirements for this feature, however, the information given should follow the corresponding changes in the other Ensemble with as little delay as possible.

3.6.12.4 Receiver implementation aspects

The decoding of this feature is essential for interpreting information about services in other ensembles.

3.6.13 Ensemble, Service & Service component labels

3.6.13.1 Introduction

Labels associated with Ensembles, Services and Service components are described in this clause.

3.6.13.2 Purpose of the features

The purpose of the Labels features is to provide the listener with a clear textual description for the Ensemble, Service or Service component, which is either available for selection, in both the received and other ensembles, or has already been selected. The display of a comprehensive list of available services on the receiver could be regarded as a step towards "ease of use" of the receiver.

3.6.13.3 End user of the feature

The listener or user of the receiver.

3.6.13.4 Provider of the feature

The Ensemble label is supplied by the Ensemble provider. The Service and any Service component labels are supplied by the Service provider.

3.6.13.5 Other parties involved

Broadcasters may wish to liaise over the assignment of the labels to prevent duplication.

3.6.13.6 Description

Labels for Programme services (16-bit SIds) are encoded separately from Data services (32-bit SIds). The Ensemble, Programme service, Data Service and Service component labels are encoded in FIG 1/0, FIG 1/1, FIG 1/5 and FIG 1/4 respectively (see [1], 8.1.13 and 8.1.14). The Label field contains the appropriate identifier of the Ensemble, Service or Service component, the Character field formed by a string of 16 bytes (forming characters) and a Character flag-field. The characters are intended to be presented in the character sets identified by the character set information carried in the first byte of the FIG data field (see figure 5 in [1]). The Character flag-field is useful for receivers which have a display of less than sixteen characters. It contains a flag for each character in the label. Each bit is set to "1" when the corresponding character is included in the abbreviated label (maximum of eight characters). The OE flag, signalled in the FIG 1 header (see 3.2.1), is used to distinguish between labels associated with services carried in the current ensemble and labels associated with other ensembles or services carried elsewhere.

3.6.13.6.1 UTF-8 character set

One of the possible entries of the character set field is UTF-8. UTF-8 is a transformation format to encode characters of the ISO/IEC 10646-1 [30] characterset (31-bit character set). The number of bytes needed to encode one character varies from one byte to five bytes. US-ASCII characters need one byte per character, most European characters (non US-ASCII) need two bytes. Other characters (Chinese) need three bytes. Characters that need more than three bytes are not yet defined. The encoding is defined in ISO/IEC 10646-1:1993 in annex R. UTF-8 uses a variable number of bytes per character. Thus the number of characters inside a character field with fixed length varies. E.g. a 16 bytes service label might contain up to 16 US-ASCII characters but only 5 Chinese characters plus one US-ASCII character. If a character field contains less than 16 characters the unused bits in the character flag field (having no corresponding character) shall be set to zero. In the above example the last 10 bits (bit 9...bit 0) shall be set to zero if 5 Chinese characters plus one US-ASCII character are used.

3.6.13.7 Mandatory requirements

Although the transmission of labels information is optional, it is strongly recommended that at least the Service labels are broadcast and implemented in the receiver.

3.6.13.8 Operational aspects of broadcasting

3.6.13.8.1 Functional minimum requirements

To allow service recognition by the listener, it is strongly recommended that at least the Service label is provided. There should always be a one-to-one correspondence between a label and its respective machine-readable code. When a label is provided, up to eight characters from the label shall be identified to form an abbreviation to suit a short display.

3.6.13.8.2 Optional extensions

The use of the Ensemble label and Service component labels is optional. Service component labels are useful to distinguish between service components of the same type. Also, the Service labels of Services in other Ensembles and of Services on FM channels can be provided. AM services can also be included by using the dummy identifier mechanism in the SId coding field (see 3.3.1). This is useful mainly for other Services found in or close to the reception area of the current Ensemble. The OE flag is set to "1" in these cases.

3.6.13.8.3 Preferred transport mechanisms and alternatives

To allow fast access to the labels of the Services in the current Ensemble, these should be carried in the FIC and repeated at repetition level B. Labels associated with other ensembles or other services broadcast on FM, AM etc. are recommended to be repeated at repetition rate C: if capacity allows, these labels may be carried in FIC, otherwise they should be transferred to the AIC.

3.6.13.8.4 Recommendations on contents and real-time aspects

When, after a multiplex reconfiguration, a Service is added to the Ensemble, then this Service's label can be transmitted beforehand during the period when the forthcoming multiplex configuration is signalled. When a Service component is shared by more than one Service, it will be assigned a common internal service component identifier, depending on how the component is transported in the ensemble (see 3.3.3). However, there will be more than one global service identifier because there is more than one SId referring to this service. For example, the component can be TMC which is assigned to SId = "C312", SCIdS = "2" and also SId = "C445", SCIdS = "3". The Service component label feature is encoded in terms of the global identifier and therefore it is recommended that the same label is used for all services which use the component. When encoding the Service component label for this TMC example, the label information should be duplicated using both global identifiers. However, the repetition rates of each version can be reduced so that the total repetition rate of the combined versions matches the recommendation. All labels should preferably be sent using character set "0000" (complete EBU Latin based repertoire) to allow (simple) DAB receivers to display these labels. Service providers should not send labels alternately using different character sets.

3.6.13.8.5 Hints and remarks

The content of Service component labels should not repeat information contained in the Service label because these can be displayed simultaneously by the receiver.

3.6.13.9 Receiver implementation aspects

3.6.13.9.1 Functional minimum requirements

All labels can be presented in a display field of 16 characters as well as in a display field of 8 characters; the flag-field signals how to abbreviate the basic 16-byte label to a maximum of eight characters.

3.6.13.9.2 Recommendations on implementation and presentation

A receiver can be designed so that it shows only the label of the current Service or it can show additionally the labels of other Services which can be received; in a menu list or in display fields that are associated to pre-selection keys. If a receiver can show only one label at a time, then it is recommended that the label, belonging to the Service which has been selected, is shown. This label can be replaced in the display by, for example the Ensemble label or Dynamic label, under user control. When Service component labels are available, the receiver should indicate to the listener that further components are available (for example, by a displayed symbol). Access to service components can only be allowed after the service has been selected. The Service component labels allow the listener to identify what is available and to make an informed choice. The use of the Ensemble label is not necessary for service access and can simply provide a useful confirmation of the ensemble supplying the selected service.

3.6.13.9.3 Fall-back in the event of failing service

It can be useful to store a table of Service labels (linked to Service identifiers and - optionally - the reception area) and of Ensemble labels (linked to Ensemble identifiers and - again optionally - the reception area) in non-volatile memory in the receiver, in order to give quicker response to user-interaction. If the transmission of the labels fails so that the table of labels can no longer be updated, then the receiver should treat the information stored in non-volatile memory cautiously. One option is for the display to present - for lack of more significant information - a text like "PRESET 1".

3.6.13.10 Vital interaction between Service provider and receiver

The Ensemble and Service labels feature is intended to convey rather static information: the name of the Ensemble is expected to change very rarely, if ever, and the name of the Service will probably change only when the programme is continued by a different Service provider, which can happen a few times per day. Service component labels can change even more frequently. Nevertheless it is recommended that the receiver follows any changes to these labels immediately to avoid obsolete information remaining in the display. Information stored on a non-volatile memory shall be updated as soon as a changed label is received. One should bear in mind that the usefulness of a non-volatile memory diminishes if labels change rather often. To convey textual information which changes rather often, the Service provider is advised to use the Dynamic Label feature or the ITTS feature, see 3.5.6 and 3.5.7. These features are designed to convey programme-related text which can change in real-time with programme contents.

3.6.14 Service linking information

3.6.14.1 Introduction

3.6.14.1.1 Purpose of the feature

The Service linking feature provides cross-referencing information for Services, having different identifiers **and** belonging to different Ensembles or to AM/FM transmissions, during periods when those Services are related. The relation can take the form of a "hard link" when the primary service components carry identical content (see 3.1.1.8) or a "soft link" when the primary service components have some generic relation, for example they are all local services. Thus, a listener can follow and retain the same programme or the same or similar data, even when he moves outside the reception area of the Service he originally selected. In the remainder of this text programme services are used for illustration although the same arguments also apply for data services. The use of a hard link effectively enlarges the programme coverage area. Outside the coverage area of the selected programme, the soft link supports information to simplify following to programmes which are related in the view of the service provider.

The service linking feature shall be used to support service following when services are simulcast on AM and/or FM and the SId differs from the PI code (or Dummy identifier). Service linking can be used to help the mobile receiver to find alternatives if the originally-tuned service is no longer available, although the best alternative cannot always be recognized. The best alternative would be, for example, the service which carries the programme for the longest time or within the largest coverage area. In the case when common service identifiers are used (SId is identical to the PI or dummy code), there is no need for service linking information and the signalling of frequency Information suffices. In the case of simulcasting programmes in different ensembles or on DAB and RDS, common identifiers (same SId or PI code or dummy code - see 3.3.1.8) instead of service linking should be preferred, because in this case Frequency information gives all information needed.

3.6.14.1.2 End user of the feature.

The receiver.

3.6.14.1.3 Provider of the feature

The Service provider.

3.6.14.1.4 Other parties involved

The Ensemble provider.

3.6.14.1.5 Description

The Service linking information is encoded in FIG (0/6) (see [1], 8.1.15). Depending on the Id list flag there are two versions of the coding, a short form which contains the Linkage Set Number (LSN) together with a flag field (ILS, S/H…) and a long form where a list of the Service Identifiers, PI codes or dummy codes, referring to the linked Services, is appended. An International link also includes the Extended Country Codes (ECCs) in the Id list.

The Linkage Set Number (LSN) forms part of an identifier to a set of programme or data services which are related in some way. In the case of hard linking this relation consists of common primary service components. A soft link includes a set of primary service components which are related in the view of the service provider. The combination of the LSN, ILS and S/H-parameters identify a particular set of services and constitutes the "key" for the service linking feature (see 3.6.20). It creates four independent sets of 2 047 possible links. The key shall be unique for the area where it can be received and also for any adjacent area. There is no relation between a hard linked set and a soft linked set, if they share the same LSN. Also there is no relation between sets with a common LSN, but with different settings of the ILS. When a link disappears the LSN can be reused again for another set of services. It is not allowed to allocate the same LSN for a group of programme services and a group of data services at the same time.

Table 3.6.14. defines the functions of the Id, LA and SIV flag combinations:

Table 3.6.14: Id, LA and SIV flag combinations

Id	LA	SIV	Action
0	0	0	(De-link CEI)
0	0	1	Rfu of de-activated link (CEI)
0	1	0	Change event (CEI), no de-link
0	1	1	Rfu of activated link (CEI)
1	0	0	Rfu for de-activated link
1	0	1	Rfu for de-activated link
1	1	0	Link is active, start of list
1	1	1	Link is active, continuation of list

Any change of information in a linkage set, identified by a particular key, shall be signalled in advance by sending a burst of change event FIGs (see 3.6.20) with the flag combination '010'. The end of a link is signalled by sending a burst of change event FIGs with the flag combination '000'. If the parameter 'Number of Ids' equals zero, it shall not be interpreted as a CEI.

The Linkage Actuator (LA) indicates whether a link is active or deactivated. If this bit is set to 1 the programme or data services indicated in the Id list are linked together through the Linkage Set Number. With the Linkage Actuator, the Id list flag and the SIV flag set to zero (flag combination '000'), a rapid de-linkage at the end of a common or related programme is signalled.

The long form of FIG 0/6 is present with any flag combinations '1xx' (x states 'don't care'). In this case, an identifier field is appended. If one of the services of a linkage set belongs to the current ensemble the OE-flag shall be set to "0". The identifier belonging to this service is called the "reference identifier" and shall be included at the beginning of the list of services (SIV-Flag set to zero) regardless of the value assigned to the IdLQ field: If the first sub-list is associated with an FM part (IdLQ is set to 01), the first entry in the list would be a DAB service identifier (the reference identifier) and the rest of the list would contain PI-Codes.

The Shorthand indicator (Shd) can be used to indicate that the 16-bit identifiers in the list, having bits b_{11} to b_8 in the range "4' to "F" (expressed as a hexadecimal value), represent each a list of up to twelve programmes each sharing the same Country Id and the same eight least significant bits of the Service reference. This device can be used for any kind of service in the following list: it has nothing to do with the signalling of generic families by a PI-code

The SIV-flag is used as a list start/list continue-flag, to handle FIB overflow. This occurs if a list identified by a certain Key cannot be transmitted in a single FIB. The first part of the list is transmitted with SIV-flag set to zero (List start). Additional list segments shall be transmitted in further FIGs using the SIV-flag set to one (List continue). If none of the services belong to the current ensemble, the OE-flag should be set to "1". In this case, no reference identifier is defined and the order of identifiers within the list is arbitrary.

3.6.14.2 Mandatory requirements

The use of Service linking information is optional for both the Service provider and the receiver.

3.6.14.3 Operational aspects of broadcasting

3.6.14.3.1 Functional minimum requirements

Linkage information shall be provided for those Services which carry the same programme or data content as Services in other DAB Ensembles or as FM/AM services. Or linkage information shall be provided for Services which are related. It is recommended that linkage information is maintained for at least 10 minutes, but preferably more than 30 minutes.

3.6.14.3.2 Optional extensions

Service linking information can be transmitted for services which are not related to any of the services of the current ensemble (using the OE flag set to 1). This can be useful if the user selects a service from another ensemble while that service is part of a set of linked services. If, because of service linking information, the receiver becomes re-tuned to FM, the DAB cross-referencing information, available as an ODA within RDS, can be decoded to enable a single front-end receiver to return back to DAB. If such a receiver is tuned to a programme within AM or FM without RDS no return path to DAB is defined.

3.6.14.3.3 Inter-relations with other features

The operation of the linkage feature relies on the transmission of frequency information. This shall be provided in FIG 0/21 (see 3.6.10). It should not be forgotten that the frequency information for FM services is provided independently via RDS. The DAB service linking feature is also related to the linking functionality available in RDS, and in some cases, part of a link can be signalled via DAB and part via RDS.

3.6.14.3.4 Transport mechanism

The Service linking information is normally carried in the FIC, but the repetition rate in the FIC can be reduced provided that the same information is additionally carried in the AIC to restore the original overall repetition rate (see 3.6.19).

3.6.14.3.5 Recommendations on content and real time aspects

For a particular link, the choice of LSN is arbitrary except that the key shall be unique within the reception area of the associated services. Any reference service shall be included at the beginning of the transmitted information for a link. The list of services associated with a link shall be split into sub-lists according to whether the services are identified by a SId, by a PI-code or by a dummy code (using the IdLQ parameter). If the number of services associated within a linkage set exceeds that which can be encoded in a single FIG, the SIV-Functionality shall be used (see 3.6.20)

The change event information (de-link CEI or list change event CEI) shall be repeated at least five times with repetition rate B for every event which has to be signalled (see 3.6.20). Long form information shall be sent with repetition rate D. New or changed information shall be transmitted within 10 seconds after the last change event is signalled or after the link becomes active. The information with SIV set to zero (list start) shall be sent before the information with SIV set to one (list continue).

The information transmitted in each FIG can contain a mixture of keys. It is up to each service provider whether to use a complete list description or the short hand device. If the short hand device is used, there should be no service identifier (SId/PI-code/Dummy Code) in the extended coverage area of the link, that matches the shorthand criteria but does not belong to the set. A service can belong to either a national or international hard link and to either a national or international soft link.

Three time schedule examples for service linking are given in figure 3.6.14. In these examples A,B and C represent subsets of the linkage set associated with the same key representing Service Id. "000, 010" are flag combinations of id list flag. LA and SIV are according to table 3.6.14.

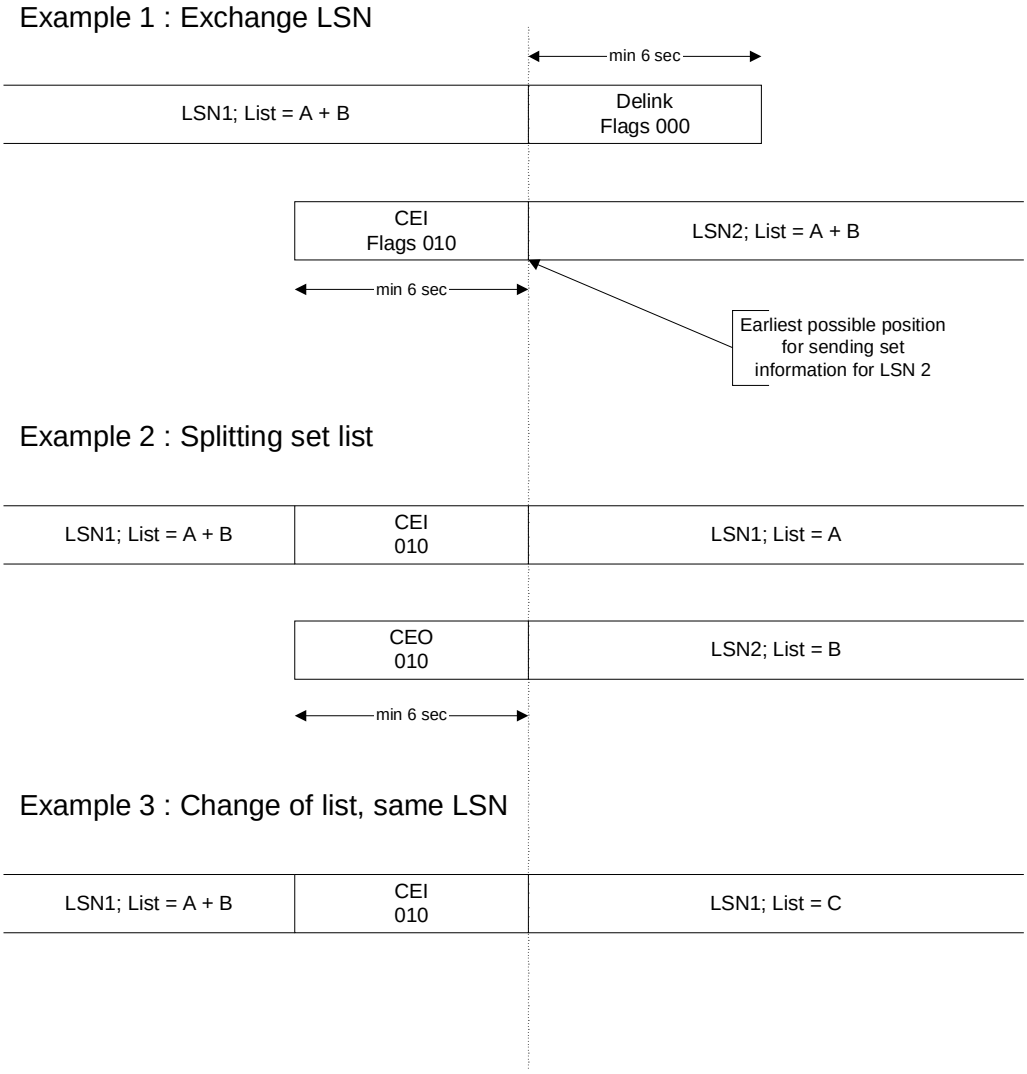


Figure 3.6.14: Three time schedule examples for Service Linking

3.6.14.3.6 Hints and remarks

If there is more then one service within an ensemble sharing the same programme or data content, then service linking information is not necessary because the multiplex should be reconfigured and the service organization can signal a common sub-channel. However, service linking information can optionally be signalled and it is necessary for it to be signalled, if there are other services outside of the ensemble included in the link. In this case, each of these services carried in the current ensemble should be treated as a reference identifier, one at a time in a cyclical transmission of the information. In other words, each of these identifiers should appear in turn as the first entry of the list (with SIV = "0"). Broadcasters are not expected to change or deactivate links during programmes. At programme boundaries there will probably be spoken information.

3.6.14.3.7 Examples

EXAMPLE 1: Consider a set comprising 16 DAB and 16 FM related services, as follows:

- DAB Services with SId DAB0, DAB1, DAB2,..., DABF;
- FM-Programmes with PI-Codes 1001,1002,1003, ..., 100F.

Assuming that the ensemble EId1 contains the service DAB0, this service is a reference service for that ensemble. The list needs to be split into four parts (carried in four different FIGs) because there are FM as well as DAB services and because there are more services in each sub-list than can be carried in one FIB. A possible encoding of the information for the set as signalled in EId1 could be:

FIG index	OE	SIV	IdLQ	Id list
a	0	0	01	DAB0, 1000, 1001, 1002, ..., 1007
b	0	1	00	DAB1, DAB2, DAB3, ..., DAB7
c	0	1	00	DAB8, DAB9, DABA, ..., DABF
d	0	1	01	1008, 1009, 100A, ..., 100F

The SIV in FIG a signals the start of the list and shall begin with the reference identifier. However, FIG a happens to have IdLQ set to '01' and therefore, the remainder of the list contains PI codes to identify the FM services. The order of the remaining FIGs is arbitrary.

EXAMPLE 2: Consider a similar situation to that of example 1, except that both services DAB0 and DAB1 are signalled in ensemble EId1 and share one sub-channel for their primary service component. A possible encoding of the information for the set as signalled in EId1 could be:

FIG index	OE	SIV	IdLQ	Id list
a	0	0	00	DAB0, DAB1, DAB2, ..., DAB7
b	0	1	01	1000, 1001, 1002, ..., 1007
c	0	1	00	DAB8, DAB9, DABA, ..., DABF
d	0	1	01	1008, 1009, 100A, ..., 100F
e	0	0	00	DAB1, DAB0, DAB2, DAB3, ..., DAB7
f	0	1	01	1000, 1001, 1002, ..., 1007
g	0	1	00	DAB8, DAB9, DABA, ..., DABF
h	0	1	01	1008, 1009, 100A, ..., 100F

The reference identifier in FIG a is DAB0 and in FIG e it is DAB1. In subsequent transmissions of the beginning of the list (SIV=0), the reference identifiers alternate (see also 3.6.14.3.5).

EXAMPLE 3: Consider a similar situation to that of example 1, except that none of the services in the linkage set belong to ensemble EId1. In this case, the information applies to other ensembles. A possible encoding of the information for the set as signalled in EId1 could be:

FIG index	OE	SIV	IdLQ	Id list
a	1	0	01	1000, 1001, 1002, ...,1007
b	1	1	00	DAB8, DAB9, DABA, ..., DABF
c	1	1	01	1008, 1009, 100A, ..., 100F
d	1	1	00	DAB0, DAB1, DAB2, ..., DAB8

3.6.14.4 Receiver implementation aspects

The feature is mainly intended for mobile receivers, either to signal alternative sources of a service content (in the case of hard links) or related services (in the case of soft links).

3.6.14.4.1 Functional minimum requirements

The receiver should be able to decode the linking information carried in FIG 0/6. In addition, in order to make use of the service linking information, the frequency information, carried in FIG 0/21, should also be decoded (see 3.6.10). The receiver is also required to be able to make decisions, based on the signal quality and other criteria, about when to switch to alternative services.

3.6.14.4.2 Optional extensions and alternatives

Information about services other than those in the current ensemble can also be signalled and, in order to acquire this information, FIG (0/24) should be decoded. Receivers that can decode RDS information as well as DAB can use the PI-code signalled in the DAB service linking feature directly.

3.6.14.4.3 Recommendations on implementation and presentation

The implementation of the Service linking feature is expected to be transparent to the listener, as far as hard links are concerned. A listener will normally only be conscious of these through the short interruptions in the programme when the receiver retunes to an another Ensemble or changes in the Service label. For services that are soft-linked, the receiver should take great care not to confuse a listener by automatically switching over to another, but related, service. Poor implementations could lead to a receiver constantly switching back and forth between two related services and frustrating the listener because of the different programme content. When a link is deactivated a receiver should try to return to the originally selected Service. Only if this fails and there is no acceptable signal, the receiver can remain tuned to the service it last found.

3.6.15 Regional Identification

3.6.15.1 Introduction

3.6.15.1.1 Purpose of the feature

The Regional Identification is used to define geographical regions (Region Definition), within an Ensemble coverage area (this corresponds to a DAB Single or Multi-Frequency Network) and textual labels (Region Label) to identify those which are used for the regionalization of announcements. A region is defined in terms of a list of TII codes corresponding to the transmitters located in the region. Such a region definition can be used to provide a geographical filter. Applications include:

- restricting the amount of Frequency Information which a receiver needs to process (see 3.6.10);
- targeting a spoken Announcement to a specific area which is equivalent to one region or several regions (see 3.6.8);
- defining where a local service can be received (see 3.6.16).

Information, applicable to a particular geographical area, can be filtered automatically by the receiver, depending on the receiver's ability to estimate its geographical location in terms of regions. Alternatively, receivers can offer a user-selectable regional filter for features which have a regional significance (by means of Region Labels for announcements and Service Labels for services restricted to a Local Service Area).

