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ETSI

European Telecommunications Standards Institute

ETSI Secretariat

Postal address: F-06921 Sophia Antipolis CEDEX - FRANCE
Office address: 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE
X.400: c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

Tel.: +33 4 92 94 42 00 - Fax: +33 4 93 65 47 16

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Foreword

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

NOTE: The EBU/ETSI JTC was established in 1990 to co-ordinate the drafting of ETSs in the specific field of broadcasting and related fields. Since 1995 the JTC 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*.

* European Broadcasting Union
Case Postale 67
CH-1218 GRAND SACONNEX (Geneva)
Switzerland

Tel: +41 22 717 21 11
Fax: +41 22 717 24 81

EUREKA Project 147 (DAB**)

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

** DAB is a registered trademark owned by one of the EUREKA 147 partners.

ETSI Project Team PT 84V

An ETSI Project Team was formed to produce this ETS describing the Digital Audio Broadcasting (DAB) Ensemble Transport Interface (ETI). The work of the Project Team was based on studies carried out by a EUREKA 147 Task Force on the definition of the ETI. The Project Team consisted of members of European broadcasting organizations and the consumer and professional electronics industry who had also been involved in the work of the EUREKA Task Force.

Transposition dates	
Date of adoption:	22 August 1997
Date of latest announcement of this ETS (doa):	31 December 1997
Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	30 June 1998
Date of withdrawal of any conflicting National Standard (dow):	30 June 1998

Introduction

This ETS is one of a set associated with ETS 300 401 [1] describes the transmitted signal, the interface between the broadcaster's transmitters and the listener's receiver. The associated ETSs describe additional interfaces which can be used by broadcasters or network providers to build DAB networks.

Figure 1 shows a DAB network in outline. For convenience, the Network is split into a number of different parts, each managed by a different entity. The different entities are: the Programme/Data provider, the Service Component provider, the Ensemble provider and the Transmission Network provider.

NOTE: A Service Component provider may be generating a full DAB service or a component of a DAB service. For the purposes of this ETS, the terms Service provider and Service Component provider are interchangeable.

Programme/Data provider

The Programme/Data provider is the originator of the audio programme or the data being carried within the DAB Service Component. The format for the output of the Programme/Data provider may take many different forms and should be agreed between the Programme/Data provider and the Service Component provider.

Service Component provider

The Service Component provider is producing one or more complete Service Components which can form the complete DAB Service, but may not. The data from the Service Component provider will be of three different types:

- Service Component data which is to be inserted into the DAB Main Service Channel (MSC);
- Service Information related to the Service Component data which is to be inserted into the Fast Information Channel (FIC);
- Other data, not intended for transmission, including status monitoring or control.

The interface between the Service Component provider and the Ensemble provider is known as the Service Transport Interface (STI) and is defined in EN 300 797 [2].

Ensemble provider

The Ensemble provider receives a set of service components from one or more Service Component providers. He then formats the FIC, and generates an unambiguous description of the full DAB Ensemble.

The ensemble description is passed to the Transmission Network provider via an interface called the ETI which is the subject of this ETS.

Transmission Network provider

The Transmission Network provider generates the DAB Ensemble and transmits it to the receiver. The output of the Transmission provider is defined by ETS 300 401 [1].

In some cases, as an intermediate step, the Transmission provider may find it convenient to generate a base-band representation of the signal to be transmitted. The base-band representation, known as the Digital baseband I/Q Interface, is a set of digital samples defining the In-phase (I) and Quadrature (Q) components of the final carrier. This interface is defined in EN 300 798 [3] and provides a convenient interface between digital processing equipment and radio-frequency modulating equipment.