3.6.15.1.2 End user of the feature

The listener, who can select announcements according to regional preferences or services according to their regional availability.

The receiver, which can automatically filter regional information according to the receiver's location.

3.6.15.1.3 Provider of the feature

The Ensemble provider in co-operation with the Service provider(s).

3.6.15.1.4 Involvement of other parties

The Ensemble provider needs to harmonize Region Identifiers (RegionIds) (see 3.6.15.8) which shall be unique in an Ensemble coverage area.

3.6.15.1.5 Description

Regional definition information can be provided in different ways within the coding of FIG 0/11 (see [1], 8.1.16.1). A region is uniquely identified, within the Ensemble coverage area, by an 11-bit RegionId, organized as a 5-bit Upper part and a 6-bit Lower part. When the full coding range is used, up to 2047 regions can be identified.

The region can be described as a geographical area specified by a TII list (see 3.6.11) and, optionally, as a spherical rectangle, specified by its co-ordinates. These descriptions have different applications:

- the TII list provides a machine-readable form suitable for receiver processing, for example, for use with the FI feature (see 3.6.10) or for automatic receiver location (see 3.6.11);

- the spherical rectangle allows external navigation systems, such as GPS, to be used for automatic receiver location. Whenever a region is specified by a spherical rectangle, a TII list description shall also be given.

When RegionId = "0" is signalled, no area is specified and this should be interpreted as applying to the whole ensemble coverage area. This rule covers both cases of RegionIds' appearance, lower part only or upper and lower part together. The G/E flag (b_{11} in figure 57 in [1]) is used to signal whether the region definition applies throughout a large area or not, i.e. globally or associated with the Ensemble coverage area (G/E). Receivers will be able to avoid switching region databases within the validity area (see below) and offer a simpler user-interface. The G/E flag is defined as follows:

0 : Ensemble, Region Id valid in the ensemble coverage area;
1 : Global, Region Id valid in the coverage area defined by CountryId + Ensemble ECC.

The G/E flag is not included in the "Key" associated with the Region identification database (see 3.6.20) It is the CountryId associated with the EId, together with the Ensemble ECC, which determines the validity area for globally-defined regions.

The Region Label feature, encoded in FIG 1/3 (see [1], 8.1.16.2) provides a textual description of the region, for example "South Coast". This is available for up to 64 labels per ensemble using the restricted range of RegionIds, identified by the 6-bit Lower part and with the 5-bit upper part set to all zeroes. This is most useful for direct listener interaction. For example, the listener can select "Munich" from a "Region menu" if he is interested in information about Munich. A list of Region descriptions comprises a database which effectively needs to be transferred from the Ensemble/Service provider to the receiver. The spherical rectangle method of encoding a region uses a method of specifying the latitude and longitude based on two's complement numbers for the southwest corner of the spherical rectangle (according to the WGS 84 geodetic reference). Coarse latitudes north of the equator are considered to be positive and coarse latitudes south of the equator are considered to be negative. Coarse longitudes east of Greenwich are considered to be positive and coarse longitudes west of Greenwich are considered to be negative. The size of the spherical rectangle is defined by the extent of the latitude and longitude, coded in unsigned form. For details see example below ("Hints and remarks" under 3.6.15.3).

3.6.15.2 Mandatory requirements

Regional Identification (definition and labels) is an optional feature.

3.6.15.3 Operational aspects of broadcasting

3.6.15.3.1 Functional minimum requirements

Region Definition information is encoded in FIG 0/11. It shall be repeated at repetition rate E.

3.6.15.3.2 Optional extensions

Region labels are encoded in FIG 1/3. They shall be repeated at repetition rate C. When labels are transmitted the Region definition should be transmitted as well.

3.6.15.3.3 Interrelations with other features

Regional identification depends upon Transmitter Identification Information TII (see 3.6.11). The Region definition feature is an essential part of the Local service area feature (see 3.6.16). It can also be used with the Frequency Information (FI) and Announcement features (see 3.6.10 and 3.6.8 respectively). When used with the FI feature, there is a benefit in keeping the associated regions small. When used with the Announcements feature, labels should be signalled for the regions.

3.6.15.3.4 Preferred transport mechanisms and alternatives

The preferred transport mechanism for Regional Identification (Region definitions and Region labels) is the FIC. However, a partial re-direction to the AIC is also possible (see 3.6.19).

3.6.15.3.5 Recommendations on contents and real-time aspects

Regional Identification is relatively static information. Once sent, it remains valid until it is explicitly superseded. In order to provide fast access for receivers entering the Ensemble coverage area, it is repeated regularly (see 3.6.15). Any change of the Regional definition information is indicated by the SIV flag and appropriate CEI (see 3.6.20).

3.6.15.3.6 Hints and remarks

Broadcasters within an area, defined by the Ensemble's CountryId and Ensemble ECC (generally a country), should agree the number and definitions of regions that are globally defined (both those with and without labels). Each ensemble provider can use none, some or all of the globally defined RegionIds that he finds appropriate for his purposes. All other RegionIds can be defined for use ensemble-wide, even if they were globally defined through the above-mentioned agreement, but they are not used as global ones by the ensemble provider.

3.6.15.3.6.1 Example of Region Identification

In general, a different set of regions can be assigned to each ensemble. Consider the following example in figure 3.6.15 which shows two large area ensembles (EId 1 and EId 2) operating on SFN 1 and 2 respectively and a city-based ensemble (EId 3) operating on SFN 3.

The large area ensemble EId 1 has three defined regions, the large area ensemble EId 2 has two and the city ensemble has just one defined area. It is probably practically impossible to arrange the mapping of regions so that there is a "perfect" fit of the regions of one ensemble with those of other ensembles. This is because Ensemble providers generally have independent requirements. However, there are some advantages in attempting to create a close fit. In the example, the same RegionIds and TII codes can be re-used in the different ensembles to identify different regions which are not globally agreed: see for example RegionId E12, which is used in both large area ensembles to represent different regions.

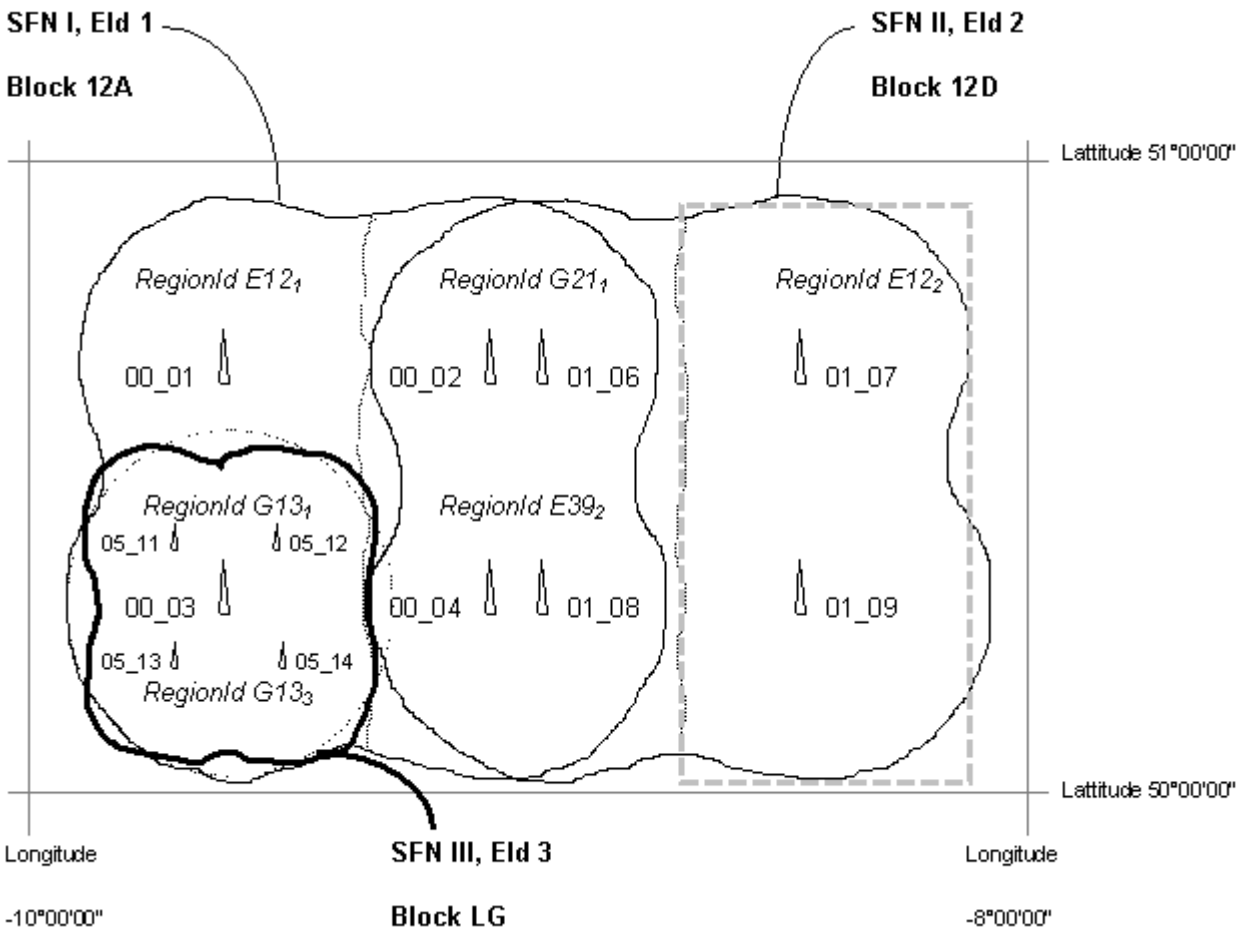


Figure 3.6.15: An example of two large area ensembles' coverage and a city ensemble's coverage area with regions defined

NOTE 1: $E39_2$= Ensemble defined Region with RegionId 39 indicated in the FIC of the ensemble identified by EId2.

NOTE 2: $G13_1$=Globally defined Region with RegionId 13 indicated in the FIC of the ensemble identified by Eld1.

3.6.15.3.6.2 Region coding for the example

The coding for FIG 0/11 (and FIG 1/3 for labels) in the respective ensembles might be as listed below (it is assumed that the region definition is first of all based on a TII list and each TII comprises a MainId and a SubId represented as MainId_SubId. The "GATy" parameter is set to "0000").

EId 1	RegionId E12	"West Land"	(SFN1)	00_01 00_03
EId 1	RegionId G21	"Middle Land"	(SFN1)	00_02 00_04
EId 1	RegionId G13	"Metropolitan Area"	(SFN1)	00_03
EId 2	RegionId E39	"Midland"	(SFN2)	01_06 01_08
EId 2	RegionId E12	"East Land"	(SFN2)	01_07 01_09
EId 3	RegionId G13	"Metropolitan Area"	(SFN2)	05_11 05_12
				05_13 05_14

However, there is an advantage for all broadcasters serving a large area (for example, a nation or part of a country) to agree a common set of global region definitions and to liaise with broadcasters serving smaller areas (for example a city) to take account of local coverage areas. This can be understood by considering the application of regional information to the FI and Announcement features operating within the areas specified in this example (see below).

3.6.15.3.6.3 Cross-reference to regions in other ensembles

Both the Frequency Information (see 3.6.10) and the Announcement features (see 3.6.8) use the region feature to target frequency information or messages to the relevant area of the country to which they apply. The features can be extended to cross-refer to other ensembles. In general, there would be a "mapping" between the regions defined for the different ensembles. In the example, there is considered to be an equivalence between the following regions:

EId 1 RegionId 21 ⇔ EId 2 RegionId 39

EId 1 RegionId 13 ⇔ EId 3 RegionId 13

3.6.15.3.6.4 Frequency Information

The Frequency Information (FI) feature (encoded in FIG 0/21) (see 3.6.10 and also [1], 8.1.8) allows the radio frequencies of other ensembles to be signalled to the receiver. It can also be used directly to signal the frequencies for FM and other services. The radio frequencies of the ensembles for particular DAB services require the additional use of the Other Ensembles (OE) services feature encoded in FIG 0/24) (see [1], 8.1.10). The use of regional signalling in an SFN can help to reduce the list of frequencies, that are relevant for the receiver in any one location, provided that the regions are chosen carefully. Labels are inappropriate for this application because the processing of the FI is transparent to the listener. The coding for FIG 0/21 for the city ensemble is straightforward because its coverage area is contained within that of the large area ensemble and there is no need to signal individual local ensemble regions. The large area ensemble (EId 1) frequency 12A is available everywhere that is covered by the city ensemble EId 3. The Region code '0' could be used in this case as well to signal 'no region specified'.

FIG 0/21 in EId 3: OE = '1' RegionId 13 EId 1 223,936 MHz, adjacent

Vice-versa, within EId 1's FIC the signalling for the frequency of EId 3 and the region within EId 1's coverage area would look like this:

FIG 0/21 in EId 1: OE = '1' RegionId 13 EId 3 1 463,232 MHz, adjacent

Also ensemble EId 2 can be signalled within the FIC of the large area ensemble EId 1:

FIG 0/21 in EId 1: OE = '1' RegionId 21 EId 2 229,072 MHz, adjacent

Similar signalling within the FIc of the large area ensemble EId 2 for the overlapping ensemble EId 1:

FIG 0/21 in EId 2: OE = '1' RegionId 39 EId 1 223,936 MHz, adjacent

The use of region codes in this case indicates that there is another ensemble available to receivers in regions $13_{1 \text{ and } 3}$, 21_1 and 39_2. Receivers located in regions 12 exclusively (not in 13 at the same time) can ignore the information. However, the slight mismatch of the coverage areas of region 21 with 39 for example means that there are areas within regions 21 and 39 where the other large area ensemble cannot be received. This means the receiver cannot always fully rely on the FI providing the decisive information that the other ensemble (or service) is surely receivable in the whole signalled region on the signalled frequency. So the receiver should adopt an appropriate strategy for checking the receivability of the other large area ensemble (in this example), whenever needed. Usually, and in contrast to the example above, regions defined exclusively for efficient FI coding will not be labelled and would carry RegionIds larger than decimal 63.

3.6.15.3.6.5 Announcements

When considering the signalling of announcements transmitted in another ensemble (see 3.6.8 and also [1], 8.1.10.5), the Service provider shall decide whether messages targeted to regions in one ensemble are appropriate to be signalled also in other ensembles. If this is the case, region identifiers associated with the other ensemble can be used to signal the region(s) which map onto the original target. The receiver does not need to know about the "mapping" in advance of receiving such messages.

When an announcement is signalled, the announcement switching information allows to indicate the RegionIds of both the tuned and the other ensembles. This requires the ensemble provider, which wishes to signal the announcement, to refer to the "mapping" definition which should be known on the broadcasting side. It should recognize the region for which the announcement is intended in the other ensemble and choose the appropriate region(s) that map onto those defined in its own ensemble. This can be made an automatic process so that regions associated with all other ensembles, that need to be cross-referenced, have "mapped" regions for their own ensemble.

For example, if there is an announcement for the region with RegionId 39 of ensemble EId 2 the ensemble EId 1 provider could signal RegionId 21 for its own ensemble. However, because the region boundaries do not perfectly align in the two ensembles, the receiver has the same problem as before and cannot rely on the other ensemble being receivable throughout the region with RegionId 21 that is signalled. Because both regions describe almost the same area, it would make perfect sense to identify them with the same global RegionId and the same Region label. A necessary precondition would be that the CountryId within both EIds (most significant nibble) is the same and the ECC is identical. Similarly, announcements for the globally defined region with RegionId 13 could be signalled by the Ensemble providers of EId 1 and EId 3.

In any case, the listener is expected to select the region(s) he is interested in from those associated with the TUNED ensemble. These regions form the first line filter for incoming announcements. Those announcements that are relayed from other ensembles will also have signalled the mapped regions associated with the other ensemble. The receiver should check that the regions signalled for the announcement in FIG 0/19 in the other ensemble corresponds with the "other ensemble" regions signalled in the tuned ensemble's FIG 0/26 after having switched to it.

3.6.15.3.6.6 Additional Region Definition with Geographical Area Type (GATy) '0001' (geographical co-ordinates)

As an example Region $E12_2$ is described with its co-ordinates (see dotted rectangle in figure 3.6.15). First of all, the "Longitude coarse" and the "Latitude coarse" of the SouthWest corner have to be coded:

Longitude: -8°41'26"

This value has to be converted into its decimal notation:

- 41' = 41/60 = 0,683 333°
- 26" = 26/3 600 = 0,007 222°

The Longitude -8°41'26" corresponds to -8,690 555°.

This is the "Longitude coarse" expressed in degrees decimal.

The decimal equivalent of the binary value to be put in the "Longitude coarse" field shall now be such that when multiplied by $(90° / 2^{15})$ it results in the value 8,690 555° before complementation. Let us call this value LG:

- $LG \times (180° / 2^{15}) = 8{,}690\ 555°$
- $LG = (8{,}690\ 555° \times 2^{15}) / 180°$
- $LG = 1\ 582_{decimal}$ (rounded off)
- $LG = 0000\ 0110\ 0010\ 1110_{binary}$
- 1's complement (LG) = 1111 1001 1101 0001
- 2's complement (LG) = 1111 1001 1101 0010

The latter binary value is the "Longitude coarse" in 2's complement representation. These two Bytes would have to be filled in the corresponding field of FIG 0/11 for the Region Definition of Region $E12_2$.

A similar calculation is done for the Latitude: 50°01'46"

Derived from the example in figure 3.6.15 one gets the (always positive and therefore unsigned)

"Extent of Longitude": 0°34'33" That value has to be converted into its decimal notation:

34' = 34 / 60 = 0,566 667°

33" = 33 / 3 600 = 0,009 167°

Longitude 0°34'33" corresponds to 0,575 833°. This is the Extent of Longitude expressed in degrees decimal. The decimal equivalent of the binary value to be put in the "Extent of Longitude" field shall now be such that when multiplied by $(180° / 2^{15})$ it results in the value 0,575 833°. Let us call this value EX_LG:

$EX\_LG \times (180° / 2^{15}) = 0{,}575833°$

$EX\_LG = (0{,}575833° \times 2^{15}) / 180°$

$EX\_LG = 105_{decimal}$ (rounded off)

$EX\_LG = 0000\ 0110\ 1001_{binary}$

This value is the "Extent of Longitude" in binary notation. These 12 bits have to be put in the "Extent of Longitude" field of FIG 0/11 for the Region Definition of Region $E12_2$. A calculation similar to the one for the "Extent of Longitude" would now lead to the "Extent of Latitude".

3.6.15.3.6.7 National regulation of Region Identifiers

The identification of regions within a DAB coverage area can be different for different ensembles. In this case, each Ensemble provider enjoys independence when defining the regions in his ensemble coverage area. No liaison is required with other ensemble providers. For regions that have an associated label, there is a benefit for smaller area ensembles which could offer the listener a choice of region at a finer resolution than is possible using a national grid alone, for example for selecting parking information in towns. Locally defined regions can give local broadcasters greater freedom to implement some system features in a more flexible manner. However, a receiver is only able to deal with the region definitions of one ensemble at a time. When re-tuning from one ensemble to another the receiver would have to re-acquire the entire region database for the new ensemble.

There are advantages in introducing some regulation to control the definition of regions. The advantages stem mainly from the vast amount of information that could potentially be generated, leading to greater complication in the receiver and its user-interface. This in turn conflicts with the "ease of use" philosophy which the listener is led to expect. When region-related information is cross-referenced from one ensemble to another, the problems faced by the receiver, in determining whether another ensemble/service is receivable, are reduced.

The distinction of global and ensemble-wide regions (G/E flag in FIG 0/11) allows both a simpler user-access (same regions and same labels) to be provided, when global definitions apply, and the advantages of finer region resolution when needed. Different ensemble providers can choose whether to adopt entries from the national region grid or to use their own.

3.6.15.4 Receiver implementation aspects

3.6.15.4.1 Functional minimum requirements

The receiver able to evaluate the TII in the Null symbol shall process and interpret FIG 0/11 and possibly FIG 1/3, depending on the application and purpose for which the feature is used.

3.6.15.4.2 Inter-relations with other features

The basic service depends on the TII transmitted in the Null symbol.

3.6.15.4.3 Recommendations on implementation and presentation

Region labels play an essential role in the receiver user-interface for applications whereby the listener is expected to make an informed selection of region-based information, such as announcements targeted to a remote region. The number of regions that can be assigned labels is restricted in order to avoid overloading the listener with hundreds of labels.

3.6.15.4.4 Hints and remarks

See the broadcasters' hints and remarks above.

3.6.16 Local service area

3.6.16.1 Introduction

3.6.16.1.1 Purpose of the feature

The DAB Single Frequency Network (SFN) allows national services to be transmitted with high frequency spectrum efficiency. However, DAB can also be used for local broadcasting so that regions within an SFN can transmit their own local programmes. The Local service area feature allows the service provider to identify the area of the ensemble coverage area that the service is intended to be received in.

3.6.16.1.2 User of the feature

The receiver and the listener.

3.6.16.1.3 Feature provider

The Service provider.

3.6.16.1.4 Other parties involved

No other parties are involved.

3.6.16.1.5 Description

The Local service area feature is encoded in FIG (0/23) (see [1], 8.1.17). The service area is simply defined by allocating a Regional Identifier (RegionId) to the Service, identified by its Service Identifier (SId). The RegionId is expressed in its full resolution (11-bit) form (see 3.6.15.1.5). Note that all components of the service have the same local service area.

3.6.16.2 Mandatory requirements

The Local service area feature is optional both for the Service provider and the receiver.

3.6.16.3 Operational aspects of broadcasting

3.6.16.3.1 Functional minimum requirements

A Local Service provider shall specify the "Region" over which the Service is valid so that an appropriate and unique RegionId can be allocated. The Ensemble provider shall include the Local service area information within the multiplex (see 3.6.16.3.3 below).

The Local service area information shall be repeated at repetition rate B.

3.6.16.3.2 Inter-Relations with other features

The Local service area feature depends on Regional Identification information (see 3.6.15). This, in turn, depends on the implementation of Transmitter Identification Information within the Null symbol (see TR 101 496-3 [17]).

3.6.16.3.3 Transport mechanism

The Local service area feature is encoded in FIG 0/23, (see [1], 8.1.17).

3.6.16.3.4 Recommendations on contents and real-time aspects

The Local service area is defined by the RegionId, which is defined in terms of the list of transmitters in the intended reception area for the local service. Once sent, it remains valid until it is explicitly superseded. In order to provide receivers entering the Ensemble fast access to the information, it is repeated regularly (see 3.6.16.3.1).

3.6.16.4 Receiver implementation aspects

The feature is intended for all receivers. For making use of this feature, the receiver needs to be able to determine its current location. This can be programmed manually by the listener or automatically, either by using the TII feature or another navigation method, e.g. GPS (see 3.6.11).

3.6.16.4.1 Functional minimum requirements

When implemented, the receiver should decode the Local service area information in FIG (0/23) to determine the valid service area. Listeners should be restricted to accessing the Service within the defined area.

3.6.16.4.2 Inter-relations with other features

The receiver needs to implement the Regional identification feature in order to understand the local service area definition. The receiver also needs to know its position and this may require a location method for determining, for example using TII within in the service area.

3.6.17 Satellite assistance

The Satellite assistance, which includes the Satellite Database fields (FIG 0/30) and Satellite Handover fields (FIG 0/29), is under consideration.

3.6.18 FM and AM services

3.6.18.1 Introduction

Information concerning several system features can be signalled for FM and AM services (see [1], 8.1.11 for FM services and 8.1.19 for AM services). A list of these is given here, together with references to other parts of these guidelines where more details can be found:

- Service linking (see 3.6.14);
- Frequency information (see 3.6.10);
- Programme Number (see 3.6.4);
- Programme Type (see 3.6.5);
- Announcements (FM only, see 3.6.8);
- Service labels (see 3.6.13).

3.6.18.1.1 Purpose

The provision of information about other services carried on FM and AM.

3.6.18.1.2 User of the feature

The receiver.

3.6.18.1.3 Provider of the feature

The Ensemble provider.

3.6.18.1.4 Involvement of other parties

Service providers who broadcast on channels in FM Band II and AM (LW, MW and SW).

3.6.18.1.5 Description

The cross-referencing of information carried on FM and AM is achieved by setting the OE flag to "1" in the FIGs used to signal a particular feature (see the references to other parts of this guideline given above). For FM services, the SId field is filled by a "PI code" (see reference [22]) and for AM services the SId field is filled by a "Dummy code" (see 3.3.1). Special FIGs are defined for FM announcement signalling (see 3.6.8).

3.6.18.2 Mandatory requirements

The implementation of FM and AM services information is optional.

3.6.18.3 Operational aspects of broadcasting

3.6.18.3.1 Functional minimum requirements

The information does not have to be comprehensive. The information provided should be kept up to date as far as possible. The information should be transmitted at repetition rate D.

3.6.18.3.2 Optional extensions

In principle, the amount of information provided about other services is extensive and the information that is signalled will need to be chosen on the basis of what is considered essential to a receiver operating within the ensemble coverage area.

3.6.18.3.3 Interrelations with other features

All other information about FM and AM services (see Introduction) rely on this feature.

3.6.18.3.4 Preferred transport mechanism and alternatives

Although such information is normally carried in the FIC (see 3.2.1), FM and AM services information may overflow into the AIC (see 3.6.19).

3.6.18.3.5 Recommendation for contents and real-time aspects

There are no real time requirements for this feature, however, the information given should follow the corresponding changes made to the services which are referenced with as little delay as possible.

3.6.18.4 Receiver implementation aspects

3.6.18.4.1 Functional minimum requirements

The receiver only needs the ability to decode the OE flag associated with the FIGs encoding these features.

3.6.18.4.2 Inter-relations with other features

All other information about FM and AM services (see Introduction) rely on this feature.

3.6.18.4.3 Recommendations on implementation and presentation

If a receiver switches over to a FM signal, carrying a FM service, as a result of "hard" Service linking information or some other means, the PI code signalled via RDS provides a means for checking the authenticity of the new signal source. A problem can arise if a receiver switches to an FM signal when there is no RDS data present or to AM, because there is no easy way for the receiver to confirm that the programme carried on the new signal is the same as that selected by the user. In most countries the problem is unlikely to be troublesome for AM services because there are clear assignments of one service per channel. In addition, although information can be provided for AM services (and FM without RDS), the receiver needs to exercise caution when switching away from a DAB signal because no cross-referencing information about DAB services can be provided there. Even for FM services with RDS the appropriate ODA information about DAB services can not be broadcast. Receivers are recommended to continue monitoring the DAB channels to provide an independent check for reliable DAB reception.

3.6.18.4.4 Hints and remarks

This cross-referencing information offers useful benefits:

- Service linking information gives the service identifiers (PI or dummy codes) of other sources of the same or similar service, so that service following can be extended to these alternative service sources;
- Frequency information gives directly the frequencies on which the other services are carried;
- Programme Number information allows FM and AM services to be included in programme identification by programme number;
- Programme Type information allows FM and AM services to be included in service selection by programme type;
- Labels identify FM and AM services.

In the case of FM services, the beginning of traffic announcements signalled on RDS can be recognized.

3.6.19 Auxiliary Information Channel (AIC)

3.6.19.1 Introduction

3.6.19.1.1 Purpose of the feature

The Auxiliary Information Channel feature provides a means to transport information, that is normally carried in the FIC, when the FIC is in danger of becoming overloaded i.e. there is so much information to include in the FIC that data repetition rates fall below the minimum recommended rates. Some information can be carried entirely in the AIC and have no presence in the FIC.

3.6.19.1.2 End user of the feature

The receiver.

3.6.19.1.3 Provider of the feature

The Ensemble provider.

3.6.19.1.4 Involvement of other parties

Service providers.

3.6.19.1.5 Description

The AIC provides an alternative transport mechanism for some system features, although the access time at the receiver will be affected by the time-interleaving processing delay. There are rules that define which SI features should remain entirely in the FIC and which may be transferred either as a whole or in part to the AIC. The rules are defined in the clause dealing with "FIC re-direction" (see [1], 8.1.12). and can be summarized:

- The MCI shall remain in the FIC and is not allowed to be carried in the AIC.
- Two features (Programme Type downloading and Satellite database) and any feature applying to other ensembles may be carried entirely in the AIC.
- All other features shall have a presence in the FIC, even though their data rate can be reduced (this ensures that receivers without a packet-mode decoder can access all the basic data feature, even though their performance can be inferior to other receivers.

A further summary is given in table 3.6.19. In column 3 (headed "Trpt" Transport), the entries are interpreted as follows:

- FIC* the ETS stipulates that the feature shall remain in the FIC;
- FIC FIC is recommended at the recommended data repetition rate;
- AIC AIC is acceptable for the whole of the information describing this feature;
- F/aic the information is recommended to be repeated more frequently in the FIC than in the AIC;
- f/AIC the information is recommended to be repeated less frequently in the FIC than in the AIC.

In column 6 ("Min rate in FIC"), the rates refer to those listed in table 2.10.1 in 2.10. Where suffices "0" or "1" are added, the rates depend on those settings of the "OE" flag of the associated FIG. The re-direction signalling uses FIG 0/31 which restricts the re-direction mechanism to features encoded in FIG types 0 and 1 (see [1], 8.1.12). The FIG type 0 flag field and FIG type 1 flag field provide a link to information encoded in the 32 FIG type 0 and 8 FIG type 1 extensions. The AIC is supported by assigning sub-channel "63" (SubChId = "111111") to packet mode and using packet address "1023". The size of the channel can be assigned by the Ensemble provider, to meet his specific requirements, by choosing an appropriate data rate (which in turn allocates a number of CUs to sub-channel 63) (see [1], 6.2). The MSC Data group and packet structure are used to carry FIGs that are generally intended for transport in FIBs in the FIC (see [1], 5.2.2). Different FIG types can be mixed together in one MSC data group data field. Certain conditions are stipulated for the MSC Data group signalling: the Data group type is set to "general data (0000)" and the maximum length of the MSC data group is 512 bytes (compared with 30 bytes for the FIB data field) (see [1], 5.4).

3.6.19.2 Mandatory requirements

The Auxiliary Information Channel feature is optional, but becomes essential if the FIC becomes overloaded.

3.6.19.3 Operational aspects of broadcasting

3.6.19.3.1 Functional minimum requirements

The provision of a suitably-sized sub-channel, capable of supporting data in packet mode. The generation of FIC re-direction information based on an analysis of the features which can appropriately be carried in the AIC.

3.6.19.3.2 Inter-relations with other features

All features that are encoded in FIG types 0 and 1 and which are allowed to be transported in the AIC.

3.6.19.3.3 Preferred transport mechanisms and alternatives

The transport mechanism for the Auxiliary Information Channel is a particular packet address "1 023" of packets carried in a packet-mode sub-channel "63". The signalling of information to be re-directed to the AIC is carried in the FIC.

3.6.19.3.4 Recommendations on contents and real-time aspects

The Ensemble provider should take the following into account:

- the extent to which the data repetition rate in the FIC is in danger of being reduced below that which is recommended;
- implementation of the packet mode transport mechanism (see 3.2.3);
- availability of a sub-channel to support the AIC with a size that matches the amount of overflow capacity required;

the extent to which receiver manufacturers have implemented detection of the overflow mechanism.

3.6.19.4 Receiver implementation aspects

3.6.19.4.1 Functional minimum requirements

In order to decode information carried in the AIC, the packet mode needs to be implemented.

3.6.19.4.2 Inter-relations with other features

All features that are encoded in FIG types 0 and 1 and which are allowed to be transported in the AIC.

3.6.19.4.3 Recommendations on implementation

If the AIC cannot be decoded there is a danger of the data repetition rate of some features' information in the FIC being reduced to a point below the recommended rate. This would result in longer data access times and a more sluggish behaviour noticeable to the listener.

3.6.19.4.4 Hints and remarks

All precautions should be taken to decode all the information for the desired system features provided by the broadcaster. This means checking for and using information in the AIC, when provided.

Table 3.6.19: Use of the Auxiliary Information Channel

FIG Type/Ext	Description	Trpt	Recmd rate	% FIC capacity	Min rate in FIC
FIG 0/0	ENSEMBLE INFORMATION	FIC*	A	1,5	A
FIG 0/1	SUB-CHANNEL ORGANIZATION	FIC*	A	~1,0/sv	A
FIG 0/2	SERVICE ORGANIZATION	FIC*	A	~1,5/sv	A
FIG 0/3	SERVICE COMPONENT IN PACKET MODE	FIC*	A		A
FIG 0/4	SERVICE COMPONENT IN STREAM MODE OR FIC WITH CA	FIC*	A		A
FIG 0/5	SERVICE COMPONENT LANGUAGE	FIC*	A/B		A/B
FIG 0/6	SERVICE LINKING INFORMATION	S=FIC L=F/aic	B C		B D
FIG 0/7	DATA SERVICE COMPONENT TYPE EXTENSION	FIC*	A?		A?
FIG 0/8	SERVICE COMPONENT GLOBAL DEFINITION	FIC	B		
FIG 0/9	COUNTRY, LTO & INTERNATIONAL TABLE	F/aic	S-B L-C	S-0,1	S-B/C L-C/D
FIG 0/10	DATE & TIME	FIC*	B/C		B/C
FIG 0/11	REGION DEFINITION	f/AIC	E	0,1	-
FIG 0/12	PROGRAMME TYPE PREVIEW	f/AIC	C	0,1	-
FIG 0/13	USER APPLICATION INFORMATION	FIC	B		
FIG 0/14-5	Rfu				
FIG 0/16	PROGRAMME NUMBER (PNum)	F/aic$_0$ f/AIC$_1$	A$^{\$}$/B$_0$ A$^{\$}$/C$_1$	~1,0/sv	A/B$_0$ C/D$_1$
FIG 0/17	PROGRAMME TYPE (PTy) [STATIC & DYNAMIC]	F/aic$_0$ f/AIC$_1$	A$^{\$}$/B$_0$ A$^{\$}$/C$_1$	~2,0/sv	A/B$_0$ C/D$_1$
FIG 0/18	ANNOUNCEMENT SUPPORT	f/AIC	B	0,2/sv	B/C
FIG 0/19	ANNOUNCEMENT SWITCHING	FIC*	A/B	0,1	A/B
FIG 0/20	SERVICE TRIGGER	FIC*	1/min		1/min
FIG 0/21	FREQUENCY INFORMATION (FI)	f/AIC	E	FM-2,0 OE-0,3	D
FIG 0/22	TRANSMITTER IDENTIFICATION DATABASE	f/AIC	E		-
FIG 0/23	LOCAL SERVICE AREA	F/aic	B		B/C
FIG 0/24	OTHER ENSEMBLES SERVICES	f/AIC	C$_0$ D$_1$	small	D$_0$ D$_1$
FIG 0/25	OTHER ENSEMBLES ANNOUNCEMENT SUPPORT	f/AIC	B	3,0	B/C
FIG 0/26	OTHER ENSEMBLES ANNOUNCEMENT SWITCHING	FIC*	A/B	small	A/B
FIG 0/27	FM SERVICES ANNOUNCEMENT SUPPORT	f/AIC	B	3,0	B/C
FIG 0/28	FM SERVICES ANNOUNCEMENT SWITCHING	FIC*	A/B	small	A/B
FIG 0/29	SATELLITE HANDOVER INFORMATION	FIC*	A/B?		A/B?
FIG 0/30	SATELLITE DATABASE	AIC	E		0
FIG 0/31	FIC RE-DIRECTION	FIC*	B		B
FIG 1/0	ENSEMBLE LABEL	F/aic	B$_0$ D$_1$	0,6	B/C$_0$ D$_1$
FIG 1/1	PROGRAMME SERVICE LABEL	F/aic	B$_0$ D$_1$	0,6/sv	B/C$_0$ D$_1$
FIG 1/2	PROGRAMME TYPE DOWNLOADING	AIC	C		0
FIG 1/3	REGION LABEL	f/AIC	C		D
FIG 1/4	SERVICE COMPONENT LABEL	F/aic	B$_0$ D$_1$		
FIG 1/5	DATA SERVICE LABEL	F/aic	B$_0$ D$_1$		B/C$_0$ D$_1$
FIG 1/6-7	Rfu				

Key: Rfu = reserved for future use; SIV = SI version; OE = Other Ensembles; n/a = not applicable, S- = "short form", "L-" - "long form". Rates: A = 10/sec; B = 1/sec; C = 1/10 sec, D = less than 1/10 sec; E = all in 2 min. A$^{\$}$ = rate increased to A at programme junctionsFIC* = FIC by ETS; FIC = recommended FIC full rate; F/aic = more in FIC, less in AIC; f/AIC = less in FIC, more in AIC; AIC = AIC only.. A$_0$ B$_1$ = A for OE="0" & B for OE="1" etc. sv = service.

3.6.20 Service Information Version (SIV) and Change event signalling

3.6.20.1 Introduction

The Service Information Version (SIV) flag and "change event" signalling are both associated with a number of service information features (a full list is given in table 1). The SIV flag is encoded in the first byte of the FIG data field of the Fast Information Group (FIG) which transports the feature (see 3.2.1 and table 3.6.1 in 3.6). In [1], several FIG type 0 extensions have the SIV assigned (C/N situation b): they are FIGs 0/6, 0/9, 0/11, 0/18, 0/21 - 25, 0/27 and 0/30. The change event indication uses a particular form of signalling based on specially-defined shortened FIG fields.

3.6.20.2 Purpose of the feature

The SIV flag is intended to assist receivers to manage databases that are associated with those system features which support basically static information, such as service linking, frequency information, region definition, announcement support, etc.. This kind of information can require more than one FIB to deliver the database associated with each feature. This means that there is a need to indicate when the information should be "accumulated" within the receiver to build up the database, or "overwritten" when the information is changed. This mechanism is in contrast to other features (such as the service label) which are totally updated on each new transmission of the relevant FIG. The signalling of changes to a database is intended to assist a receiver to manage the transfer of database information, from broadcaster to receiver, efficiently and without the need to continually compare incoming information with what is already stored.

3.6.20.3 End user of the feature

The receiver.

3.6.20.4 Provider of the feature

The Ensemble and Service provider.

3.6.20.5 Involvement of other parties

The Service provider supplies information for some of the relevant features, such as service linking and local service area.

3.6.20.6 Description

All the features affected by the SIV flag support a database which effectively needs to be transferred from the Service or Ensemble provider to the receiver. The relevant features are those encoded using the FIG type 0 extensions given in table 3.6.20A. The amount of information associated with each feature can be quite large, in which case more than a single FIG is required to convey it. The information is generally fairly stable and can be transmitted at a relatively slow rate. However, changes can be made from time to time and it is then necessary to signal the changes in an efficient manner. The efficiency of database management is increased by sub-dividing the database associated with each feature so that when a change is made to one part, the remaining part can be left alone.

3.6.20.6.1 Keys to subdivide each database

The database information that is associated with each feature is considered to be subdivided into a number of shorter 'lists'. Each list is identified by a 'key' which varies according to the particular FIG type 0 extension concerned and table 1 gives the key for each of these. For example, consider the FM announcement support feature. The complete database for this feature comprises a list of PI codes for each Service to be cross-referenced. The SId is chosen to be the key in this case. Suppose that there are 36 PI codes for one of the services, identified by SId1. The list can be written:

Key	***Item1***	***Item2***		***Item35***	***Item36***
SId1	PI1	PI2	.....	PI35	PI36.

For SId1 there are 36 PI codes, but FIG 0/27 can only carry up to twelve before the FIB becomes full. In this case, the list has to be split into at least three FIGs and transported in separate FIBs.

Table 3.6.20A: Keys and CEI definitions for the FIG type 0 extensions

FIG type/extension		Database key			Special values of FIG parameters for CEI (SIV = "0" in all cases)
		OE	P/D	key parameter	
0/6	Service Linking	0/1	0/1	ILS, S/H and LSN	IdList flag = 0
0/9	Country, LTO	Rfu	0/1	No parameter needed as there is only one list.	Ext.flag = 1 Number of services = 0 LTO field = 0
0/11	Region Definition (GATy = 0)	Rfu	Rfu	RegionId	Length of TII list = 0
0/18	Announcement support	Rfu	Rfu	SId	Number of Clusters = 0; ASu = 0
0/21	Frequency Information	0/1	Rfu	RegionId, Id field, R&M	Length of Freq. list = 0
0/22	TII database (M/S=1)	Rfu	Rfu	MainId	Number of SubId fields = 0
0/23	Local Service Area	0/1	0/1	SId	RegionId = 0
0/24	OE Services	0/1	0/1	SId	Number of EIds = 0
0/25	OE announcement support	Rfu	Rfu	SId	Number of EIds = 0
0/27	FM announcement support	Rfu	Rfu	SId	Number of PI codes = 0
0/30	Satellite Database	0/1	Rfu	EId	Latitude, Longitude, DSF, TDF and ADF = 0

3.6.20.6.2 Signalling requirements

Two functions are recognized to be required to manage databases in the receiver: one is an assurance that the database is "complete" and the other one is a notification that a change is about to be made to a particular database.

3.6.20.6.3 Start/Continuation indication

The first required function is served by using the SIV flag, associated with each FIG to signal "start" or "continuation" of the list. In general, SIV = '0' indicates that the FIG contains the first part of one or more lists. SIV = '1' indicates that the FIG contains additional parts of one or more lists. The coding of FIG 0/27 for the three separate FIGs, delivered in three separate FIBs (Index 1,2,3) could be signalled as follows:

FIB index	***FIG Type/Ext***		***SIV***	***Type 0 field for FIG 0/27***
Key	Item1	Item2	Item11	Item12
1	FIG 0/27,	SIV = 0,	SId1	PI1 PI2 ..... PI11 PI12.
2	FIG 0/27,	SIV = 1,	SId1	PI13PI14 ..... PI23 PI24.
3	FIG 0/27,	SIV = 1,	SId1	PI25PI26 ..... PI35 PI36.

The information is transmitted with the three FIBs kept in their correct order (index 1, 2, 3) and repeated cyclically. The first FIG in the FIB with index 1 is signalled to be the first or "start" of the list. The second and third FIGs, carried in the FIBs with indices 2 and 3, are signalled to be the "continuation" of the list. On recognizing the start of the list for SId1, the receiver can watch for subsequent FIGs identified to be a continuation of the list for SId1. When the start of the list appears again, the receiver can expect to have retrieved the whole list. In order to be sure that no intermediate parts of the list have been lost, the receiver might adopt some strategy, such as repeating this operation several times, to build up confidence that the list is complete.

3.6.20.6.4 Change of database indication

A separate signalling strategy is used to signal changes made to a database. Whenever there is a change in the information content of one list, this is signalled to the receiver by first transmitting a "Change Event Indicator" (CEI), comprising a burst of specially-defined short FIGs associated with the affected key. After the CEI, the new information is transmitted. The definition of the specially-defined FIG field for each FIG 0 extension is given in table 3.6.20.1. The SIV shall be set to "0" for this function. The signalling of the specially-defined FIG field with SIV = "1" is reserved for future use.

The use of the SIV flag, in conjunction with both normal and specially-defined FIG fields, is shown table 3.6.20B.

Table 3.6.20B: Use of the SIV-flag in conjunction with FIG parameters

FIG parameters	SIV	Action	Functionality
Special values	0	Change event	CEI
	1	Rfu	not defined
Normal values	0	Start of list	SIV
	1	Continuation of list	SIV

3.6.20.6.5 Expected receiver response

When a change to a database is detected, the receiver is expected to look for the start of a list and overwrite the appropriate stored information. Then the rest of the list is accumulated until the receiver is satisfied that the list is complete. Receivers can or can not take notice of the "change event indicator" (CEI) signalling to determine whether a change has been made to a database.

3.6.20.7 Mandatory requirements

3.6.20.7.1 For broadcasting

The SIV flag shall be implemented when any of the features listed in table 3.6.20A are implemented and when any of them support a database (subdivided by a "key") such that the data associated with one key cannot be transmitted within a single FIG. Whenever there is a change made to a database, a CEI (see below) shall be transmitted just before any database change.

3.6.20.7.2 For receiving

The SIV flag shall be decoded when any of the features listed in table 3.6.20A are implemented in order to be able to detect lists of information that exceed what can be transmitted within a single FIG.

3.6.20.8 Operational aspects of broadcasting

3.6.20.8.1 Functional minimum requirements

For a particular feature and for a particular key, the information shall be partitioned into FIGs. The start and continuation FIGs need to be identified and the SIV flag assigned to the FIGs appropriately. All the information transmitted in one FIG shall share the same SIV state. The information shall be transmitted cyclically until the information is no longer valid. When a change is made to a database (including start-up and ending), a burst of the appropriate Change event FIGs should be transmitted.

3.6.20.8.2 Inter-relations with other features

The SIV flag and CEI functionality applies to the following FIGs: 0/6, 0/9, 0/11, 0/18, 0/21, 0/22, 0/23, 0/24, 0/25, 0/27 & 0/30.

3.6.20.8.3 Preferred transport mechanisms and alternatives

The SIV flag is associated with the FIG sub-header (first byte of FIG data field) and FIGs are normally transported in the FIC. However, database features tend to be those that can also be carried entirely in the Auxiliary Information Channel (AIC) (see 3.6.19). During a change event the FIGs transporting the CEIs are expected to remain in the FIC except for keys referring to database information carried entirely within the AIC. In figure 3.6.20 the old information has to be carried entirely in the AIC, if the CEI signalling can also be directed entirely to the AIC. Otherwise, the CEIs have to be transmitted entirely within the FIC.

3.6.20.8.4 Recommendations on contents and real-time aspects

A FIG may contain several sub-fields, each of which are used to encode lists of information associated with different keys. A FIG should contain either any number of specially-defined FIG fields exclusively or normal database information exclusively, but never a mixture of the two. A burst of change event FIGs at rate B over a period of at least six seconds shall be used to signal a "change event". The burst shall always precede the changing of information associated with a key. A timing diagram for the validity and transmission of the CEI and database information is given for a single key (x) in the figure 3.6.20 below.

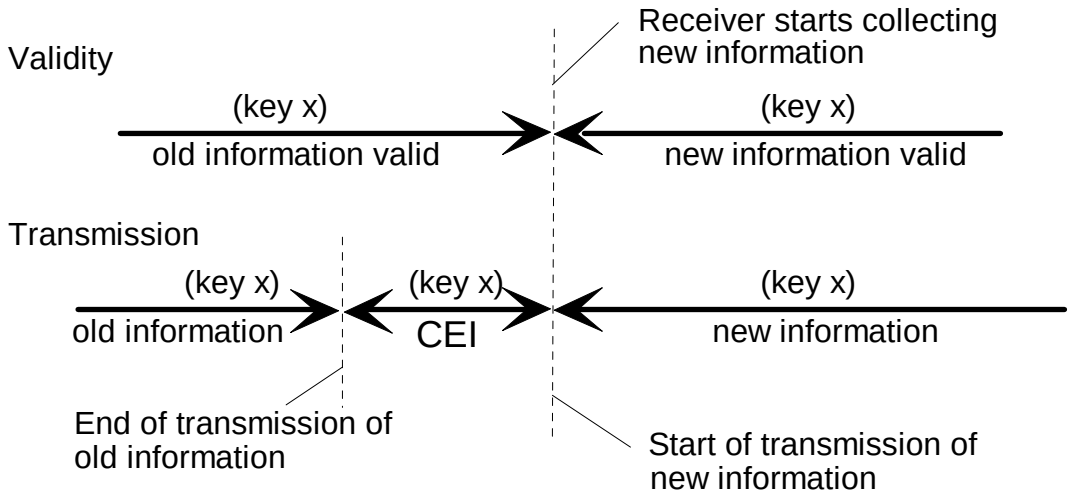


Figure 3.6.20: Validity and transmission of CEIs

From a transmission point of view the transmission of the "old" database information associated with a particular key is stopped at the beginning of the CEI for that key and the new information is sent after the end of the CEI. The transmission of information concerning other keys in the database is unaffected.

3.6.20.8.5 Hints and remarks

Changes to databases should generally only be made infrequently. An exception can be the case of Service linking information, where information can change more frequently than once per hour. When there is a change in the information associated with a particular database, the repetition rate of the newly transmitted information should be increased, for example by up to four times.

3.6.20.9 Receiver implementation aspects

The feature is intended for all types of receiver.

3.6.20.9.1 Functional minimum requirements

When any of the features listed in table 3.6.20.1 are implemented, the receiver is required to maintain the database information. The receiver should monitor changes in this information and keep it updated. Independent parts of each database are identified by a FIG Type 0 extension and a key. For each of these parts, the SIV flag in the FIG sub-header should be decoded in order to detect whether the information is carried in more than one FIG. If so, the "start/continue" functionality should be examined and some strategy adopted to determine whether the complete part of the database has been received correctly.

3.6.20.9.2 Optional extensions and alternatives

The receiver can determine whether a change has been made to a database by one of two methods:

i) watching the relevant FIGs continuously and carrying out a comparison of the information already stored with that being transmitted;

ii) monitoring the "change event" indicator for each part of the database.

When a change is detected for a particular part of a database, the old information should be ignored and the new information built up again from scratch.

3.6.20.9.3 Inter-relations with other features

The SIV flag applies to the following FIGs: 0/6, 0/9, 0/11, 0/18, 0/21, 0/22, 0/23, 0/24, 0/25, 0/27 & 0/30.