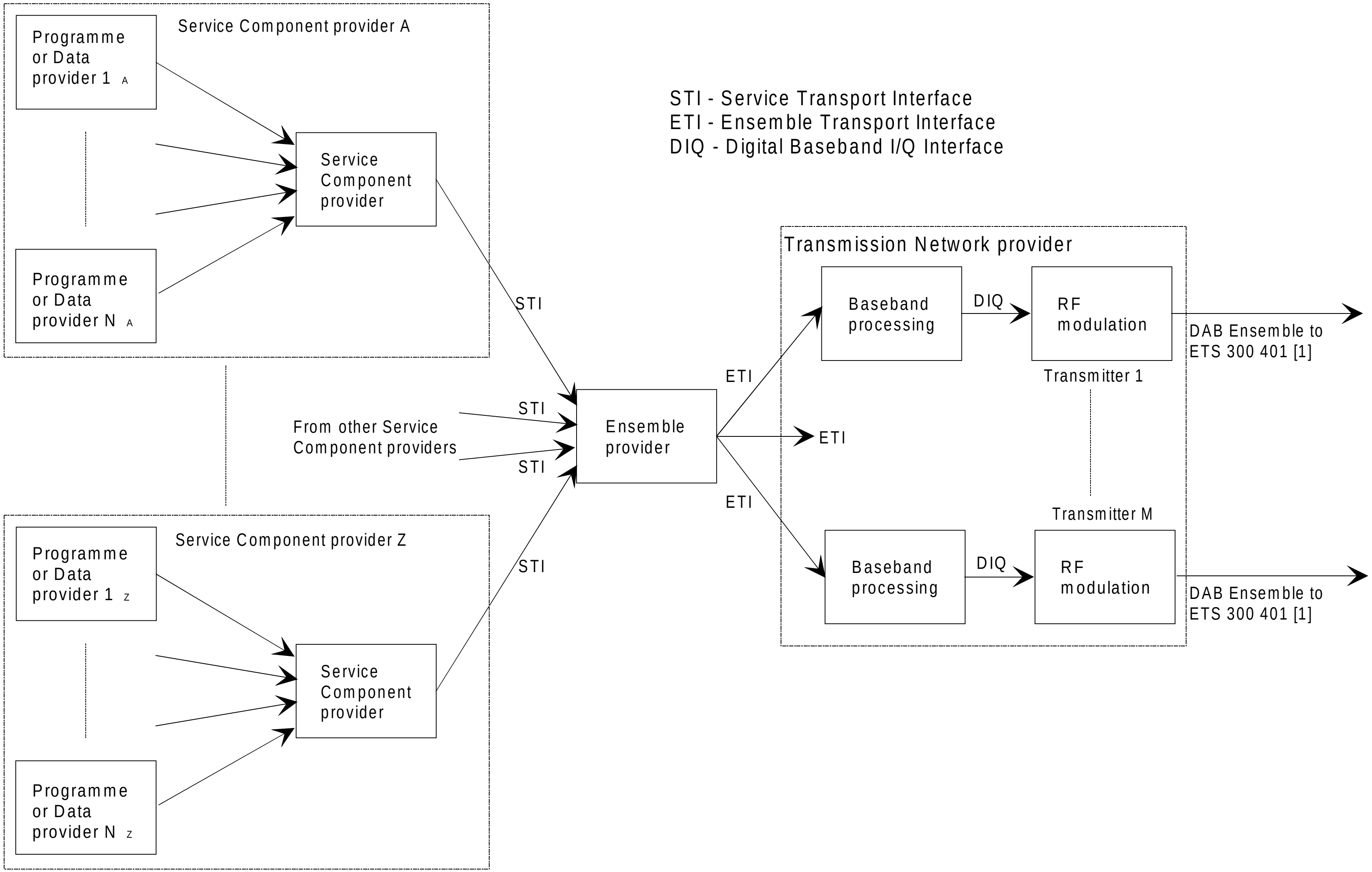

Figure 1: DAB network outline

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1 Scope

This European Telecommunication Standard (ETS) establishes a standard method for the distribution of DAB signals between DAB multiplexing equipment, which may be located at the broadcaster's studio centres, and DAB modulation equipment located at transmission sites.

ETS 300 401 [1] established a broadcasting standard for a DAB system. Broadcasters who implement DAB networks require methods for transporting DAB signals, or the component parts of a DAB signal, between studio centres, where the programme or data service originates, and the transmitter sites from which the signal will be radiated. The network of circuits connecting the studio centre to the transmitters is generally known as the Distribution Network.