3.6.20.9.4 Recommendations on implementation and presentation

Monitoring the "change event" signalling can help to reduce signal processing because, when a change has been detected, the receiver can immediately identify the associated FIG and key. The receiver should wait for the end of the CEI and then start to overwrite the database with the new information. The old database thus remains valid until the end of the CEI. A receiver which does not monitor the change event shall continually carry out a comparison of the database information already stored with that being transmitted. In the case of a change event which is not followed by new information, the receiver should interpret this change event as a withdrawal of information instead of waiting in vain for new information.

3.6.20.9.5 Hints and remarks

Several FIG Type 0 Extensions have either one or two Rfu bits in the FIG sub-header because they have no assigned "OE" or "P/D" flag. For those FIGs that can be governed by the SIV flag, this applies to FIGs 0/9, 0/11, 0/13, 0/18, 0/21, 0/22, 0/25, 0/27 and 0/30, the receiver needs to check such Rfus because if they are defined later, the associated FIG type 0 field can serve a different purpose from that which is defined now.

3.6.21 Transmitter Identification Information (TII) database

3.6.21.1 Introduction

Applications of Transmitter Identification Information (TII) are described in 3.6.11. Additionally TII location **database** information can be signalled in the SI to provide a cross-reference between the TII codes and the geographical location of transmitters. This SI feature is the subject of this TII clause.

3.6.21.2 Purpose of feature

The Transmitter Identification Information (TII) feature signalled in the SI (see 3.6.11) provides a database for cross-referencing the TII codes to the geographical location of the corresponding transmitters, expressed in grid co-ordinates, and for defining the relative delay offset. This information is required for determining the absolute position of a receiver. The TII database feature can help to provide an improved estimate of the receiver's geographical position and driving direction. This improvement can be useful in cases, for example, where a receiver needs to make a decision to re-tune to another frequency and the decision criteria is marginal using the TII list alone.

3.6.21.3 End user of the feature

The receiver.

3.6.21.4 Provider of the feature

The Ensemble providers supply the TII database which contains the location information and signal delays of every transmitter within the SFN of MFN.

3.6.21.5 Involvement of other parties

None.

3.6.21.6 Description

The location of a transmitter is described in terms of its geographical latitude and longitude, in the same way as the output format of GPS (Global Positioning System). The TII database feature is encoded in FIG 0/22 (see [1], 8.1.9). The TII database feature relates the identifiers to the geographic locations and relative time delays of the transmitters. The latitude and longitude information is separated into coarse and fine levels with the coarse level encoded in two's complement format. In this case, the first bit is the sign bit, which is positive for northerly and negative for southerly latitudes and is positive for easterly and negative for westerly longitudes. The following bits describe 90° of latitude and 180° of longitude, respectively. The location reference should be given in terms of the WGS84 geodetic reference.

The M/S flag is used to differentiate between signalling the reference location of the MainId (M/S flag = 0) and signalling the location of transmitters relative to that reference location (M/S flag = 1). The reference location may be sited at a transmitter (in this case, the latitude offset and longitude offset are equal to zero for that transmitter) but need not to be. The maximum offset from the reference location that can be signalled is ±5,625° of latitude and ±11,25° of longitude. Each transmitter has both a MainId and a SubId which correspond to the pattern number and comb number associated with the coding of the TII in the null symbol, respectively (see 3.6.11).

For terrestrial frequency planning, it can be necessary to delay various transmitter signals in order to optimize the combined signal at the receiver. For example, one high power transmitter signal can be delayed relative to other nearby low power transmitter signals. The constant time delay of the various transmitter signals is also signalled in the TII field. For an accuracy of ±0,5 μs and 11 bit data range, the maximum acceptable delay is 2 047 μs.

3.6.21.7 Mandatory Requirements

The Implementation of the TII database feature is optional.

3.6.21.8 Operational aspects of broadcasting

3.6.21.8.1 Functional minimum requirements

All the information about the various transmitters should be transmitted within 2 minutes.

3.6.21.8.2 Inter-relations with other features

The TII database feature provides a better-specified area definition than is possible with only the geographical description in the region definition. This can affect the presentation and use of those features which are location dependent, such as Local service area, FI, Announcement Switching, TMC, and Other Ensembles.

3.6.21.8.3 Preferred transport mechanisms

This information is normally carried in the FIC. However, the AIC may also be used, but the TII database should also be carried in the FIC at a lower repetition rate.

3.6.21.9 Receiver implementation aspects

3.6.21.9.1 Functional minimum requirements

FIG (0/22) shall be decoded.

3.6.21.9.2 Inter-relations with other features

See 3.6.21.8.2 above.

3.6.22 Country, LTO and international table

3.6.22.1 Introduction

3.6.22.1.1 Purpose of the feature

The Local Time Offset (LTO) shall define the Ensemble and/or service associated time offset to the universal time (UTC) encoded in FIG 0/10. In combination with the SId and the EId (which both include the Country identifier) the extended country code (ECC) provides worldwide unique identifiers for the services and ensemble. With the international table information a set of international agreed tables (see reference [1]) is specified.

3.6.22.1.2 End user of the feature

The receiver.

3.6.22.1.3 Provider of the feature

The ensemble provider.

3.6.22.1.4 Involvement of other parties

Service providers for service associated LTO and for ECC. International Bodies for Int. table and Country Id.

3.6.22.1.5 Description

The Country, LTO and international table information is encoded in FIG 0/9 (see [1], 8.1.3.2). The Ensemble ECC is an 8-bit field which together with the EId provides a worldwide unique identification of an ensemble and specifies the validity of the downloaded PTy codes. Within the ensemble it is also possible to assign different ECCs to the services carried in a (multinational) ensemble using the extended field. The LTO describes the Local time offset of the ensemble from the time transmitted in FIG 0/10 in multiples of half an hour. If there are services using a different LTO within the ensemble, the presence of the extended field is used to signal this. The international table specifies the PTy and announcement table used within the ensemble. Every service within the ensemble shall make use of the same table. If the extension field is present (Ext. Flag is set to 1), the Number of services is set to zero and the LTO is set to '0', a change within the transmitted information is signalled (e.g. change from summer to winter time, see also 3.6.20).

3.6.22.2 Mandatory requirements

3.6.22.2.1 For broadcasting

The provision of the country, LTO and international table information is optional.

3.6.22.2.2 For receiving

The response to the country, LTO and international table information is optional.

3.6.22.3 Operational aspects of broadcasting

3.6.22.3.1 Inter-relations with other features

Together with the date and time information (see 3.6.3) the LTO is useful in connection with the Programme Number (3.6.4) feature. The international table is required with the announcement feature (see 3.6.8), the PTy feature (see 3.6.5.1.5) and the PTy preview feature (see 3.6.7.3.1). If PTy codes are downloaded, the ECC is also needed (see 3.6.6). TMC needs Country Id and ECC (see 3.7.2).

3.6.22.3.2 Preferred transport mechanisms and alternatives

The country, LTO and international table information shall be transmitted in the FIC using FIG 0/9, but can also be transmitted in the AIC, if the repetition rate in the FIC shall be reduced.

3.6.22.3.3 Recommendations on contents and real-time aspects

All the Services are associated with the "Ensemble LTO" code unless the Extension flag is set. In this case, the Services listed in the Extension field shall be associated with the LTO code given in the information triplet containing the SId, the specific LTO and the specific ECC.

3.6.23 Service following

3.6.23.1 Introduction

3.6.23.1.1 Purpose of the feature

Service following information provided by the broadcaster enables the receiver to switch to a proper alternative in the case of failing service, disturbed reception, etc.

3.6.23.1.2 End user of the feature.

The mobile receiver.

3.6.23.1.3 Provider of the feature

The ensemble and/or the service provider.

3.6.23.1.4 Other parties involved

None.

3.6.23.1.5 Description

Service following relies on other features like Frequency information, Service linking, Other ensemble services and Region definition. It helps a receiver to find alternatives in the case of disturbed reception and/or failing service. Alternatives can be found within DAB, on FM-RDS or on some other broadcasting systems without control information (like FM without RDS and AM). In table 3.6.23 possible subsets of alternatives are listed with the associated features and needed FIGs.

Table 3.6.23: Sets of possible alternatives

Alternatives on	Condition	used features	FIGs	Priority
DAB	same ensemble on other frequency	Frequency information Region definition	FIG 0/21 FIG 0/11	mandatory optional
	same service within other ensembles	Other ensemble services Frequency information Region definition	FIG 0/24 FIG 0/21 FIG 0/11	mandatory mandatory optional
	hard/soft linked DAB services	Service linking Other ensemble services Frequency information Region definition	FIG 0/6 FIG 0/24 FIG 0/21 FIG 0/11	mandatory mandatory mandatory optional
FM-RDS	PI Code is identical with the SId	implicit hard link Frequency information Region definition	 FIG 0/21 FIG 0/11	 recommended recommended for large lists, else optional
	hard/soft linked PI-Codes	Service linking Frequency Information Region definition	FIG 0/6 FIG 0/21 FIG 0/11	mandatory recommended recommended for large lists, else optional
FM, AM	Dummy Id is identical with the SId	implicit hard link Frequency Information Region definition	 FIG 0/21 FIG 0/11	 mandatory recommended for large lists, else optional
	hard/soft linked Dummy Ids	Service linking Frequency Information Region definition	FIG 0/6 FIG 0/21 FIG 0/11	mandatory mandatory recommended for large lists, else optional

3.6.23.2 Mandatory requirements

All the service following features are optional.

3.6.23.3 Inter-relations with other features

Service following information consists of information carried within the features Frequency Information (see 3.6.10), Service linking (see 3.6.14), OE Services information (see 3.6.12) and the Ensemble/Service identifier structure (see 3.3.1). Additionally regional information (see 3.6.15) can be useful.

3.6.23.4 Operational aspects of broadcasting

3.6.23.4.1 Functional minimum requirements

If the broadcaster wants to give information about alternatives for a particular service/ensemble, at least the mandatory FIGs should be broadcast (see table 3.6.23).

3.6.23.4.2 Optional extensions

Within the Frequency information the additional support of regional and geographical adjacency information helps the receiver to qualify the availability of alternatives.

3.6.23.4.3 Transport mechanism

Service following is intended mainly for mobile receivers and not all of them are able to decode AIC. It is recommended to transport as many of the features listed in 3.6.23.3 as possible within the FIC.

3.6.23.4.4 Recommendations on content and real time aspects

If the same programme is available from other sources, Service following information extends the programme reception area known within the receiver. Thus, the receiver can remain tuned to the same programme for a longer time. This is in the interest of broadcasters and listeners. Therefore, as much Service following information as possible should be given. The best way is to use implicit information (e.g. equal identifier for same ensemble, same programme, for conditions see 3.3.1). Such an implicit relation is always valid independent of the reception conditions. Service linking shall be used if equal identifiers cannot be implemented or the alternative service source is not always available throughout the day. Providing regional information within the Frequency information helps the receiver to select the most regional probable alternatives and therefore a better switching behaviour.

3.6.23.5 Receiver implementation aspects

3.6.23.5.1 Functional minimum requirements

In the case of failing service or disturbed reception the receiver shall, depending on its abilities, first search for 'regular' alternatives shown in table 1.

3.6.23.5.2 Optional extensions and alternatives

The processing of TII and the decoding of regional information can enable a better switching behaviour, if the broadcaster supports regional information. If no 'regular' alternative can be found, the further behaviour is up to receiver.

3.6.24 User Application Information

3.6.24.1 Introduction

3.6.24.1.1 Purpose of the feature

User Application Information is provided to allow data applications to be associated with the correct User Application decoder by the receiving equipment. For example, it is necessary for the receiving equipment to know that the data application in a particular MSC packet data service component is a "MOT Broadcast Web Site" rather than a "MOT Slide Show".

3.6.24.1.2 End user of the feature

The receiving equipment (receiver plus periphery) and the person using it.

3.6.24.1.3 Provider of the feature

The user application provider.

3.6.24.1.4 Involvement of other parties

The provider of the related service (component).

3.6.24.1.5 Description

The User Applications Information (UAI) feature is encoded in extension 13 of FIG type 0 (FIG 0/13). It associates the globally valid identifier for a service component (combination of SId and SCIdS) with a registered application identifier (User Application Type), and also allows a limited amount of application specific information to be signalled. User application signalling has to be in line with the DSCTy/X-PAD Application Type signalling as far as the non-DAB transport protocol is concerned. In fact the change of the DSCTy (multiplex re-configuration) or of the X-PAD Application Type is the most accurate indication of changes in conjunction with the non-DAB transport protocol.
FIG 0/13 supplies the information required to decode a user application for all DAB data transport mechanisms (PAD part of a MSC stream mode audio service component, MSC stream or packet mode data service component or an FIDC service component). When the identified service component is an audio component, the user application data signalled is considered to be carried within the PAD of the audio. Since PAD is assumed to be a multiplex of user applications a number of FIG 0/13 subfields can point to the same audio sub-channel. This signalling, however, does restrict the number of user applications that can be carried in a single PAD channel, to a maximum of twelve. (The restriction is due to the maximum number of bytes available in a single FIG to signal all user applications of one programme service completely).

In addition, there are fundamental limits on the ability of PAD to support multiple applications: PAD can convey several user applications in parallel, but only one single user application of a particular type. This is due to the fact, that at the same time the transport protocol applied by a user application in PAD, is identified by the "X-PAD application type" and that the transport mechanism in PAD allows for one PAD application of a particular type only (see clause 3.2.4.2). So a programme service can have only a single user application "Dynamic Label".

This implies further on, that a particular X-PAD application type (and the corresponding transport protocol) can be used only by a single user application: e.g. a stream of MOT data (identified by the appropriate X-PAD application types) cannot be used by both the "MOT Slide Show" and the MOT Broadcast Website", but only by the one or the other.

FIG 0/13 allows giving an overview over all data applications of the whole ensemble, carried as Programme Associated Data of an audio service component (being part of an audio or data service) or as data service components of audio or data services. FIG 0/13 features the OE and the P/D flag. It doesn't use the SIV flag, which means that for a particular combination of SId and SCIdS each related FIG 0/13 overwrites the previous one. The OE flag enables signalling of data applications transmitted in Other Ensembles. With the P/D flag the distinction between programme and data services is realized and herewith the length of the SId is determined.

3.6.24.2 Mandatory requirements

The provision of User Application Information is mandatory for all data applications.

3.6.24.3 Operational aspects of broadcasting

3.6.24.3.1 Functional minimum requirements

User Application Information is encoded in FIG 0/13. It shall be repeated at repetition rate B. Currently following user applications are defined: Dynamic Label (X-PAD only), MOT Slide Show (see TS 101 499 in bibliography, MOT Broadcast Web Site (see [16]), TPEG (see [15]) and DGPS. A packet mode service component shall carry only one user application. As far as PAD is concerned, a maximum of twelve applications is permitted. However it is recommended that only programme associated user applications are transported in PAD and other applications use (packet or stream mode) service components instead. Moreover applications in PAD cannot be labelled (for service components the service component label exits) and therefore access to these user applications is assumed to be in parallel to the selected audio (see 3.6.24.4, point 3 and 4).

3.6.24.3.2 Optional extensions

With the OE flag it is possible to support receiving equipment with information about user applications currently present in other ensembles. In order to meet the high accuracy requirements a permanently updated overview over the applications, which are carried in the affected other ensembles, should be enabled in one or the other way.

3.6.24.3.3 Inter-relation with other features

The DSCTy signalled with FIG 0/2 or FIG 0/3 and possibly FIG 0/7 and the X-PAD Application Types signalled with the Contents Indicators should be consistent with the User Application Type signalled within FIG 0/13. See also clauses 3.2 and 3.3.6.

EXAMPLE: For a MOT Slide Show the DSCTy (Transport Mechanism: MSC packet data) equals "MOT" (0x3C) and the User Application Type equals "MOT Slide Show" (0x002).

Furthermore the Service Component Global Definition (FIG 0/8) associates the global SCIdS to the ensemble-internal SCId (signalled in FIGs 0/2 and 0/3). See also clause 3.3.7. The language of a data service component (the language of the HTML text for example) can be signalled with FIG 0/5 (Service Component Language). For applications transported within PAD the language description given with FIG 0/5 for the audio should also be valid for the PAD contents. See also clause 3.6.2. The User Application "MOT Slide Show" requires the Date and Time (MJD/UTC) information (FIG 0/10) to be signalled, if TriggerTimes not equivalent to NOW are used. See also clause 3.6.3. For some content with local or regional relevance (visual traffic information, ...) it could be very useful to restrict its validity area by means of the feature Local Service Area (FIG 0/23). See also clause 3.6.16.

3.6.24.3.4 Preferred transport mechanisms and alternatives

When implemented, the User Application Information feature shall be carried in the FIC in FIG 0/13. When the OE flag is set, i.e. for user application information applying to other ensembles re-directing FIG 0/13 to the AIC is allowed – either partly or completely.

3.6.24.3.5 Recommendations on contents and real-time aspects

The "User Application data field" in FIG 0/13 is used for signalling application specific information. Each single User Application itself determines the interpretation of this field. For the user application "MOT Broadcast Web Site" this field would, for example, contain the identifier for the Basic Profile (ProfileId 0x01), if the provider wishes to address the receiving equipment compliant with that profile (here including the so called "Integrated Receivers"). Since the User application "Dynamic Label" doesn't make use of this field, the "User Application data length" is put to "0" for that one. The above mentioned profiles represent a bilaterally agreement between application providers and set makers for what concerns attributes of an application, that application providers can implement and that receiving equipment is able to interpret or to cope with. Examples are topics like image size, memory size, HTML tags and so on. When an application changes, starts or ceases in a particular service component, a new FIG 0/13 with up-dated information should immediately be transmitted in order to prevent unpredictable receiver responses during a potential inconsistency period.

3.6.24.4 Receiver Implementation aspects

3.6.24.4.1 Functional minimum requirements

The receiving equipment shall process and interpret the User Application Information encoded in FIG 0/13 in order to make only applications selectable for which it has all resources available.

It is assumed, that the receiving equipment follows the basic service access philosophy:

1) Aided by a service label, the user first selects a service.

2) The primary service component is presented automatically. The User Application Information provides the information which user application(s) is/are available, how to access the service component and which application decoder has to be started and provided with the service component data.

3) If the receiving equipment has sufficient resources, further service components are presented automatically, too; otherwise a choice (aided by a service component label) has to be offered to the user.

4) If the receiving equipment has sufficient resources, PAD is automatically decoded and presented with its user application(s) in parallel to the selected audio service component.

3.6.24.5 Registered Tables

User Application Information utilizes two tables: The User Application Type table (see table 16 in [20]) which contains the User Application type identifiers and the table of Profiles (see the specification of the concerned application).

3.7 Fast Information Data Channel (FIDC)

The Fast Information Data Channel (FIDC) is a dedicated part of the FIC intended to carry Data applications (service components) with low data rate. The use of the FIC makes it possible to implement "barebones" Data services in simple portable and mobile receivers. It can also be suitable for receivers where power consumption is critical. Receivers can be dedicated to one data application or combined with normal audio applications. The FIDC is formed by FIGs of Type 5. In order to distinguish between different types, the Extension field is used. Furthermore, in order to distinguish between different service components of the same type, a Type Component Identifier (TCId) is used. Together, these form the FIDC Identifier (see [1], 5.2.2.3 and 6.3.1). Service components carried in the FIDC can be scrambled. The following clauses describe the FIDC features so far defined.

3.7.1 Paging feature

3.7.1.1 Introduction

3.7.1.1.1 Purpose of the feature

The Paging feature makes it possible to send a message to an end-user or a group of end-users equipped with special receivers. Messages can be sent directly or by using a pointer. The target receiver type is the portable one (pocket receiver), a receiver for which the main problem is the power consumption. To minimize the power consumption, receivers process the FIC during a short time window lasting only about 1 minute or so. For those receivers which process the FIC at fixed intervals, the transmission of the feature should take into account these receiver limitations. The time window mechanism for different groups of receivers is described in the 3.6.9.4 and illustrated in 3.6.4. The windows indicate when the receiver is active and when the FIC is processed. Between windows receivers can ignore the FIC. The Paging receiver only needs to be active in the "windows" related to its user group and then only FIG (5/0) should be processed. The duration of the window is variable from one group of receivers to another: it can vary between one COFDM symbol period and several thousands of transmission frames. Paging information can be repeated in the same window or in different windows.

3.7.1.1.2 End user

The Paging feature is designed for special receivers.

3.7.1.1.3 Provider

The Service provider shall deliver the message to be sent to the Ensemble provider. The Ensemble provider shall insert the Paging information or the Paging pointer and the associated message at the appropriate place in the appropriate Logical frame.

3.7.1.1.4 Other parties involved

None.

3.7.1.1.5 Description

The Paging feature makes it possible to send a message to an end-user or a group of end-users equipped with receivers able to manage FIDC. To deliver a message to a particular end-user or a group of end-users, this message or the Paging pointer shall be transmitted when the receivers are actively checking the FIC. Two modes have been defined to send a message by Paging features. It is possible to send a message directly in the FIC (D1 flag = "0"). If the message is too long to be carried in one FIG (5/0) it shall be segmented. The segmentation of the message is related to the Service Provider. This is out of the scope of the present document. A scrambling mechanism is defined (see 3.8). For a more sophisticated Paging Service (D1 flag = "1")., it is possible to signal in information carried in the FIC (with the same constraints as mentioned above), how a Paging message can be re-directed to the MSC, using the following parameters:

- Paging pointer is used (D1 flag = "1");
- the sub-channel and the packet address carrying the message (SubChId and Packet address);

- the time of the beginning or the end of the transmission of the message:
  - by frame counter: LFN field indicates the number of the frame from which the broadcast of the service will start (F2 flag = "0") or end (F2 flag = "1");
  - by time (F1 flag = "1", F3 flag = "1"): Time field specifies when the emission of the service component will start (F2 flag = "0") or end (F2 flag = "1");
- the conditions for accessing the message (F1 flag = "1", CAId and SCCA fields) and identifying the end-users (Paging user group field).

3.7.1.2 Operational aspects of broadcasting

These aspects depend on the definition of the complete Service and are partially outside the scope of the DAB specification. These also depend on the kind of receiver addressed:

a) Broadcasting to receivers processing the FIC in continuous manner

in this case, the Paging messages may be transmitted in the FIC or redirected in the MSC at any time

b) Broadcasting to low power consuming receivers

in this case, the Paging messages shall be transmitted in such a way as to take into account the limited FIC processing potential (see 3.6.9.4).

3.7.1.2.1 Functional Minimum Requirements

Paging is optional. When implemented, in relation with the Service provider, the Ensemble provider shall insert the Paging message or pointer in the FIC or the associated message in the MSC at the appropriate place in the appropriate Logical frame(s) (see [1], 8.2.1). For a Service user group, a Paging pointer signalling the beginning of a message, shall be sent in advance. In some cases, the signalling of the end of a Service is not necessary. This is the responsibility of the Service provider. If Paging pointer is signalled and the time value is set to "0", or is absent, and if the LFN parameter is set to "1FFF", the transmission of the indicated Service is considered to have just started or ended.

3.7.1.2.2 Preferred Transport Mechanisms and Alternatives

The Paging message should be carried in the FIC. Alternatively the Paging pointer may be carried in the FIC and the message in the MSC. This choice is the responsibility of the Ensemble provider in co-operation with the Service Provider (because it could be linked to the targeted receivers). For the receivers which only process just the FIC regularly, the Paging message shall be carried in the FIC only.

3.7.1.3 Receivers Implementation Aspects

3.7.1.3.1 Functional Minimum Requirements

Paging is optional. When implemented, the receiver shall process at least the FIG 5/0. If the associated message is carried in the MSC, the receiver shall process the MSC during the time period indicated in the Paging pointer to get the message. For a Service user group, a Paging pointer signalling the beginning of a Service, shall be received in advance.

3.7.1.3.2 Optional Extensions

None.

3.7.1.4 Vital interaction between Service provider and Ensemble provider

There is a strong relation between the Service provider and the Ensemble provider because of the need to insert the Paging message or the Paging pointer into the FIC at the appropriate frame and to follow the indication of the Paging pointer to insert the associated message in the MSC. The targeted receivers can be negotiated in co-ordination in order to choose the preferred transport mechanism.

3.7.2 TMC

3.7.2.1 Introduction

3.7.2.1.1 Purpose of the feature

The Traffic Message Channel (TMC) is used to deliver coded traffic messages in a (bitrate) efficient way. The used transport protocol for DSCTy = '000001' is TMC-"ALERT-C".

3.7.2.1.2 End user of the feature

TMC messages are intended for dedicated decoders, which perform a selection of the relevant messages and transform them to human-intelligible output, e.g. by a display or a speech synthesizer.

3.7.2.1.3 Provider of the feature

The messages are usually provided from different sources (such as a traffic authority or the police) and are collected in a central place (e.g. a computer). Then they are fed to the (TMC) Service provider.

3.7.2.1.4 Involvement of other parties

The Service provider can edit the messages received from the central place.

3.7.2.1.5 Description

TMC messages are split into user messages (messages which carry the actual traffic data) and system messages (messages which carry meta-data, e.g. table numbers).

3.7.2.2 Mandatory requirements

The implementation of the TMC feature is optional.

3.7.2.3 Operational aspects of broadcasting

3.7.2.3.1 Functional minimum requirements

The implementation of both user and system messages is required.

3.7.2.3.2 Inter-relations with other features

For decoding TMC the Date and Time (see 3.6.3), CountryId (see 3.3.1) and ECC (see 3.3.8) has to be known. Therefore, transmitting these is mandatory if TMC is sent.

For TMC service following the Frequency Information and the Other Ensemble Services shall be provided.

A TMC service can be enhanced when used in combination with the Regional Identification feature (see 3.6.15). If TMC messages are sent it is recommended that geographical co-ordinates are supplied within the region feature (GATY=0001) to enable a receiver to map the TMC provided regions onto DAB-provided regions.

TMC could be much more effectively implemented if the position of the receiving vehicle and its driving direction were known from the TII (see 3.6.21). This would allow TMC decoders to automatically select messages which are relevant within the locality. If a service has a secondary TMC component on one ensemble it is recommended to provide this component on all ensembles the service is being broadcast in (see 3.3.1).

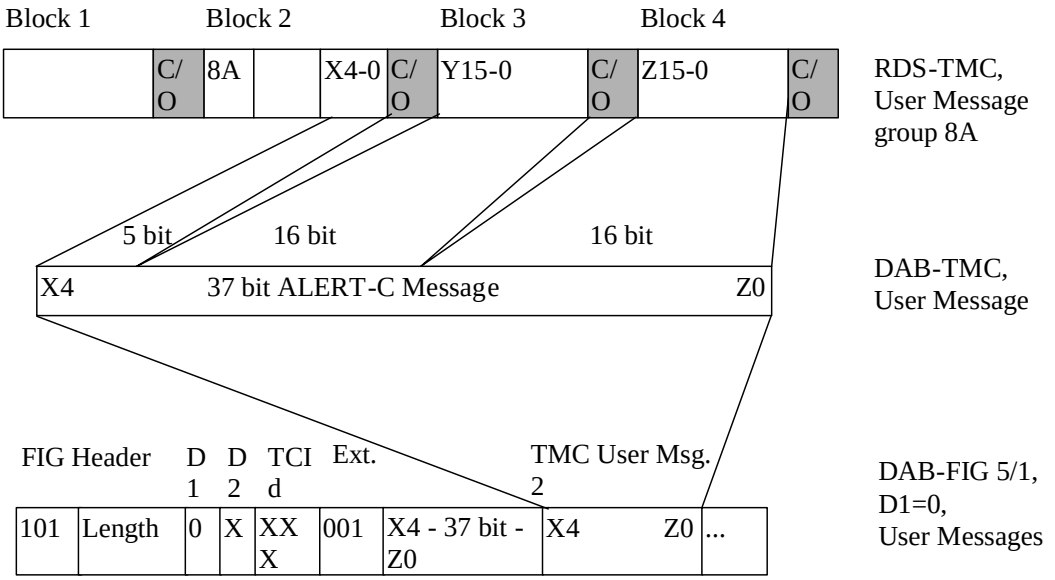
3.7.2.3.3 Preferred transport mechanisms and alternatives

TMC messages are carried in the FIDC using FIG (5/1). User messages use D1=0 and System messages use D1=1.

3.7.2.3.4 Recommendations on contents and real-time aspects

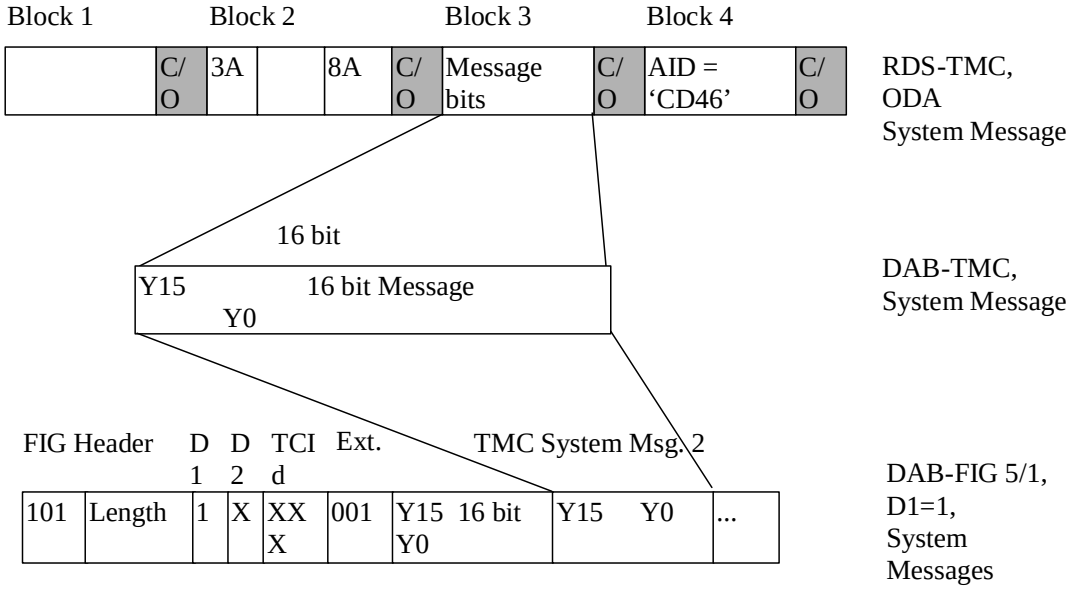
TMC is defined for the DSCTy 000001. TMC user messages (37 bits long) are encoded as described in the "ALERT-C" protocol [9], [10], [11], which is also used for RDS-TMC (see EN 50067 [22]). TMC system messages (16 bits long) using the DSCTy entry 000001 are encoded according to the message bits of the TMC-RDS specification. These message bits are taken from the ODA feature of the RDS specification EN 50067 [22] for AID equals "CD46" (TMC, ALERT-C). As the TMC feature is adopted from RDS-TMC, it is important to know how those messages are built from the RDS-TMC messages:

User Messages



NOTE: Although RDS ODA Group 8A is used for this example, it is possible for other Group types to be used for TMC. For the use of D2 and TCId see 3.7.

System Messages



NOTE: Although RDS ODA Group 8A is used for this example, it is possible for other Group types to be used for TMC.

If a Service Component Label is provided for a TMC service component, it should be identical to the Service Provider Name defined in TMC. If TMC is the one and only component, the Service Label should be identical to the Service Provider Name defined in TMC. TMC system messages, which are specifically intended to support RDS-TMC (such as tuning information) can be omitted in DAB. The validity and order of the TMC messages should be adopted from RDS-TMC as TMC was originally designed to work with RDS. The direct repetition of TMC messages (used in RDS for error detection) is not needed in DAB and is therefore optional. Multi-group TMC messages can be grouped together into one FIG. However, the Cycle Management should be adopted from the ALERT-C specification.

3.7.2.4 Receiver implementation aspects

3.7.2.4.1 Functional minimum requirements

Both system and user messages should be decoded.

3.7.2.4.2 Inter-relations with other features

Decoding the Date and Time (see 3.6.3), CountryId (see 3.3.1) and ECC (see 3.3.8) is necessary for correct decoding of TMC. For TMC service following the Frequency Information (see 3.6.10) together with the Region feature (see 3.6.15) and the Other Ensemble Services (see 3.6.12) can be used. The Region Identification and the TII database features can be used for filtering TMC messages. Moreover, if the co-ordinates are supplied with the region feature (GATY=0001) and a database exists for the TMC location database with co-ordinates supplied, those co-ordinates can be mapped automatically and the appropriate DAB region can be chosen for filtering. Moreover, if the current receiver position is known from the TII, TMC messages can be filtered automatically.

3.7.2.4.3 Recommendations on implementation and presentation

Traffic Messages, decoded from TMC, can be displayed or offered to the listener via a speech synthesizer. TMC messages which are specifically defined for RDS-TMC (e.g. tuning information, service information) may not be useful for a DAB-receiver. They can either be passed on from the DAB part to the RDS part or be ignored on the DAB side. The TMC Service Provider Name can be found in the Service Component Label (if available) or as fallback (if TMC is the one and only component and no Service Component Label is available) in the Service Label.

3.7.3 Emergency Warning Systems (EWS)

3.7.3.1 Introduction

3.7.3.1.1 Purpose of the feature

Emergency Warning Systems (EWS) provide coded messages and control information in the case of emergencies. These messages are intended for dedicated receivers only. The details of the coding and operation are not subject to standardization but remain confidential within the group of users of the system (often government authorities).

3.7.3.1.2 User of the feature

EWS messages are intended for dedicated decoders.

3.7.3.1.3 Provider of the feature

EWS messages are usually provided by the authority operating the system.

3.7.3.1.4 Involvement of other parties

Authorities wishing to implement EWS will need to negotiate with the Ensemble provider regarding its implementation and operation.

3.7.3.2 Mandatory requirements

The implementation of the EWS feature is optional.

3.7.3.3 Operational aspects of broadcasting

3.7.3.3.1 Functional minimum requirements

These requirements depend on the actual purpose of the individual EWS.

3.7.3.3.2 Optional extensions

These options depend on the actual purpose of the individual EWS.

3.7.3.3.3 Interrelations with other features

These features depend on the actual purpose of the individual EWS. It could be assumed that some implementations of EWS rely on the DAB frame counter or the TII feature. No other features depend on EWS.

3.7.3.3.4 Preferred transport mechanism and alternatives

EWS messages should be carried in the FIDC, because they are intended for dedicated receivers which do not decode the MSC (because low power consumption can be a crucial point for these receivers). In cases where power consumption is not important, EWS messages may also be carried in the MSC in a Stream or Packet mode sub-channel.

3.7.3.3.5 Recommendation for contents and real-time aspects

These requirements depend on the actual purpose of the individual EWS.

3.7.3.4 Receiver implementation aspects

Dedicated receivers are used for EWS.

3.8 Conditional access

3.8.1 Introduction

Digital broadcast services can require conditional access for several reasons. The primary purpose of a CA system for broadcasting is to determine which individual receivers shall be able to deliver the particular services to the user. DAB provides an unsecure addressing mechanism based on end user address which can be used for addressing specific mechanisms (i.e. receiver software updates). For services needing secure access control mechanisms the tools are described within this clause. Some of the reasons why access control is needed need to be restricted include:

- Payment. To introduce new services on a commercial base, a mechanism that exclude users that do not pay for the services is required.
- Intellectual and proprietary rights. A service provider that has bought the rights to use a material for a specific event must be able to show how many users that have been able to access the content.
- Confidentiality. The system shall guarantee that vital information intended for a specific user group shall not accessible by others.
- Parental control. To restrict access to certain categories of services.
- Geographical black out. Geographical restrictions due to legal and intellectual propriety reasons. This feature could be useful for satellite broadcasting.

3.8.1.1 Overview of the conditional access system tools

The Conditional access system compromises three major tools, scrambling, control and management.

a) scrambling: The scrambling process should render the service components unintelligible for unauthorized users by adding a true random sequence of bits to the data. The scrambler is a device that produces a very long pseudo random sequence which looks like a true random sequence. The operation of the scrambler is controlled by a key called Control Word, CW, that sets the scrambler in a well-defined state.

b) control operation: The function consists of broadcasting the conditions required to access a service, together with the encrypted parameters enabling the descrambling by authorized receivers. These messages are called ECM, Entitlement Checking Messages. An ECM contains a cryptogram containing of the CW with the access conditions required to before scrambling the service component. The ECMs are sent to all receivers, synchronized with the scrambled components in the same multiplex. Each receiver extracts the ECMs, sends them to the security processor which checks the entitlements and computes the CW if authorized. The ECMs are sent together with the scrambled data to which it refers

c) management operation: The management function consists of distributing entitlements to receivers. The messages are called EMM, Entitlement Management Messages. An EMM contains entitlements or new keys to the receivers. The EMMs are non- real time messages and can be sent to the intended receivers in the same multiplex as the scrambled service component or by any other media i.e. Smart Cards.

3.8.1.2 Operation of conditional access within the DAB specification

The DAB specification does not specify a complete conditional access system but provides a toolbox for handling different conditional access systems. Several parameters are specified for signalling to the receiver, whether the data is scrambled or not, where the Entitlement Checking Messages (ECMs) and Entitlement Management Messages (EMMs) are found, how the de-scrambler is to be initialized and how an access control transition (for example, a switch from scrambled to unscrambled mode) can be performed. These parameters are described below:

- the **Conditional Access identifier (CAId)** and **Conditional Access (CA) flag** are carried with all Service components, even those which are not access controlled;

- the **Service Component Conditional Access (SCCA) field** is used for access controlled Service components independently of the transport mechanism used (except for some particular Service components in FIDC);

- the **Fast Information Data Channel Conditional Access (FIDCCA)** and its extension **(FIDCCA_Ext)** are extra parameters which can be used for access controlled data sent in the FIDC;

- the **Data Group Conditional Access (DGCA)** is an extra parameter which can be used for access controlled data sent in packet mode or PAD.

The DAB multiplex is designed to transport a great variety of service components having very different characteristics and requirements. Each of the following transport mechanisms make use of specific scrambling parameters:

- Stream mode for audio or data;

- Program associated data (PAD);

- Packet mode for data such as a file sent at variable bit rates;

- Fast Information Data Channel (FIDC) for low bit-rate data, such as a Paging Service in a time-windowed transmission.

Some transport mechanisms allow the scrambling operation to be performed at two different locations, with or without logical frame counter. A signalling mechanism is specified to signal which location is appropriate. It is not allowed to scramble a service at both locations. Moreover, in order to offer complete flexibility, several possibilities are offered for inserting the ECMs and EMMs in the multiplex. These messages can be sent in the FIC, in Sub-channel 63 or in the same Sub-channel as the component. Each of these possibilities is specifically signalled.

3.8.1.3 Scrambling operation

The scrambling/de-scrambling process uses a Pseudo Random Binary Sequence (PRBS). This PRBS is generated by a PRBS generator and is added modulo 2 with the Service component data bits as shown in the figure 3.8.1.

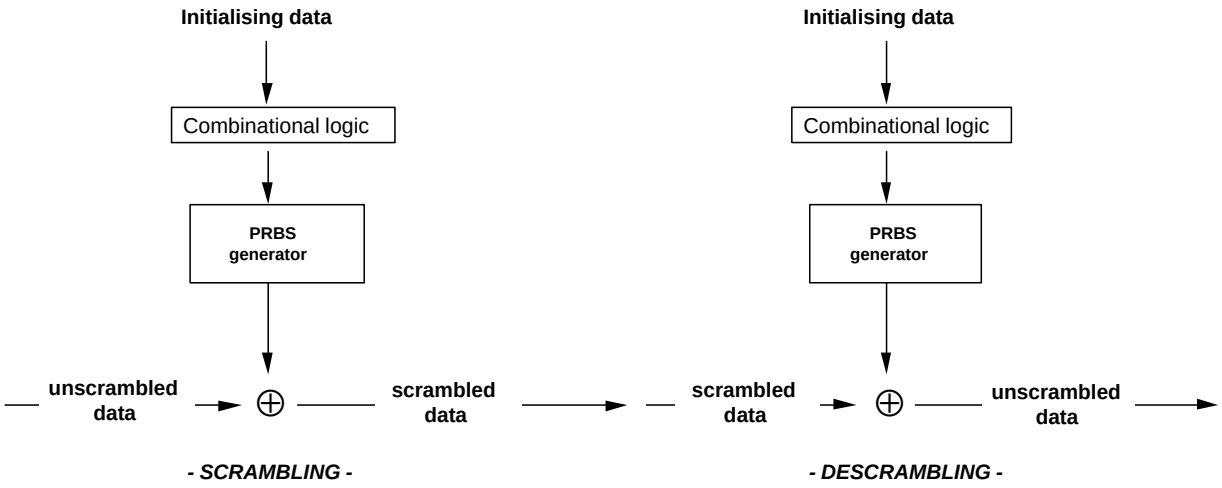


Figure 3.8.1: Scrambling and de-scrambling operations

When initialized, the PRBS generator outputs pseudo-random bits over a very long period (the period of the sequences output by modern PRBS generators exceeds 10^{35} bytes). The sequences generated from two different initial states are completely unrelated to each other. The initial state of the PRBS generator results from a combination of secret and public parameters making most unlikely the possibility of having two identical initial states. The PRBS sequence is added modulo-2 to the sequence of bits of the Service component having the same length. This sequence of bits is called the "Scrambled unit" (for example, a packet payload). In order to allow correct operation of the scrambling/de-scrambling process, the PRBS at the Scrambler and the PRBS at the De-scrambler shall be the same and shall be applied to the whole Scrambled unit. This means that the Scrambler and the De-scrambler share the same CW, IM and Scrambled unit boundaries. The initializing data comprise a control word (CW) and an initialization modifier (IM). The control word is a secret parameter known only by the Scrambler and authorized De-scramblers. It needs to be sufficiently long and changed sufficiently frequently to avoid any exhaustive research (the period of time during which a CW is constant is called a CW-phase). The IM is a public parameter evolving very fast (typically, at each new Scrambled unit), enabling a fast synchronization of the PRBS generators of the Scrambler and he De-scrambler. In most of the cases, the CW is transmitted in an encrypted form in the ECM (in a few cases, it can be a local CW known at both transmitter and receiver). The security device at the decoder (generally a Smart card) requires a few hundreds of milliseconds to decrypt the CW. This is why, the ECM often carries two CWs: the "current" CW and the "future" CW. In practice, each CW and each CW-phase is allocated one of two parities. The "even" CW is used during an even CW-phase and an "odd" CW is used during an odd CW-phase. The value of the CW is changed at the beginning of each CW-phase. (See figure 3.8.2)

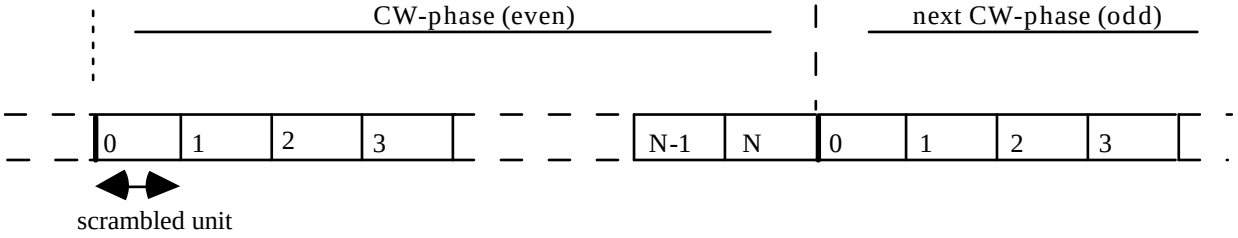


Figure 3.8.2: CW phases

Therefore, in order to be able to recover the correct CW, the decoder needs to know the ECM and the parity of the current CW-phase. The scrambler defined for DAB is defined in ETS 300 174 (Decoding of component television signals for contribution quality applications in the range 34 Mbit/s to 45 Mbits/s).

3.8.1.4 General Restrictions

DAB specifies only the frame format work for EMM and ECM but dose not specify the fields. A service should not be scrambled twice even if it is possible.

3.8.1.5 Conditional Access configurations

To access a Service component, the decoder first has to know whether the component is subject to CA or not. This is the role of the CA flag and CAId parameters. If the component uses CA, the decoder needs to recover all the additional CA control information. In addition to the CA parameters, this includes the ECM, CW phase parity, IM and the Scramble unit boundaries. In general, the Scrambling mode (unscrambled, use of CW local, use of ECM) together with a change between one of these modes, or any other CA transition, has to be signalled (for example, a change of ECM pointer, change of access condition) (see s 3.8.3, 3.8.4 and 3.8.5 for more details). Three different signalling Configurations are defined and can be used independently on each Service component. This signalling also depends on the transport mode. The following tables 3.8.1 to 3.8.3 summarize how the CA control information are transported for each of the three configurations and for each transport mode.

3.8.1.5.1 CA signalling Configuration 1

This configuration applies for a Service component with the first byte of SCCA ≠ "00000000". Table 3.8.1 indicates how the CA information are carried for each transport mechanism using CA signalling Configuration 1.

Table 3.8.1: Transport of CA parameters in Configuration 1

	Stream mode	Packet mode	FIDC
CA parameters	MSByte of SCCA	MSByte of SCCA	MSByte of SCCA
ECM	LSByte of SCCA gives a pointer to the ECM	LSByte of SCCA gives a pointer to the ECM	LSByte of SCCA gives a pointer to the ECM
CW-phase parity	Bit b8 of logical frame number	Bit b8 of logical frame number	Bit b8 of logical frame number
IM	Combination of (bits b7..b0 of logical frame count + 2 bits "00" + 6 bits SubChId)	Combination of (bits b7..b0 of logical frame count + 2 bits "00" + 6 bits SubChId + 8 bits number of the packet in the sub-channel)	Combination of (bits b7..b0 of CIF counter + 2 bits "00" + 6 bits FIDCId + 8 bits number of the FIG type 5 in the FIC)
scrambled unit boundaries	All bytes within a logical frame	Packet data field	FIG type 5 field

3.8.1.5.2 CA signalling Configuration 2

This Configuration applies for a Service component with first byte of SCCA = "00000000" and second byte of SCCA ≠ "11x00000". Table 3.8.2 indicates how the CA information are carried for each transport mechanism using CA signalling Configuration 2.

Table 3.8.2: Transport of CA parameters in Configuration 2

	Stream mode	Packet mode	FIDC (with FIDCCA)	FIDC (with FIDCCA_Ext)
CA parameters	Configuration 2 is not allowed for data in Stream mode	Bits b2..b0 of DGCA	Bits b2..b0 of FIDCCA	Bits b10..b8 of FIDCCA_Ext
ECM		LSByte of SCCA gives a pointer to the ECM	LSByte of SCCA gives a pointer to the ECM	Bits b7..b0 of FIDCCA_Ext give a pointer to the ECM
CW-phase parity		Bit b3 of DGCA	Bit b3 of FIDCCA	Bit b11 of FIDCCA_Ext
IM		Bits b15..b6 of DGCA + 6 bits set to 0	Bits b15..b6 of FIDCCA + 6 bits set to 0	Bits b23..b14 of FIDCCA_Ext + 6 bits set to 0
Scrambled unit boundaries		MSC data group data field	FIG type 5 field starting after FIDCCA	FIG type 5 field starting after FIDCCA_Ext

3.8.1.5.3 CA signalling Configuration 3

This Configuration applies for a Service component with first byte of SCCA = "00000000" and second byte of SCCA = "11x00000". It exists only for data in Packet mode. Table 3.8.3 indicates how the CA information are carried for each transport mechanism using CA signalling Configuration 3.

Table 3.8.3: Transport of CA parameters in Configuration 3

	Stream mode	Packet mode	FIDC
CA parameters	Configuration 3 is not allowed for data in Stream mode	bits b2..b0 of DGCA	Configuration 3 is not allowed for data in FIDC
ECM		Same packet address as the Service component	
CW-phase parity		bit b3 of DGCA	
IM		bits b15..b6 of DGCA + 6 bits set to 0	
scrambled unit boundaries		MSC data group data field	

3.8.1.6 Relations between CA signalling configurations and ECM/EMM transport mechanisms

Table 31 in [1] defines five mechanisms for ECM/EMM transport inside a DAB Ensemble. Signalling is provided to define which mechanism applies for each access controlled Service component, by using the LSByte of SCCA or the LSByte of FIDCCA_Ext. Table 3.8.4 gives the relation between the CA signalling configurations described above and the five possible ECM/EMM transport mechanisms which are presented in table 31 in [1].

Table 3.8.4: CA configurations and allowed ECM/EMM transport mechanisms

CA signalling Configuration	Config. 1	Config. 2	Config. 3
Transport mechanism that can use this CA configuration	Stream, Packet, FIDC	Packet, FIDC	Packet
Allowed ECM/EMM transport mechanism	Cases 1, 2 and 3	Cases 1, 2 and 3	Cases 4 and 5

It could happen that the EMMs are distributed by other media, mail or new smart cards for instance. This case is not clearly defined in the ETS which always declares a EMM channel associated with the scrambled service component. The only solution is to declare an EMM flow that will never contain EMM. This is not a problem, except if it forces the receiver to decode one sub-channel uselessly. Among the different possibilities to send ECM and EMM, all can be used, except case 2 (ECM in FIC and EMM in SubCh63) and case 5 (ECM in component and EMM in SubCh 63).

3.8.2 Conditional Access Identifier and Conditional Access flag

3.8.2.1 Introduction

3.8.2.1.1 Purpose of the features

The CAId parameter identifies the Access Control System (ACS). An ACS is a device, partly inside and partly outside (e.g. smart card) the receiver, which is used to process all access control features. So far, two ACSs are defined (EUROCRYPT and NRMSK). The CAId allows the direct identification of five other access control systems. The CA flag is a one-bit flag indicating whether a Service component uses access control mechanisms or not. The CAId and CA flag allow the receiver to discover very quickly whether the Service and its associated Service components use access control mechanisms and, if so, which ACS is used. Even receivers without CA capability shall analyse the CA flag of each Service component. If the CA flag indicates that the Service component uses access control mechanisms, these receivers can choose to mute the Service component or make it non-selectable. The receiver can implement one or more ACSs for processing the access control messages (ECMs and EMMs). Each ACS is associated with a CAId and, by trying to match received CAIds with those known to it, the receiver is able to select which scrambled Services can be de-scrambled and those which can not.

3.8.2.1.2 End user of the features

The end-user is that part of the receiver dealing with access control.

3.8.2.1.3 Provider of the features

Each access controlled Service shall be allocated a CAId by the Service provider (when scrambling is performed at the source side) or by the Ensemble provider (when scrambling is performed at the multiplex side).

3.8.2.1.4 Involvement of other parties

For new CA systems which have no defined CAId, new CAId codes shall be allocated at an International level by the appropriate broadcasting authorities, for example European Broadcasting Union (EBU) in Europe.

3.8.2.1.5 Description

The CAId can be found either in the header of an access control message (ECM or EMM) in the Service organization (FIG 0/2), in the Service Component Trigger (FIG 0/20), in the OE Services (FIG 0/24) or in the Paging feature (FIG 5/0). When located in the header of an access control message, it identifies the ACS which has to be used by the decoder to interpret and process the message. When located in the Service organization information, it identifies the ACS which has to be used by the receiver for controlling access to the Service. If no access control feature is used for all the components of that Service, CAId is set to zero. If at least one component of the Service is access controlled, the CAId parameter identifies the ACS used. The CAId parameter acts at the service level. This means that two components of a same Service can not use different ACSs. So far, two codes are defined: "001" for the NRMSK ACS and "010" for the Eurocrypt ACS. Other codes are reserved for future use. The CA flag is a one bit flag located in the Service component information. CA flag = "0" means that the Service component does not use an access control mechanism. CA flag = "1" means that the Service component can use access control mechanisms. CA flag = "1" does not necessarily mean that the Service component is always scrambled: it can be unscrambled for short periods. However, in this latter case, access to the Service component can not be guaranteed by all receivers. Whether the Service component is scrambled or not is indicated in real time in the scrambling mode field of the SCCA, DGCA or FIDCCA parameter associated with the Service component.

3.8.2.2 Mandatory requirements

3.8.2.2.1 For broadcasting

The CAId parameter is mandatory in the Service organization information carried in FIG (0/2). The CA flag is mandatory in the Service component information carried in FIG (0/2). If conditional access is not implemented for a Service, the CAId = "0" in the Service organization information and the CA flags of all the components of that Service shall be set to "0".

3.8.2.2.2 For receiving

All receivers shall check the CA flag. Receivers with no conditional access facilities shall process Service components with the CA flag = "0". All access controlled audio Services which cannot be de-scrambled by the receiver shall be muted or not selectable.

3.8.2.3 Operational aspects of broadcasting

3.8.2.3.1 Functional minimum requirements

When conditional access mechanisms are used, the CAId parameter is mandatory in the header of each ECM and EMM. The CAId and CA flag are carried in (FIG 0/2) and shall be transmitted at repetition rate A.

3.8.2.3.2 Optional extensions

The CAId parameter is sent in the Other Ensembles Services feature carried in FIG (0/24). The CAId parameter is optional in the Service trigger information, carried in FIG (0/20), and in the Paging feature FIG (5/0) where its presence depends on the value of bit F1.

3.8.2.3.3 Inter-relations with other features

The CAId and CA flag are used in combination with the following other access control signalling features: SCCA, FIDCCA and DGCA (see 3.8.3 to 3.8.5). These are used to guide the decoder in the entitlement checking and de-scrambling processes.

3.8.2.3.4 Preferred transport mechanisms and alternatives

The receiver shall determine quickly whether it is able to decode the Service and to process the conditional access message. This is why the CAId parameter is sent in the FIC and in the very first location of all conditional access messages.

3.8.2.3.5 Default contents in the event of failing service

There is no substitute for the CAId and CA flag information.

3.8.2.4 Receiver implementations aspects

3.8.2.4.1 Functional minimum requirements

Receivers with conditional access facilities (supporting at least one ACS) shall analyse CAId and should process all the access controlled Service components with a CAId matching the CAId of the ACS (provided that the user has the correct entitlement). Concerning the access control messages, those receivers which support an ACS, require a filter mechanism (hardware or software) in order to select those messages which can be processed by the ACS. Indeed, the ACS has a limited processing capability and cannot deal adequately with all incoming messages. Furthermore, most messages are not intended to the ACS, either because they are repeated messages already processed by the receiver, or because they are addressed to an ACS which is not present in the receiver. It should be noted that other parameters need to be filtered at the same time, such as the Toggle bit, the ECMId or the address field for the EMMs.

3.8.2.4.2 Recommendations on implementation and presentation

The filtering of the conditional access messages shall be performed in real-time by the receiver. This implies that if the bit-rate allocated for the ECMs and EMMs is too high, only a hardware filter will be able to perform that function.

3.8.2.4.3 Fall-back in the event of failing service

There is no substitute for the CAId and CA flag information. In case a problem occurs in the FIC, the receiver should continue to operate with the last CAId and CA flag values received for each Service. If the value of the CAId for one Service changes suddenly, the receiver should wait for two other received CAId parameters before changing its access control policy. If, after several transmissions of Service and Service component information, CAId = "000" for a Service and one Service component has CA flag set to "1" (this should never occur), then the receiver should not decode the component.

3.8.3 Service Component Conditional Access (SCCA)

3.8.3.1 Introduction

3.8.3.1.1 Purpose of the feature

The SCCA parameter is a 16-bit code which is mandatory for each access-controlled Service component (except some Service components sent in FIDC). It indicates which CA signalling configuration is used and provides all signalling information allowing the de-scrambling of the Service component and the switching of access conditions.

3.8.3.1.2 End user of the feature

The end-user is that part of the receiver dealing with access control.

3.8.3.1.3 Provider of the feature

The provider of the feature is the Ensemble provider receiving its instructions from the scrambler.

3.8.3.1.4 Description

The content of SCCA depends on which one of three CA signalling Configurations is used (the choice for this depends on the location of the scrambler). The three Configurations allow scrambling for different data packages, referred to as "Scrambled units". A scrambled unit is a string of bytes which is scrambled with a pseudo-random binary sequence (PRBS) output by a PRBS generator. This generator is initialized at the beginning of the scrambled unit and keeps on running until reaching the end of the scrambled unit. When scrambling is performed after the building of the Logical frames (Configuration 1), the scrambled unit is the sub-channel for data in Stream mode, the Packet data field for data in Packet mode and the FIG 5 field for data in the FIDC. When scrambling is performed after the building of the Data groups and before assembly into packets (Configurations 2 and 3), the Scrambled unit is the MSC data group data field. The difference between Configurations 2 and 3 depends on how the ECMs are transmitted. In Configuration 2, the ECMs are carried either in the FIG 6 or the sub-channel 63. In Configuration 3, the ECMs are carried in the same Sub-channel as the Service component. The first byte of SCCA = "00000000" in the case of Configurations 2 and 3. In the case of Configuration 1, it contains the scrambling mode and the updating flags. The second byte of SCCA indicates where to find the ECMs and the EMMs of the Service component. There are five possibilities:

- ECMs and EMMs in FIG (0/6);
- ECMs in FIG (6/0) and EMMs in SubCh 63;
- ECMs and EMMs in SubCh 63;
- ECMs and EMMs in the same SubCh as the Service component;
- ECMs in the same SubCh as the Service component and EMMs in SubCh 63.

3.8.3.2 Mandatory requirements

3.8.3.2.1 For broadcasting

This feature is mandatory only when conditional access mechanisms are used (i.e. CAId ≠ "000" and CA flag = "1").

3.8.3.2.2 For receiving

Receivers with access control capabilities shall extract and analyse the SCCA parameter.

3.8.3.3 Operational aspects of broadcasting

3.8.3.3.1 Functional minimum requirements

The transmission of the SCCA parameter is mandatory for each access controlled Service component, except some Service components sent in FIDC which can instead use the FIDC_Ext parameter (e.g. Paging). Moreover, for Service components scrambled in Configuration 1, the transmission of SCCA shall be synchronized with the component data because the validity of the information in SCCA is limited to a few Logical frames only (16 frames maximum). This constraint is due to the updating information sent in SCCA. Indeed, when an update is signalled, it has to be taken into account when the 4 LSbits of the Logical frame counter = "0000". The SCCA parameter contained in FIG (0/20) and FIG (5/0) is repeated with the same rules as these FIGs. The Service provider shall manage the scrambling and access control transitions without affecting the reception of the component for those users who have valid entitlements. For this purpose, the Service provider uses the four updating flags according to the rules given in annex E. The major access control transitions are the following:

- switching of a component from unscrambled to scrambled with local control word or with a control word transmitted in ECMs;
- switching from scrambled with local control word or with a control word transmitted in ECMs to unscrambled;
- changing the access conditions of a component;
- changing the organization of a component and its access conditions:
  - grouping of two or more components with different access conditions using the same access condition of one of the components;
  - separation of the access conditions for two or more components, one of them preserving the initial access condition;
  - regrouping of two or more components with different access conditions on a new access condition;
  - separation of the access conditions for two or more components, with change of access condition for both components.

3.8.3.3.2 Inter-relations with other features

The SCCA parameter is used in conjunction with CAId, CA flag, DGCA and FIDCCA. The SCCA parameter is valid and should be sent only if, for the Service component, CAId ≠ "000" and CA flag is equal to "1". When the first byte of SCCA is equal to "0", the receiver knows that the signalling information has to be fetch in DGCA at the beginning of each data group or in FIDCCA at the beginning of each FIG.

3.8.3.3.3 Preferred transport mechanisms and alternatives

The SCCA parameter is sent in FIG (0/3) - Service component in Packet mode, FIG (0/4) - Service component in Stream mode, in FIG (0/20) - Service trigger and in Fig (5/0) with D1="1" - Paging pointer. The SCCA parameter in FIG (0/3) and FIG (0/4) should be sent at repetition rate A in order to reduce the acquisition time.

3.8.3.3.4 Recommendations on contents and real-time aspects

See annex E for the management of the access control transitions.

3.8.3.3.5 Default contents in the event of failing service

There is no substitute for the SCCA parameter.

3.8.3.3.6 Hints and remarks

For Paging data FIG (5/0) with D1 = "0", the use of Configuration 2 with FIDCCA_Ext is preferred to the use of Configuration 1 with SCCA. Indeed, Paging receivers need direct and simple access to the information requested, without analysing the Service organization information. In this case, SCCA is not used.

3.8.3.4 Receiver implementations aspects

3.8.3.4.1 Functional minimum requirements

SCCA shall not be interpreted by the receivers for component without access control (CAId = "000" and/or CA flag = "0"). The receiver should manage the scrambling and access control transitions without affecting the reception of the component for those users who have valid entitlements. For this purpose, the receiver handles the four updating flags according to the rules given in annex E. The major access control transitions are described in 3.8.3.3 above.

3.8.3.4.2 Optional extensions and alternatives

When CA flag = "1", receivers with no CA capabilities can extract the SCCA parameter associated with the Service component and analyse the scrambling mode field to check whether the Service component is scrambled or not. Receivers dealing with Paging information should not analyse the Service component information in order to obtain the SCCA parameter. They should decode all of the FIG (5/0). If D1 = "0" and D2 = "1", then the Paging message begins with the 3-byte FIDCCA_Ext parameter which gives all the information for the de-scrambling of the message. In this case, SCCA is not used.

3.8.3.4.3 Recommendations on implementation and presentation

Fast processing of SCCA is required to allow rapid access to the de-scrambled component.

3.8.3.4.4 Fall-back in the event of failing service

Without SCCA, a component cannot be de-scrambled.

3.8.3.4.5 Hints and remarks

A Service component scrambled in Configuration 1 shall be de-scrambled before any required storage. Indeed, the de-scrambling needs knowledge of the Logical frame counter. A Service component scrambled in Configuration 2 or 3 can be stored and de-scrambled later, provided that the ECMs are also stored.

3.8.4 Fast Information Data Channel Conditional Access

3.8.4.1 Introduction

3.8.4.1.1 Purpose of the feature

The FIDCCA parameter is a 16-bit code which is mandatory for each access controlled Service component sent in the FIDC and using CA signalling Configuration 2 (i.e. first byte of SCCA = "00000000"). It is used in addition to the SCCA parameter which is sent in the Service component information.

3.8.4.1.2 End user of the feature

The end-user is that part of the receiver dealing with the de-scrambling of FIDC.

3.8.4.1.3 Provider of the feature

The provider of the feature is the FIDC scrambler (either service provider or ensemble provider).

3.8.4.1.4 Involvement of other parties

None.

3.8.4.1.5 Description

FIDCCA transports the Initialization Modifier (IM) which is used to scramble the following FIG type 5 field. It also provides signalling information allowing the FIG to be de-scrambled. The FIDCCA_Ext is a 24-bit code which is used when receivers cannot process the SCCA parameter, mainly because they cannot interpret the FIC. This is the case for example for the Paging receivers which need to access information directly and simply, without analysing all the Service organization information. The first two bytes of FIDCCA_Ext are the same as those of FIDCCA. The third byte contains information on the location of the ECMs and the EMMs of the component in the multiplex. Up to now, two applications sent in FIDC are recognized to warrant scrambling: Paging using FIG (5/0) (which will only use Configuration 2 with FIDCCA_Ext) and TMC (which can use any of the scrambling configurations proposed).

3.8.4.2 Mandatory requirements

3.8.4.2.1 For broadcasting

FIDCCA ad FICCA_Ext are used only when conditional access mechanisms are operational.

3.8.4.2.2 For receiving

Receivers with access control capabilities should extract and analyse the FIDCCA or FIDCCA_Ext parameter.

3.8.4.3 Operational aspects of broadcasting

3.8.4.3.1 Functional minimum requirements

The transmission of FIDCCA or FIDCCA_Ext is mandatory at the beginning of each FIG type 5 field scrambled in Configuration 2. In this case, it is located just after the FIDCId and it is not scrambled.

3.8.4.3.2 Inter-relations with other features

The FIDCCA parameter is used in conjunction with CAId, CA flag and SCCA.

An FIDCCA parameter for a Service component is valid only if:

- CAId ≠ "000" for the Service; or
- CA flag = "1" for the Service component; or
- first byte of SCCA = "00000000" for the Service component.

The FIDCCA_Ext parameter is used in conjunction with one of the two bits D1 or D2 at the beginning of any FIG Type 5.

3.8.4.3.3 Preferred transport mechanisms and alternatives

FIDCCA_Ext is preferred to FIDCCA for Services addressed to mobiles or any other plug-free equipment (for example, Paging). Indeed, the use of FIDCCA_Ext allows the remainder of the FIC to be ignored. Consequently, the receiver is able to know implicitly where to find the Service inside the multiplex.

3.8.4.3.4 Default contents in the event of failing service

There is no substitute for the FIDCCA and FIDCCA_Ext parameters. Without these parameters, the FIG 5 cannot be scrambled in Configuration 2 at the sending end.

3.8.4.3.5 Hints and remarks

If Scrambling mode = "01" (unscrambled), then IM and Parity flag have no meaning. IM is set to "0" and Parity flag = "0". If Scrambling mode = "10" (free access), then the Parity flag has no meaning. Parity flag is set to "0".

3.8.4.4 Receiver implementations aspects

3.8.4.4.1 Functional minimum requirements

The receiver needs to know which Services use FIDCCA_Extended instead of SCCA and FIDCCA. If Scrambling mode = "01" (unscrambled), then IM and parity flag have no meaning and are not read by the receiver. If Scrambling mode = "10" (free access), then parity flag has no meaning and is not read by the receiver. If Scrambling mode = "11" (controlled access), then IM is used for the initialization of the PRBS and the parity flag is used to select the appropriate Control Word (even CW or odd CW). The PRBS should be initialized with the 10-byte Initialization Word before de-scrambling the first byte of the FIG 5.

3.8.4.4.2 Optional extensions and alternatives

When CA flag = "1", receivers with no CA capabilities can extract the FIDCCA or FIDCCA_Ext parameter associated with the Service component and analyse the scrambling mode field to check whether the Service component is scrambled or not.

3.8.4.4.3 Fall-back in the event of failing service

Without FIDCCA or FIDCCA_Ext, a Service component in FIDC scrambled in Configuration 2 cannot be de-scrambled.

3.8.4.4.4 Hints and remarks

De-scrambling of FIG type 5 in Configuration 2 with FIDCCA or FIDCCA_Ext can be performed after storage. The receiver should also store the ECMs of the Service.

3.8.5 Data Group Conditional Access

3.8.5.1 Introduction

3.8.5.1.1 Purpose of the feature

The DGCA parameter is a 16-bit code which is mandatory for each access-controlled Service component in Packet mode when using CA signalling Configuration 2 or 3 (i.e. first byte of SCCA equal to "0"). DGCA transports the Initialization Modifier (IM) which is used to scramble the following Data group. It also provides signalling information allowing the de-scrambling of the Data group.

3.8.5.1.2 End user of the feature

The end-user is that part of the receiver dealing with the de-scrambling of Data groups.

3.8.5.1.3 Provider of the feature

The provider of the feature is the Data group scrambler.

3.8.5.2 Mandatory requirements

3.8.5.2.1 For broadcasting

DGCA is mandatory only when conditional access mechanisms are used.

3.8.5.2.2 For receiving

Only receivers with access control capabilities have to extract and analyse the DGCA parameter.

3.8.5.3 Operational aspects of broadcasting

3.8.5.3.1 Functional minimum requirements

The transmission of DGCA is mandatory in the Extension field of each Data group scrambled in Configuration 2 or 3 (first byte of SCCA of the corresponding Service component = "00000000"). In this case, DGCA is not scrambled (neither are the following optional session header). The headers of the Data groups with DGCA have the extension flag set to "1" and a Data group type equal to "0010" or "0101".

3.8.5.3.2 Inter-relation with other features

The DGCA parameter is used in conjunction with CAId, CA flag and SCCA. A DGCA parameter for a Service component is valid only if:

- CAId ≠ "000" for the Service; or
- CA flag = "1" for the Service component; or
- first byte of SCCA = "00000000" for the Service component.

3.8.5.3.3 Hints and remarks

If Scrambling mode = "01" (unscrambled), then IMW and Parity flag have no meaning. IM is set to "0" and Parity flag is set to "0". If Scrambling mode = "10" (free access), then Parity flag has no meaning. Parity flag is set to "0".

3.8.5.4 Receiver implementations aspects

3.8.5.4.1 Functional minimum requirements

If Scrambling mode = "01" (unscrambled), then IMW and Parity flag have no meaning and need not to be read by the receiver. If Scrambling mode = "10" (free access), then parity flag has no meaning and is not read by the receiver. If Scrambling mode = "11" (controlled access), then IMW is used for the initialization of the PRBS and the parity flag is used to select the appropriate Control Word (even CW or odd CW). The PRBS has to be initialized with the 10-byte Initialization Word before being able to de-scramble the first byte of the MSC Data group data field.

3.8.5.4.2 Optional extensions and alternatives

When CA flag = "1", receivers with no CA capabilities can extract the DGCA parameter associated with the Service component and analyse the scrambling mode field to check whether the Service component is scrambled or not.

3.8.5.4.3 Recommendations on implementation and presentation

High speed is needed in the treatment of DGCA to allow rapid initialization of the PRBS.

3.8.5.4.4 Fall-back in the event of failing service

Without DGCA, a component scrambled in Configuration 2 or 3 cannot be de-scrambled.

3.8.5.4.5 Hints and remarks

De-scrambling of Data groups in Configuration 2 with DGCA can be performed after storage. The receiver should store also the ECMs of the Service.

Annex A:
Conditional Access control with SCCA parameter

A.1 Introduction

This annex provides operational rules for the management of transitions from one conditional access situation to another. The access controlled components using CA signalling Configuration 1 are used as an example. In Configuration 1, the description of the scrambling and access control modes of each component is sent with the Service Component Conditional Access (SCCA) parameter - see figure A.1.1 (see also 3.8.3).

b15	b14 b13	b12	b11 b7	b6 b0
FIC/SC	Scr	Rp	Upd	ECMId

Figure A.1.1: Structure of the SCCA parameter for Configuration 1

The two Scrambling mode bits are coded as follows:

00 : not allowed;

01 : unscrambled;

10 : scrambled with the local CW;

11 : scrambled with CW sent in ECMS.

The four Update bits are used to signal transitions and are coded as follows:

0 0 0 0 : No update;

x x 0 1 : Update mode: future mode is unscrambled;

x x 1 0 : Update mode: future mode is scrambled with the local CW;

x x 1 1 : Update mode: future mode is scrambled with CW sent in ECMs;

x 1 x x : Update ECM: change in the ECM transmission;

1 x x x : Update access: change in the access conditions.

A.2 Scrambling mode and Update coding

This clause describes the coding rules of the two Scrambling mode (Scr) bits and the four Update (Upd) bits during an access control transition. The following assumptions are made:

- FIG (0/3) or FIG (0/4) commands are sent at least once every 16 frames.
- The smart card requires less than 600 ms to calculate an ECM (25 Logical frames of 24 ms).
- The receiver synchronizes itself when the Logical frame counter reaches a value with the 4 LSbits equal to "0".
- The SCCA parameter is carried in one of the FIBs associated to the CIF corresponding to the Logical frame counter.

The coding details are given in tables A.2.1 to A.2.6. The steps in italics are optional. Their number and position depend on the performances of the decoder and smart card, and can be redefined.

Table A.2.1: Transition unscrambled ⇒ scrambled (with local CW)

Step N°	Logical frame count	Scr b14 b13	Update access Iacc, Iecm, Imode b12 b9	ECMId	Receiver action
0	x	0 1	0 0 0 0	Irrelevant	Unscrambled component, no ECM are sent for this component by the coder
1	x+16	0 1	0 0 1 0	Irrelevant	Update mode: the data are still in clear. The 2 bits of Imode indicate the future scrambling mode ("scrambled with local CW") that will be used as soon as the 4 LSBits of the Logical frame counter = "0"
2	4 LSbits="0"				The following data are scrambled. The CW to use is the local CW
3	x+32	10	0 0 0 0	Irrelevant	end of transition

The duration of the transition is 16 Logical frames.

Table A.2.2: Transition scrambled with local CW ⇒ unscrambled

Step N°	Logical frame count	Scr b14 b13	Update access Iacc, Iecm, Imode b12 b9	ECMId	Receiver action
0	x	1 0	0 0 0 0	Irrelevant	Component scrambled with the local CW
1	x+16	1 0	0 0 0 1	Irrelevant	Update mode: the data are still scrambled with the local CW. The future mode is "unscrambled" and will be used as soon as the 4 LSbits of the Logical frame counter = "0"
2	4 LSbits="0"				The following data of the component are in clear
3	x+32	0 1	0 0 0 0	Irrelevant	End of the transition

The duration of the transition is 16 Logical frames.

Table A.2.3: Transition from unscrambled ⇒ scrambled with ECMs

Step N°	Logical frame count	Scr b14 b13	Update access Iacc, Iecm, Imode b12 b9	ECMId	Receiver action
0	x	0 1	0 0 0 0	Empty or Irrelevant	Component in clear, no ECM sent by the coder
1	x+16	0 1	0 1 0 0	ECMId	Update ECM. Receive and send to the card the ECM sent in the indicated ECM channel. Keep in memory the CW calculated (if the customer has access)
1.1	x+32	0 1	0 1 0 0	ECMId	Update ECM. Buffer step Receive and send to the card the ECM sent in the indicated ECM channel (if not already done, or if the toggle bit T has changed). Keep in memory the CW calculated (if the customer has access)
1.2	x+48	0 1	0 1 0 0	ECMId	Update ECM. Buffer step Receive and send to the card the ECM sent in the indicated ECM channel (if not already done, or if the toggle bit T has changed). Keep in memory the CW calculated (if the customer has access)
2	x+64	0 1	0 0 1 1	ECMId	Update mode: the data are still in clear. The 2 bits of Imode indicate the future scrambling mode (scrambled with ECMs) that will be used as soon as the 4 LSbits of the Logical frame counter = "0"

The duration of the transition is 24 Logical frames.

NOTE 1: In the table above, step 2 (Update mode) is signalled 3 times before switching to the new scrambling mode. This repetition is recommended and can be applied whenever a transition occurs. It can require the service component descriptors to be sent faster.

NOTE 2: To simplify the switching, we can apply the following rules:

- x = 0 mod 16 (i.e. the service component descriptors are sent in Logical frames n° 0, 16, 32, ..., 208, 224, 240, 0, ...);
- the increased speed for transmitting the descriptors is performed automatically every 4 Logical frames in 16 (also for Update ECM). Example, if x = 0 mod 16, step 2 of the table above might be repeated in the 4 following Logical frames: x + 64, x + 68, x + 72, x + 76 before finishing the transition at x + 80.

NOTE 3: If the computation of the ECM by the smart card is performed faster, it is possible to omit the buffer steps 1.1 and 1.2.

NOTE 4: ECMs can be transmitted in the Logical frame immediately following that containing the Service component descriptor. This allows the receiver to quickly acquire all the information used for descrambling. It would then be possible then to omit the two buffer steps.

Table A.2.4: Transition scrambled with ECMs ⇒ unscrambled

Step N°	Logical frame count	Scr b14 b13	Update access Iacc, Iecm, Imode b12 b9	ECMId	Receiver action
0	x	1 1	0 0 0 0	ECMId	Scrambled component
1	x + 16	1 1	0 0 0 1	Irrelevant	Update mode: the data are still scrambled. Future mode is unscrambled. Transition to unscrambled as soon as the 4 LSBits of the logical frame counter = "0"
2	4 LSbits="0"				The following data of the component are unscrambled
3	x + 32	0 1	0 0 0 0	Irrelevant	End of transition

The duration of the transition is 16 Logical frames of 24 ms The transition illustrated in table A.2.5 occurs when the access conditions to a service are changed (switch from access condition a to access condition b).

Table A.2.5: Transition from condition a ⇒ condition b

StepN°	Logical frame count	Scr b14 b13	Update access Iacc, Iecm, Imode b12 b9	ECMId content	Receiver action
0	x	1 1	0 0 0 0	ECMId (ECMa)	Scrambled component with access condition a
1	x + 16	1 1	0 1 0 0	ECMId (ECMb)	Update ecm. Receive and send to the card the ECM broadcast in the indicated ECM channel. This ECM contains the access conditions b. Keep in memory the CW calculated (if the customer has access)
1.1	x + 32	1 1	0 1 0 0	ECMId (ECMb)	Update ecm. Buffer step Receive and send to the card the ECM broadcast in the indicated ECM channel (if not already done, or if the TB has changed). Keep in memory the CW calculated (if the customer has access)
1.2	x + 48	1 1	0 1 0 0	ECMId (ECMb)	Update ecm. Buffer step Receive and send to the card the ECM broadcast in the indicated ECM channel (if not already done, or if the TB has changed). Keep in memory the CW calculated (if the customer has access)
2	x + 64	1 1	1 0 0 0	ECMId (ECMb)	Update "access". The component is still in access condition a. The new access conditions (cond b) will be taken into account as soon as the 4 LSbits of the Logical frame counter = "0"
2.1	x + 65	1 1	1 0 0 0	ECMId (ECMb)	Update access: repetition (we suppose x _ 15 mod 16)
2.2	x + 66	1 1	1 0 0 0	ECMId (ECMb)	Update access: repetition (we suppose x _ 15 mod 16)
3	4 LSbits="0"				Erase the former CW (not secured operation). Use, if available, the new CW for the descrambling.
4	x + 80	1 1	0 0 0 0	ECMId	End of the transition

The duration of the transition is 64 Logical frames of 24 ms.

NOTE 5: In the table above, step 2 (Update mode) is signalled 3 times before switching to the new scrambling mode. This repetition is recommended and can be applied whenever a transition occurs. It can require the service component descriptors to be sent faster.

NOTE 6: To simplify the switching, we can apply the following rules:

- x = 0 mod 16 (i.e. the service component descriptors are sent in Logical frames n° 0, 16, 32, ..., 208, 224, 240, 0, ...);
- the increased speed for transmitting the descriptors is performed automatically every 4 Logical frames in 16 (also for Update ECM). Example, if x = 0 mod 16, step 2 of the table above might be repeated in the 4 following Logical frames: x + 64, x + 68, x + 72, x + 76 before finishing the transition at x + 80.

NOTE 7: If the computation of the ECM by the smart card is performed faster, it is possible to omit the buffer steps 1.1 and 1.2.

NOTE 8: If the user accesses the service for the first time between steps 1 and 3, the ECMs will not be available and it will not be possible to descramble the service component even if he has access. However, this is not a significant problem because the transition is very short and can even be reduced (see note 7). To avoid the problem completely, it would be necessary to send both ECM1 and ECM2 during the transition.

The transition illustrated in table A.2.6 describes how to modify the ECMId of one component. This operation allows two components either to be grouped in a single access condition or separated.

Table A.2.6: Grouping of two components on the access conditions of the first one (or separation of two components)

Step N°	Logical frame count	Scr b14 b13	Update access Iacc, Iecm, Imode b12 b9	ECMId content	Receiver action
0	x	1 1	0 0 0 0	ECMId 2	Scrambled component (ECMId = "2")
1	x + 16	1 1	0 1 0 0	ECMId 1	Update ECM. Receive and send to the card the ECM sent in the indicated ECM channel. Keep in memory the CW calculated (if the customer has access)
1.1	x + 32	1 1	0 1 0 0	ECMId 1	Update ECM. Temporization step Receive and send to the card the ECM sent in the indicated ECM channel (if not already done, or if the toggle bit T has changed). Keep in memory the CW calculated (if the customer has access)
1.2	x + 48	1 1	0 1 0 0	ECMId 1	Update ECM. Temporization step Receive and send to the card the ECM sent in the indicated ECM channel (if not already done, or if the toggle bit T has changed). Keep in memory the CW calculated (if the customer has access)
2	x + 64	1 1	1 0 0 0	ECMId 1	Update "access". The component is still in access condition 2. The new access conditions (cond 1) will be taken into account as soon as the 4 LSbits of the Logical frame counter = "0"
2.1	x + 65	1 1	1 0 0 0	ECMId 1	Update access: repetition (we suppose x _ 15 mod 16)
2.2	x + 66	1 1	1 0 0 0	ECMId 1	Update access: repetition (we suppose x _ 15 mod 16)
3	4 LSbits="0"				Erase the former CW (not secured operation). Use, if available, the new CW for the descrambling
4	x + 80	1 1	0 0 0 0	ECMId 1	End of the transition. Scrambled component with ECMId = "1"

The duration of the transition is 64 Logical frames.

NOTE 9: In the table above, step 2 (Update mode) is signalled 3 times before switching to the new scrambling mode. This repetition is recommended and can be applied whenever a transition occurs. It can require the service component descriptors to be sent faster.

NOTE 10: To simplify the switching, we can apply the following rules:

- x = 0 mod 16 (i.e. the service component descriptors are sent in Logical frames n° 0, 16, 32, ..., 208, 224, 240, 0, ...);
- the increased speed for transmitting the descriptors is performed automatically every 4 Logical frames in 16 (also for Update ECM). Example, if x = 0 mod 16, step 2 of the table above might be repeated in the 4 following Logical frames: x + 64, x + 68, x + 72, x + 76 before finishing the transition at x + 80.

NOTE 11: If the computation of the ECM by the smart card is performed faster, it is possible to omit the buffer steps 1.1 and 1.2.

NOTE 12: If the user accesses the service for the first time between steps 1 and 3, the ECMs will not be available and it will not be possible to descramble the service component even if he has access. However, this is not a significant problem because the transition is very short and can even be reduced (see note 11). To avoid the problem completely, it would be necessary to send both ECM1 and ECM2 during the transition.

A.3 Test patterns for the PRBS

This clause gives two test patterns for the PRBS. For each pattern, the following data are given:

- bytes of IW, most significant byte first. These bytes are used to initialize the PRBS;
- 64 first bytes output by the PRBS after initialization;
- 64 bytes of clear data;
- 64 bytes of scrambled data.

Test Pattern 1

IW (10 bytes)	01 00 01 02 03 04 05 06 07 08
Output from the PRBS	45 7B 2D D7 1B 9B FC 08 2A FA FD E4 35 75 46 A1
	05 56 00 98 58 9C 3F C8 CD 66 ED E1 E8 E2 0D 9B
	63 1E 03 92 A9 47 63 3F 71 1E AC 90 D3 29 89 34
	EC 83 9B B4 10 45 18 6E F2 82 DD 6A F2 63 0D 83
Clear data	00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F
	10 11 12 13 14 15 16 17 18 19 1A 1B 1C 1D 1E 1F
	20 21 22 23 24 25 26 27 28 29 2A 2B 2C 2D 2E 2F
	30 31 32 33 34 35 36 37 38 39 3A 3B 3C 3D 3E 3F
Scrambled data	45 7A 2F D4 1F 9E FA 0F 22 F3 F7 EF 39 78 48 AE
	15 47 12 8B 4C 89 29 DF D5 7F F7 FA F4 FF 13 84
	43 3F 21 B1 8D 62 45 18 59 37 86 BB FF 04 A7 1B
	DC B2 A9 87 24 70 2E 59 CA BB E7 51 CE 5E 33 BC

Test Pattern 2

IW (11 bytes)	10 20 30 01 02 03 04 05 06 07 08
Output from the PRBS	94 49 3A B1 45 26 DD 0B 07 EE C0 29 4C 66 29 2C
	F3 C9 88 77 D3 57 D9 B0 81 FF 33 82 CB E0 75 68
	05 B0 7E 66 24 2E 7E 6B 23 50 21 C5 9E E6 62 C1
	5C 80 80 01 8A 18 47 1E 91 B0 DD FD 83 F9 FC 35
Clear data	00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F
	10 11 12 13 14 15 16 17 18 19 1A 1B 1C 1D 1E 1F
	20 21 22 23 24 25 26 27 28 29 2A 2B 2C 2D 2E 2F
	30 31 32 33 34 35 36 37 38 39 3A 3B 3C 3D 3E 3F
Scrambled data	94 48 38 B2 41 23 DB 0C 0F E7 CA 22 40 6B 27 23
	E3 D8 9A 64 C7 42 CF A7 99 E6 29 99 D7 FD 6B 77
	25 91 5C 45 00 0B 58 4C 0B 79 0B EE B2 CB 4C EE
	6C B1 B2 32 BE 2D 71 29 A9 89 E7 C6 BF C4 C2 0A

Annex B:
Example Programme schedule showing the use of PNum

PNum structure:

/SId(Service identifier)/PNum(date, hour, minute)/flagbyte(continuity flag, update flag/New SId/New PNum/

(This character indicates that

two Pnum:s are interleaved

Radio 1 **(R1)** The original schedule	**Radio1'** **(R1')** A late revised version due to a long sports event	**Radio 3** **(R3)** The original schedule
0800 News SId(P1)/PNum(200800)/00/	**0800 News** SId(P1)/PNum(200800)/00/	**0800 News** SId(P3)/PNum(200800)/00/
		0803 Sport SId(P3)/PNum(200803)/00/
0805 Weather SId(P1)/PNum(200805)/00/	**0805 Weather** SId(P1)/PNum(200805)/00/	**0805 "Good morning"** SId(P3)/PNum(200805)/00/
0810 "Direct" SId(P1)/PNum(200810)/00/	**0810 "Direct"** SId(P1)/PNum(200810)/00/	
		0827 Traffic message SId(P3)/PNum(000002)/00/ **Action:** Temporary stop of recording
		0828 "Good morning" SId(P3)/PNum(200805)/00/
0900 News SId(P1)/PNum(200900)/00/	**0900 News** SId(P1)/PNum(200900)/00/	**0900 News** SId(P3)/PNum(200900)/00/
		0903 "Davis cup" SId(P3)/PNum(200903)/00/
0905 "Tendency" SId(P1)/PNum(200905)/00/	**0905 "Tendency"** SId(P1)/PNum(200905)/00/	
		0916 Traffic message SId(P3)/PNum(000002)/00/
		0917 "Davis cup" SId(P3)/PNum(200903)/00/
		0957 "Davis Cup" SId(P3)/PNum(200903)/11/SId(P1)/200959/
		NOTE: "Davis Cup" will continue in P1 under a New PNum(200959) which is transmitted at least during the last minute of the programme

Radio 1 (R1) The original schedule	Radio1' (R1') A late revised version due to a long sports event	Radio 3 (R3) The original schedule
		Action: Receiver will switch to Radio 1 when News starts.
1000 "Ten hour" SId(P1)/PNum(201000)/00/	**1000 "Davis Cup"** SId(P1)/PNum(200959)/00/ **NOTE:** PNum for "Davis Cup", a new inserted programme SId(P1)/PNum(201000)/01/SId(P1)/P-Num(000001)/ **NOTE:** "Ten hour" has been deleted. This information is transmitted at least until 1001	**1000 News** SId(P3)/PNum(201000)/00/
		1003 "Gale Warning" SId(P3)/PNum(201003)/00/
	1057 "Davis cup" SId(P1)/PNum(200959)/10/ **NOTE:** "Davis Cup" will go on after next PNum. This information is transmitted until the news starts **Action:** Receiver will record "Davis Cup" until News starts	
1100 News SId(P1)/PNum(201100)/00/	**1100 News** SId(P1)/PNum(201100)/00/	**1100 News** SId(P3)/PNum(201100)/00/
		1103 Messages SId(P3)/PNum(201103)/00/
1105 Sacred music SId(P1)/PNum(201105)/00/	**1105 "Davis cup"** SId(P1)/PNum(200959)/00/ **NOTE:** PNum for "Davis cup" **Action:** Receiver resumes recording SId(P1)/PNum(201105)/01/SId(P1)/P-Num(000001)/ **NOTE:** Sacred music has been deleted. This information is transmitted at least until 1106	**1105 "Gale Warning"** SId(P3)/PNum(201105)/00/
1135 "Speak up" SId(P1)/PNum(201135)/00/	**1135 "Davis cup"** SId(P1)/PNum(200959)/00/ **NOTE:** PNum for "Davis cup" SId(P1)/PNum(201135)/01/SId(P1)/P-Num(201450)/ **NOTE**: New emission time for "Speak up" (repeat). This information is transmitted at least until 1136 **Action:** Receiver programmed to record "Speak up" will wait for PNum 201450 to start recording.	
	1140 Music (after "Davis cup") SId(P1)/PNum(000001)/00/ **NOTE:** Non-scheduled programme	
1145 "OBS" SId(P1)/PNum(201145)/00/	**1145 "OBS"** SId(P1)/PNum(201145)/00/	
1200 "Twelwe o'clock" SId(P1)/PNum(201200)/00/	**1200 "Twelwe o'clock"** SId(P1)/PNum(201200)/00/	**1200 News** SId(P3)/PNum(201200)/00/
		1205 Intermission due to reconfiguration SId(P3)/PNum(000000)/00/ **NOTE:** No meaningful PNum is currently provided

Annex C:
Example schedule showing PTY and Announcement Codes in RDS and DAB

Time	Programme Item	RDS "Dynamic" PTY & DAB Dynamic "International" PTy Code	Additional DAB Dynamic PTy Coarse Code	RDS "Traffic Anno" TA Flag Status	DAB Anno Flags used	Comments and Explanation
0630	"How Weather is made"	SCIENCE	WEATHER	0	---	PTY "Science" is used for this feature about the weather, as the PTY code 16 (weather) is intended for use only for short reports and forecasts.
0700	News Headlines followed by:	NEWS		0	NEWS	PTY code 01 (news) used for the headlines, to provide PTY search, select, standby and store functionality in RDS receivers. In DAB, PTy 01 provides search and select functionality. If PTy is combined with language it also provides standby and store, otherwise the DAB receiver uses the announcement flag instead for these functions.
(0703)	"Inside the News"	CURRENT AFFAIRS	NEWS	0	---	This part of the programme expands upon the news, and the PTY code is changed to PTY 02 (Current Affairs). This and the removal of the News announcement flag in DAB causes RDS and DAB receivers in standby mode for "News" to end the interrupt. DAB may use PTy code 01 in addition to Current Affairs.
0758	Weather Forecast	WEATHER		0	WEATHER	This Weather item is intended to cause an interrupt, so PTY code 16 used for RDS, and "Weather" flag in DAB.
0800	News Headlines	NEWS		0	NEWS	
0803	Road Traffic Information	UNDEFINED OR ROCK MUSIC	BLUES	1	TRAFFIC	This Traffic Report falls between two dissimilar programmes. The broadcaster has the option of coding it as "undefined" or anticipating the following programme type.
0805	"Eric Clapton at the RAH"	ROCK MUSIC	BLUES	0	---	Agreed PTy description downloaded to receiver.
0821	Bomb Explosion Report	NEWS	UNDEFINED OR ROCK OR BLUES	0	NEWS	"News Flash" message of a bomb explosion – DAB Announcement flag for News raised, and PTY 01 broadcast to cause interrupt in RDS receivers.
0823	"Eric Clapton at the RAH"	ROCK MUSIC	BLUES	0	---	
0830	News	NEWS		0	NEWS	
0832	Weather Forecast	WEATHER		0	WEATHER	

Time	Programme Item	RDS "Dynamic" PTY & DAB Dynamic "International" PTy Code	Additional DAB Dynamic PTy Coarse Code	RDS "Traffic Anno" TA Flag Status	DAB Anno Flags used	Comments and Explanation
0833	Road Traffic Information	UNDEFINED OR POP MUSIC		1	TRAFFIC	TA flag traditionally raised for both Traffic and Transport news in RDS. DAB supports separate "Road Traffic" and "Public Transport" flags. The actual use of TA, and Announcement flags, will vary according to broadcasters editorial policies.
0835	Rail Transport Information	UNDEFINED OR POP MUSIC		1	TRANSPORT	- ditto =
0836	"The Chart Show"	POP MUSIC		0	---	
0850	Ghost Driver	POP MUSIC		1	TRAFFIC	Driver travelling on wrong side of the road causes broadcaster to raise RDS "TA" flag and DAB "Traffic" flag.
0851	"The Chart Show"	POP MUSIC		0	---	
0900	"Consumer Watchdog"	INFORMATION	CONSUMER	0	---	Agreed PTy description downloaded to receiver
0920	Chernobyl	ALARM !!		0	ALARM !!	PTY 31 (Alarm) in RDS and "Alarm" Announcement flag in DAB.

Annex D:
Example of announcement support coding

It is important to distinguish in which FIGs the announcement support is given and from where the ClusterIds can be derived for a certain service.

The following abbreviations are used throughout the example:

- CE = current ensemble
- OE = other ensemble
- FM = from FM

D.1 Announcement Support (FIG 0/18)

Gives the ASu flags of those announcement types supported in the current ensemble (so a receiver knows which announcement types are expected within the ensemble), but gives the ClusterId for those clusters supported within CE, FM and OE (because these are not given in FM or OE FIGs).

SId	ASu flags	List of clusters
	CE	CE+FM+OE

D.2 FM Announcement Support (FIG 0/27)

Gives the ASu (which is for traffic only and therefore no ASu field is needed) for all the FM services from which announcements are expected (combined dual-frontend DAB/FM receivers can additionally take the FM TP flag into account). The ClusterIds are given with FIG 0/18.

SId	List of PI

D.3 OE Announcement Support (FIG 0/25)

Gives the ASu for those ensembles from which OE announcements of the given announcement types are expected. The ClusterIds are given with FIG 0/18.

SId	ASu flags	List of EId

D.4 Example

This example illustrates a service which is having announcements from various sources with different types.

SId	ClusterId	Announcement Type	Announcement Source	PI/EId
8 321	0001	News	CE	
	0002	Traffic	FM (2 Programmes)	PI=8 324, PI=8 327
	0003	Weather	OE (2 Ensembles)	EId=1 234 EId=5 678
	0004	Event	OE	EId=5 678

D.5 Generated FIGs

Announcement Support Information:

FIG 0/18:

8321	ASu=New	CusterId=0001, 0002, 0003, 0004

Only those ASu Flags for the announcement types in the current ensemble are set but the ClusterId of all the Clusters the Service is participating in (including FM and OE) are listed.

FIG 0/27:

8321	PI=8324, 8327

All the FM Services which provide traffic announcements are listed.

FIG 0/25:

8321	ASu=Weather	EId=1234, 5678

8321	ASu=Event	EId=5678

All ASu flags have to be valid for all listed EIds. Therefore, the information of EId=5 678 (ASu Weather and Event) needs to be split up into two FIG 0/25 because EId=1 234 has only ASu for Weather.

Annex E:
Guidelines for Rfa and Rfu

E.1 Rfa: Reserved for future addition

Rfa bits do not change the meaning of other parts of an information entity (e.g. a FIG subfield). They shall be set to 0 by the Service or Ensemble provider. The receiver does not need to evaluate the Rfa bits because they have no meaning and do not affect any other parts of the information entity. In the future, when a new requirement is determined and specified, the Rfa bits will be replaced by fields with definite functions, but this will have no effect on any associated parts of the information entity.

E.2 Rfu: Reserved for future use

Rfu bits do change the meaning of other parts of an information entity. They shall be set to 0 by the Service or Ensemble provider. The receiver shall evaluate the Rfu bits. Only when the Rfu bits are 0, the receiver shall be able to decode the associated parts of the information entity. If any of the Rfu bits are 1, then the meaning of the associated parts of the information entity cannot be determined. In the future, when a new requirement is determined and specified, the Rfu bits will be replaced by fields with definite functions and some associated parts of the information entity can also change.

Annex F:
PTy preview restrictions

F.1 Introduction

National PTy codes will have a different meaning in different countries.

For example PTy coarse code "57could mean PIANO MUSIC in Germany (labelled as "KLAVIER MUSIK ") and WOMAN's programme in France (labelled as "FEMMES").

A PTy preview is given for a whole Ensemble, not for a specific service in the Ensemble. So, when an International Ensemble contains services from more than one country the receiver will not be able to interpret the previewed PTy in an unambiguously way.

For an unambiguously interpretation of a national PTy it is important to know for which country this code is applicable i.e. both the Country Id and ECC has to be known.

International Ensembles can contain one or more services with different CountryId/ECC.

FIG 0/9 signals which of the services in the Ensemble have an ECC that is different from the Ensemble ECC. With FIG 0/9 it is possible to know exactly which service the Ensemble is French, which is German etc.

However, FIG 0/9 has no OE functionality (the OE flag is a Rfu). This means that ECCs for *another* Ensemble cannot be signalled from the current Ensemble. Only by temporarily tuning to the other Ensemble the ECC of that Ensemble will be known.

F.2 Restrictions

The consequence of the above is that in some cases a preview of a national PTy code will be ambiguous and should not be done i.e. there will be restrictions for doing a PTy preview of national codes. The following cases illustrate the conditions under which the PTy preview of a national and international PTy code is allowed or not.

F.2.1 Current Ensemble = Ensemble containing services which all have the same Country Id/ECC

EXAMPLE: A German Ensemble with EId = D888, containing only German services.

The German Ensemble provider does a preview for national PTy code "57". He should also give the definition of this code by means of the PTy downloading feature for FIG 1/2. The receiver will then know unambiguously that code "57" stands for PIANO MUSIC and is labelled "KLAVIER MUSIK".

Conclusion: In this case the preview of national PTy codes is allowed on condition to give their definition by means of PTy downloading. The preview of international PTy codes is allowed.

F.2.2 Current Ensemble = International terrestrial Ensemble containing one or more services with Country Id/ECC different from the Ensemble ECC

EXAMPLE: Current Ensemble =German Ensemble D888 containing a few French services.

The German Ensemble provider does a preview of national PTy code "57". He also transmits the definition of this code by means of FIG 1/2. The receiver is informed that "57" stands for PIANO MUSIC in Germany (labelled as "KLAVIER MUSIK") and for "WOMAN'S PROGRAMME" in France (labelled as "FEMMES").

Although the receiver knows from FIG 0/9 which services in this German Ensemble are French services and which are German services, it will not know whether the signalled code "57" is applicable to a German or a French Service because the PTy preview of code "57" applies to the whole Ensemble, not to a particular service in the Ensemble. Consequently the receiver does not know that the previewed code "57" stands for PIANO MUSIC or for WOMAN'S PROGRAMME.

Because of this ambiguity the PTy preview of a national code has no sense and is not allowed. However, if there is an agreement to use only one set of national PTy codes for this international ensemble e.g. only the German codes, then the receiver will know unambiguously that code "57" stands for KLAVIER MUSIK (not for FEMMES) and in this case PTy preview of national PTy codes can be allowed.

With the preview of International codes there is no ambiguity but there is a risk that a German user watching for the previewed code "SPORT" will be disappointed if his CD playing is interrupted with a SPORT programme in French. Therefore it is strongly recommended to signal the language i.e. the Language field in PTy preview should be present (L flag in FIG 0/12 should be set).

Conclusion: The preview of *national* PTy codes is allowed under following conditions:

- there is an agreement among the service providers to use only one set of national PTy codes in the international ensemble;
- the definition of this set of national PTy codes is given with FIG 1/2;
- the language field is signalled in FIG 0/12.

The preview of *international* PTy codes is *allowed* on condition to transmit the PTy language.

F.2.3 Other Ensemble = Ensemble containing services which all have the same Country Id/ECC (equal to the Ensemble Id/ECC)

EXAMPLE: Let us assume at the borderline between Germany and France: *Current Ensemble = German Ensemble with EId = D888. Other Ensemble = French Ensemble with EId = F333. It contains only French services*

The Ensemble provider of the current (German) Ensemble does a preview of national PTY code "57" for the other (French) Ensemble with EId = F333.

In the PTy downloading feature (FIG 1/2) he shall give the definition of this code in France. The receiver is then informed from FIG 1/2 that national PTy code "57" stands for WOMAN'S PROGRAMME in France, labelled as "FEMMES".

However, the receiver does not know the ECC of the other Ensemble F333 because FIG 0/9 in the current German Ensemble D888 does not feature the OE functionality. Only by (temporarily) tuning to the other Ensemble F333 the receiver will know the ECC of this Ensemble and the CountryId/ECC of the Services in this Ensemble. The receiver therefore does not know that Ensemble F333 is a French Ensemble. It could indeed also be a Norwegian Ensemble and in Norway code 57 could stand for something totally different from WOMAN'S PROGRAMME.

Because of this ambiguity PTy preview of a national code has no sense and is not allowed. With the preview of International codes there is no ambiguity since the same international table is used as in the current ensemble. However there is a risk that a German user watching for the previewed code "SPORT" in the other (French) Ensemble will be disappointed if his CD playing is interrupted with a SPORT programme in French. Therefore it is strongly recommended to signal the language i.e. the Language field in PTy preview should be present (L flag in FIG 0/12 should be set).

Conclusion: The preview of national PTy codes is *not* allowed. The preview of international PTy codes in the other Ensemble is allowed as long as in the other ensemble the same international table is used (Inter.Table Id = 00000001 in Europe) as in the current ensemble. The PTy language should preferably be given i.e. the Language field in PTy preview should be present.

F.2.4 Other Ensemble = Ensemble containing one or more services with Country Id/ECC different from the (other) Ensemble's Country Id/ECC

EXAMPLE: At the boarder line between France and Germany: *Current Ensemble: German Ensemble with EId = D888. Other Ensemble: French Ensemble with EId = F555, containing a few German Services.*

The Ensemble provider of the current (German) Ensemble does a preview for national PTy code "57" for the other (French) Ensemble.F555. As in case F2.3 above the receiver will not know that F555 is a French Ensemble because it does not know the ECC of Ensemble F555.

Even if it would know the ECC of the Ensemble, the receiver will not know whether the signalled code"57" applies to a German or a French Service in this Ensemble because the previewed code applies to the whole Ensemble, not to a specific service in the Ensemble. There is thus an ambiguity and PTy preview of a national code has no sense and is not allowed.

With the preview of International PTy codes there is no ambiguity since the same international table is used as in the current ensemble.. However, just like in case F.2.3 above there is a risk that a user watching for a previewed code in the other (French) Ensemble F555 will be disappointed if his CD playing is interrupted with a programme in a language he doesn't understand. Therefore it is strongly recommended that the language is signalled i.e. the Language field in PTy preview should be present (L flag should be set).

Conclusion: The preview of *national* PTy codes is *not* allowed. The preview of *international* PTy codes is allowed on condition that in the other ensemble the same International table (Inter.Table Id = 00000001 in Europe) is used as in the current ensemble, the Frequency Information is given and the language field in the PTy Preview feature is present.

F.2.5 Current Ensemble = Multi-lingual Ensemble containing services which all have the same Country Id/ECC but one or more services have a different language

EXAMPLE: Current Ensemble = Swiss Ensemble with EId = 4567 and ECC = E1. This Swiss Ensemble contains spoken services in German, French and Italian from respectively DRS, RSR and RSI.

The Swiss Ensemble provider could decide to adopt in Switzerland the national PTy codes that are applicable in Germany. He should anyhow re-encode them in the PTy downloading feature of FIG 1/2 with the Swiss Country Id and ECC. However it is obvious that once the German national PTy codes have been adopted, the national PTy codes in use in France or Italy cannot be adopted in Switzerland.

For example: PTy code "57" stands for PIANO MUSIC in Germany where it is labelled as "KLAVIER MUSIK". In Switzerland this code can be re-used to mean PIANO MUSIC. With the PTy downloading feature of FIG 1/2 it can be labelled as "KLAVIER MUSIK" or "RECITAL PIANO" or "PIANOFORTE" depending on whether it is a DRS or RSR or RSI service that will start soon with a programme having this code in the Swiss Ensemble 4567.

In France code "57" stands for WOMAN'S PROGRAMME where it is labelled as "FEMME". In Italy this code may be used to mean the same thing and can be labelled as "DONNA". In Switzerland however, once national PTy code "57" has been allocated to PIANO MUSIC, it is no longer possible to allocate this code to WOMAN'S PROGRAMME or anything else.

The table F.1 below illustrates how a national PTy code in one country can be re-used in other countries, together with the restriction that within one country the meaning of a national PTy code shall be unique.

Table F.1: Re-use of national PTy codes in different countries

National PTy code	Country Id	ECC	Country	Label	Remarks
57	D	E0	D	KLAVIER MUSIK	
57	4	E1	CH	KLAVIER MUSIK	e.g. in case of DRS
57	4	E1	CH	RECITAL PIANO	e.g. in case of RSR
57	4	E1	CH	PIANOFORTE	e.g. in case of RSI
57	F	E1	F	FEMMES	
57	5	E0	I	DONNA	
57	4	E1	CH	~~FRAUEN~~	not allowed because in Switzerland code 57 is already allocated to PIANO MUSIC

From the label the user can derive that it is worthwhile watching for the previewed programme type or not. A German speaking Swiss user can decide to watch for an (Italian spoken) RSI programme to start soon with "PIANOFORTE" because for him the language can be of less importance than the piano music. On the other hand the same user can decide not to watch for " INFOS" i.e. the NEWS programme (in French) from RSR.

Conclusion: The Preview of international PTy codes in a multi-lingual Ensemble is allowed on condition that the language is signalled i.e. the Language field in the PTy preview feature should be present. The preview of national PTy codes is allowed on condition that the codes are unique and their definition is given with the PTy downloading feature. The Language field in the PTy preview feature should be present.

F.2.6 Other Ensemble = Multi-lingual Ensemble containing services which all have the same Country Id/ECC but one or more of them have different languages.

EXAMPLE: At the borderline between Germany and Switzerland: *Current Ensemble = German Ensemble with EId = D888. Other Ensemble = Swiss Ensemble with EId = 4 567, containing only Swiss services, some of them in German (DRS services), in French (RSR services), or in Italian (RSI services).*

The Ensemble provider of the current (German) Ensemble D888 does a preview of a (Swiss) national PTy code "57" in the other (Swiss) Ensemble 4 567. He shall also give the definition of the national Swiss codes by means of the PTy downloading feature (FIG 1/2).

As in case F2.3 above the receiver does not know the ECC of the other Ensemble because FIG 0/9 is the current German Ensemble D888 does not feature the OE functionality.

The receiver therefore does not know that Ensemble 4 567 is a Swiss Ensemble. Because of this ambiguity PTy preview of a national code has no sense and is not allowed.

With the preview of International codes there is no ambiguity since the same international table is used as in the current ensemble. However there is a risk that a user watching for the previewed code "SPORT" in the other (Swiss) Ensemble will be disappointed if his CD playing is interrupted with a SPORT programme in French. Therefore it is strongly recommended to signal the language i.e. the Language field in PTy preview should be present (L flag in FIG 0/12 should be set).

Conclusion: The preview of national PTy codes in another (multi-lingual) Ensemble is *not* allowed. The Preview of international PTy codes in another multi-lingual Ensemble is allowed on condition that in the other ensemble the same international table (Inter.Table Id = 00000001 in Europe) is used as in the current ensemble, the Frequency Information is given and the language is signalled i.e. the Language field in the PTy preview feature should be present.

F.3 Summary

Table F.2 below summarizes the conditions under which PTy preview of international and national codes is allowed or not.

Table F.2: PTy preview restrictions

Ensemble	PTy preview of Int.codes	PTy preview of National codes
Case F.2.1 Current Ensemble = National Ensemble: all services have same Country Id/ECC	Allowed	Allowed if definition of codes is given with FIG 1/2
Case F.2.2 Current Ensemble = International terrestrial Ensemble: some services have different Country Id/ECC	allowed, if language is signalled in FIG 0/12	Allowed if agreement to use only one set of national PTy codes; their definition is given with FIG 1/2 and language is signalled in FIG 0/12
Case F.2.3 Other Ensemble = Ensemble in neighbouring country: all services have same Country Id/ECC	Allowed if same Inter.Table Id as in current ensemble and language is signalled in FIG 0/12	Not allowed
Case F.2.4 Other Ensemble = International Ensemble in neighbouring country: some services have different Country Id/ECC	Allowed if same Inter.Table Id as in current ensemble and language is signalled in FIG 0/12	Not allowed
Case F.2.5 Current ensemble = National multi-lingual Ensemble: all services have same Country Id/ECC but some of them have different language	Allowed if Language is signalled in FIG 0/12	Allowed if codes are unique and their definition given with FIG 1/2; language is signalled in FIG 0/12
Case F.2.6 Other Ensemble = National multi-lingual Ensemble: all services have same Country Id/ECC but some of them have different language	Allowed if same Inter.Table Id as in current ensemble and language is signalled in FIG 0/12	Not allowed

Annex G:
An example to illustrate Service linking

G.1 Requirements

In this example, two BBC Regions (BBC West Midlands and BBC East Midlands) are considered. The BBC has already implemented service linking information using RDS on FM in these regions. Within each region, there are several BBC Local stations which provide local services from their own studios for most of the day. During the evening and at night, the local stations link up with other stations (these can be stations within their own region, stations belonging to other regions, or national services). This pattern applies similarly in other BBC regions.

Tables G.1 and G.2 indicate how the programme feed changes during the evening and night-time for the two BBC regions.

Table G.1: Programme feed allocation for BBC Local services in the West Midlands region

Time e.g. Service	$< T_1$ < 19.05	$T_1 – T_2$ 19.05 – 20.00	$T_2 – T_3$ 20.00 - 20.03	$T_3 – T_4$ 20.03 - 20.05	$T_4 – T_5$ 20.05 - 21.00	$T_5 – T_6$ 21.00 - 21.03	$T_6 – T_7$ 21.03 - 21.05	$T_7 – T_8$ 21.05 - 22.00	$T_8 – T_9$ 22.00 - 00.00	$> T_9$ 00.00 – 05.00
WM	WM	WM	WM	WM	Derby	WM	WM	WM	WM	World
C&W	WM	C&W	WM	WM	Derby	WM	WM	WM	WM	World
H&W	H&W	H&W	WM	WM	Derby	WM	WM	WM	WM	World
Shrop	Shrop	H&W	WM	WM	Derby	WM	WM	WM	WM	World
Stoke	Stoke	H&W	WM	WM	Derby	WM	WM	WM	WM	World

Table G.2: Programme feed allocation for BBC Local services in the East Midlands region

Time Service	$< T_1$	$T_1 – T_2$	$T_2 – T_3$	$T_3 – T_4$	$T_4 – T_5$	$T_5 – T_6$	$T_6 – T_7$	$T_7 – T_8$	$T_8 – T_9$	$> T_9$
Notts	Notts	Notts	WM	Notts	Derby	WM	Notts	WM	WM	Radio 2
Derby	Derby	Notts	WM	Notts	Derby	WM	Notts	WM	WM	Radio 2
Leics	Leics	Notts	WM	Notts	Derby	WM	Notts	WM	WM	Radio 2
Lincs	Lincs	Notts	WM	Notts	Derby	WM	Notts	WM	WM	Radio 2

The BBC expects to simulcast its local services on DAB and FM. Service linking information is required when stations carry a common programme feed. The BBC allocates Linkage Set Numbers (LSNs) on the basis of their programme source, although this is not essential to the linking process: other broadcasters can adopt a different strategy. Tables G.3 and G.4 indicate how the LSNs can be allocated during the evening and night-time for the two BBC regions. Two service identifiers are associated with each BBC Local station: the first is the DAB SId and the second is the PI code. LSNs, which are given within brackets, are for information only: they do not need to be signalled in connection with service linking.

Table G.3: LSN allocation for BBC Local services in the West Midlands region

Time Service	Service Ident.	$< T_1$	$T_1 – T_2$	$T_2 – T_3$	$T_3 – T_4$	$T_4 – T_5$	$T_5 – T_6$	$T_6 – T_7$	$T_7 – T_8$	$T_8 – T_9$	$> T_9$
WM	C423 C413	121	121	121	121	041	121	121	121	121	500
C&W	C823 C813	121	(117)	121	121	041	121	121	121	121	500
H&W	C523 C513	55	55	121	121	041	121	121	121	121	500
Shrop	CA23 CA13	(101)	55	121	121	041	121	121	121	121	500
Stoke	CC23 CC13	(107)	55	121	121	041	121	121	121	121	500

Table G.4: LSN allocation for BBC Local services in the East Midlands region

Time Service	Service Ident.	< T_1	T_1 – T_2	T_2 – T_3	T_3 – T_4	T_4 – T_5	T_5 – T_6	T_6 – T_7	T_7 – T_8	T_8 – T_9	> T_9
Notts	C723 C713	091	091	121	091	041	121	091	121	121	003
Derby	C623 C613	041	091	121	091	041	121	091	121	121	003
Leics	C923 C913	(073)	091	121	091	041	121	091	121	121	003
Lincs	CB23 CB13	(075)	091	121	091	041	121	091	121	121	003

G.2 DAB signalling

BBC local stations are being broadcast in different DAB ensembles, managed by the independent broadcasters. Ensembles are expected to be assigned on a conventional frequency planning grid. Consider the example of one such ensemble which carries BBC Radio Derby. The DAB Service linking information, required for this ensemble, is indicated in table G.5. The example covers the evening period and the night-time until 5 o'clock the next morning, and is based on the linking requirements given in tables G.3 and G.4. For each time slot, a short linking information description is given and a summarized version of the coding. Note that the Shorthand (Shd) device cannot be used in these cases.

NOTE 1: This example is based on the current RDS implementation in the UK and the relatively short periods (3 minutes) of the links that are signalled are not recommended for DAB. For this reason, the clock times given in the first column are represented by the periods T_1, T_2, T_3, etc.

NOTE 2: This example does not include details of the change event signalling that is required for DAB implementation.

Table G.5: DAB Service linking information for BBC Radio Derby (C623) in the evening

Time	Linking description	OE	LA	S/H	Id list	LSN	Id lst qul	Id list
T_1	Link to Notts (+ Leics & Lincs): DAB I	0	1	1	1	091	00	C623, C723, C923, CB23
	Link to Notts (+ Leics & Lincs): FM	0	1	1	1	091	01	C613, C713, C913, CB13
T_2	Link to WM (+ C&W, H&W, Shrop, Stoke, Notts, Leics & Lincs):DAB	0	1	1	1	121	00	C623, C423, C823, C523, CA23, CC23, C723, C923,
	Link to WM (+ C&W, H&W, Shrop, Stoke, Notts, Leics & Lincs):FM	0	1	1	1	121	01	CB23 C613, C413, C813, C513, CA13, CC13, C713, C913, CB13
T_3	Link to Notts (+ Leics & Lincs): DAB	0	1	1	1	091	00	C623, C723, C923, CB23
	Link to Notts (+ Leics & Lincs): FM	0	1	1	1	091	01	C613, C713, C913, CB13
	Link to WM maintained for C&W, H&W, Shrop & Stoke:DAB	1	1	1	1	121	00	C423, C823, C523, CA23, CC23
	Link to WM maintained for C&W, H&W, Shrop & Stoke:FM	1	1	1	1	121	01	C413, C813, C513, CA13, CC13
T_4	Link with WM, C&W, H&W, Shrop, Stoke, Notts, Leics & Lincs:DAB	0	1	1	1	041	00	C623, C423, C823, C523, CA23, CC23, C723, C923,
	Link with WM, C&W, H&W, Shrop, Stoke, Notts, Leics & Lincs:FM	0	1	1	1	041	01	CB23
II								C613, C413, C813, C513, CA13, CC13, C713, C913, CB13
T_5	Link to WM (+ C&W, H&W, Shrop, Stoke, Notts, Leics & Lincs):DAB	0	1	1	1	121	00	C623, C423, C823, C523, CA23, CC23, C723, C923,
	Link to WM (+ C&W, H&W, Shrop, Stoke, Notts, Leics & Lincs):FM	0	1	1	1	121	01	CB23
III								C613, C413, C813, C513, CA13, CC13, C713, C913, CB13
T_6	Link to Notts (+ Leics & Lincs):DAB	0	1	1	1	091	00	C623, C723, C923, CB23
	Link to Notts (+ Leics & Lincs):FM	0	1	1	1	091	01	C613, C713, C913, CB13
	Link to WM maintained for C&W, H&W, Shrop & Stoke:DAB	1	1	1	1	121	00	C423, C823, C523, CA23, CC23
	Link to WM maintained for C&W, H&W, Shrop & Stoke:FM	1	1	1	1	121	01	C413, C813, C513, CA13, CC13
T_7	Link to WM (+ C&W, H&W, Shrop, Stoke, Notts, Leics & Lincs):DAB	0	1	1	1	121	00	C623, C423, C823, C523, CA23, CC23, C723, C923,
	Link to WM (+ C&W, H&W, Shrop, Stoke, Notts, Leics & Lincs):FM	0	1	1	1	121	01	CB23 C613, C413, C813, C513, CA13, CC13, C713, C913, CB13
T_8	Link to BBC Radio 2 (+ Notts, Leics, Lincs, Norfk, Suffk, Essex, NHant, 3CR & Cambr):DAB	0	1	1	1	003	00	C623, C222, C723, C923, CB23, C921, CA21, C821, CF21, C721, C421
	Link to BBC Radio 2 (+ Notts, Leics, Lincs, Norfk, Suffk, Essex, NHant, 3CR & Cambr):FM	0	1	1	1	003	01	C613, C202, C713, C913, CB13, C911, CA11, C811, CF11, C711, C411
T_9	De-activate link to BBC Radio 2 IV	0	0	1	0	003		

Examples of particular service linking requirements are indicated using a bold symbol in the time or at the end of the description box.

I Activate the links of at least two services;

II Link at least one additional service to an activated link;

III Maintain a link but change the source;

IV De-activate a link;

The information in table G.5 is only concerned with linking services that can or do carry the same audio programme (and so the S/H flag is always set to "1"). Separate information is given for signalling DAB and FM services (using the Id list qualifier field).

G.3 Service linking information for defining generic families

Soft links are treated entirely separately from hard links. This is additional information that can be signalled explicitly in DAB and replaces the indirect signalling approach, using the structure of the PI code, used in RDS. An example showing the service linking information required to define a family of BBC English Local stations is given in table G.6. In this case, the S/H flag is reset to "0" and the LSN field becomes an identifier for the generic family. In this example, the family identifier is "001". This service linking information is unlikely to change often: services may be added or removed from time to time.

Table G.6: Service linking information for defining the Generic family for BBC Local stations

Time	Linking description	OE	LA	S/H	Id list	Shd	LSN	Id lst qul	Id list
All	The Generic family for BBC English Local stations comprises:	0	1	0	1	1	001	00	
	Derby, 3CR, Berks, Bristol, Cambr, Clevedon, Cornwall, CumbriaN, CumbriaS, Devon, Dorset & Essex (DAB), Glos, Guernsey, H&W, Humb, Jersey, Kent, Lancs, Leeds, Leics, Lincs, GLR & GMR (DAB), Mersey, Newcastle, Norfk, NHant, Notts, Oxford, Sheff, Shrop, Solent, Stoke, Suffk & SCR (DAB), C&W, WM, Wilts, Sals & York (DAB);	1	1	0	1	1	001	10	C623, C421, C422, C424, C427
	3CR, Berks, Bristol, Cambr, Clevedon, Cornwall, CumbriaN, CumbriaS, Derby, Devon, Dorset & Essex (FM), Glos, Guernsey, H&W, Humb, Jersey, Kent, Lancs, Leeds, Leics, Lincs, GLR & GMR (FM), Mersey, Newcastle, Norfk, NHant, Notts, Oxford, Sheff, Shrop, Solent, Stoke, Suffk & SCR (FM), C&W, WM, Wilts, Sals & York (FM).								C411, C412, C413, C414, C417

G.4 Deaf-Blind illustration

Some of the problems associated with signalling service linking information can be illustrated by considering an imaginary journey, travelling through the coverage areas of three different Single Frequency networks (SFNs) as shown in figure G.1. Within these areas, there is one particular Service of interest. For most of the time, all three services are independent and broadcast their own programmes. At other times, they share the same programme and, during this period, the three services are "hard-linked" together (using a common LSN = "112". In addition, OE Services information signals the presence of other ensembles and FI provides the corresponding radio frequencies. A key element of this example is that neighbouring SFNs cross-reference each other, but SFN 1 and SFN 3, which are geographically separated, do not. During the linked period, the parameters can be summarized as follows:

SFN 1:	SIdp;	LSN (112);	OE Services (SIq);	FI (SFN 2);
SFN 2:	SIdq;	LSN (112);	OE Services (SIdp), OE Services (SIdr);	FI (SFN 1,3);
SFN 3:	SIdr;	LSN (112);	OE Services (SIdq);	FI (SFN 2).

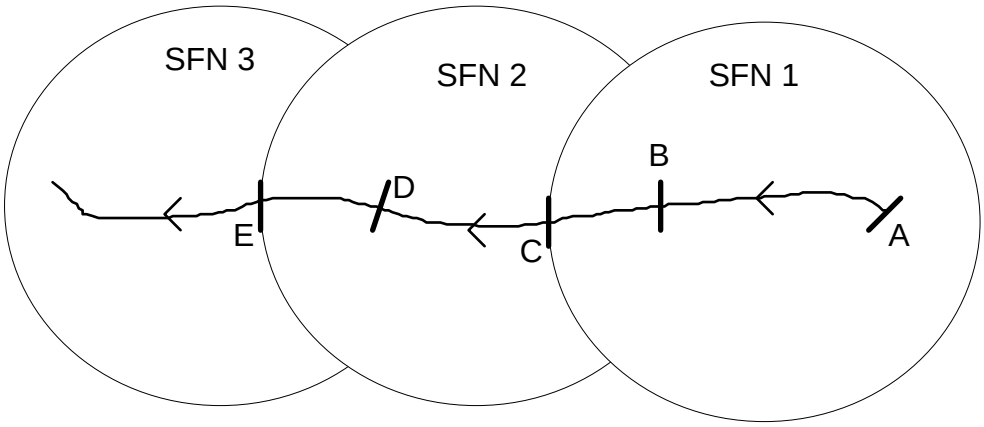


Figure G.1: An imaginary route through Three SFN coverage areas

Starting at **A**, suppose that the listener selects SIdp (this is his preferred service and can be considered to be the *original* service). When the point **B** is reached, the receiver enters the coverage area of SFN 2 and the receiver is now able to make use of the Service linking information to provide an alternative service source using SIdq, which is hard-linked to SIdp. Although a receiver is expected to provide sufficient hysteresis to prevent unnecessary switching between the two ensembles, there is always a chance to return to the *original* service. At point **C**, the coverage area of SFN 1 comes to an end and there is no longer an alternative service source. If Link 112 terminated at this point, the receiver would be left with the service SIdq because the original service is lost. The receiver is said to be "DEAF" at this point. When the journey is continued to point **D**, the receiver enters the coverage area of SFN 3 and the receiver is now able to make use of the Service linking information to provide an alternative service source using SIdr, which is hard-linked to SIdq. At point **E**, the coverage area of SFN2 comes to an end and there is no longer an alternative service source. If Link 112 terminated at this point, the receiver would be left with the service Sidr. Also, the *original* service is no longer signalled as an OE service (and there is no FI for it). The receiver is said to be "DEAF" and "BLIND" at this point. In general, if a Service Link comes to an end at a point where the *original* service is no longer receivable, the receiver is probably best advised to remain with the service it is currently accessing.

Annex H: Bibliography

ETSI TS 101 500: "Digital Audio Broadcasting (DAB) Multichannel Audio".

ETSI TS 101 499: "Digital Audio Broadcasting (DAB), Slide Show Application".

History

Document history		
V1.1.1	November 2000	Publication
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