This ETS is applicable to Distribution Networks used in a DAB System. It describes the characteristics of a signal suitable for transporting a full DAB Ensemble, comprising a number of sub-channels and a formatted Fast Information Channel (FIC), between the DAB Ensemble provider and the Transmission network provider. The interface is suitable for use on a number of different physical media including standard 2 Mbit/s switched telecommunication networks. Provision is made for the inclusion of appropriate error detection and correction and for the management of network transit delay. Limited capacity is also made available for signalling from the studio centre to other equipment in the distribution network.

This ETS is not applicable to the distribution of DAB signals where the Service Information is available in any form other than as a complete, correctly formatted, FIC. The interface described is intended for use on unidirectional networks and this ETS does not cover the provision of status nor control information in the reverse direction (i.e. from transmitters back to the Ensemble provider or any other central monitoring point).

2 Normative references

This ETS incorporates, by dated and undated references, provisions from other publications. These normative references are cited at appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions to any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

[1] ETS 300 401 (1996): "Radio broadcasting systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers".

[2] prEN 300 797: "Digital Audio Broadcasting (DAB); Distribution interfaces; Service Transport Interface (STI)".

[3] prEN 300 798: "Digital Audio Broadcasting (DAB); Distribution interfaces; Digital baseband I/Q interface (DIQ)".

[4] ITU-T Recommendation G.703 (1972): "Physical/Electrical characteristics of hierarchical digital interfaces: Section 6. Interface at 2 048 kbit/s".

[5] ITU-T Recommendation X.24 (1988): "List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) on public data networks".

[6] ITU-T Recommendation V.11 (1988): "Electrical characteristics for balanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communications".

[7] ITU-T Recommendation G.704 (1988): "Synchronous frame structures used at primary and secondary hierarchical levels: Section 2.3 Basic frame structure at 2 048 kbit/s".

[8] ITU-T Recommendation G.706 (1988): "Frame alignment and cyclic redundancy check (CRC) procedures relating to basic frame structures defined in Recommendation G.704".

3 Definitions, abbreviations and symbols

3.1 Definitions

For the purposes of this ETS, the definitions of ETS 300 401 [1] and the following definitions apply:

block: A component part of an ETI(NA, G.704) multiframe consisting of 8 G.704 frames. Each block comprises 256 bytes.

CIFcount: The common interleaved Frame (CIF) counter as defined in ETS 300 401 [1].

codeword: A Reed-Solomon codeword, as used by ETI(NA, G.704), comprises 240 bytes. Some of these bytes are data bytes, others are check bytes.

coding array: An array used in the conceptual description of ETI(NA, G.704).

CRC_h: A part of ETI(LI) containing a Cyclic Redundancy Check for header information.

distribution network: The network of data circuits linking the Service provider, Ensemble provider and Transmission Network provider.

ensemble multiplex: A set of data which describes the component parts of the DAB ensemble.

ensemble multiplexer: A multiplexer which generates an Ensemble multiplex.

ensemble provider: The manager of the DAB Ensemble multiplexer.

ensemble transport network: The network carrying the Ensemble Transport Interface.

EOF: A part of ETI(LI) containing End-Of-Frame information.

EOH: A part of ETI(LI) containing End-Of-Header information.

ERR: A part of ETI(LI) which can be modified by the physical layers to allow the reporting of ERRor status information.

ETI(LI): The logical definition of the Ensemble Transport Interface.

ETI(NA, G.704): A network adapted Ensemble Transport Interface containing DAB data as well as additional data to deal with network errors and delay variations.

ETI(NA, X): Any of the specific implementations of ETI(NA) which are described in this ETS.

ETI(NI): A generic reference to a basic physical implementation of the ETI suited to the local connection of equipment. If there is any ambiguity in the text, then ETI(NI) shall be taken to be equivalent to ETI(NI, G.703).

ETI(NI, G.703): A specific implementation of an ETI(NI) used on G.703 interfaces.

ETI(NI, V11): A specific implementation of an ETI(NI) used on V.11 interfaces.

ETI(NI, X): Any of the specific implementations of ETI(NI) which are described in this ETS.

FC: A part of ETI(LI) containing Frame Characterization data.

FCT: A part of ETI(LI) containing a Frame CounT.

FICF: A part of ETI(LI) indicating whether FIC information is included, FIC Flag.

FICL: The length, in words, of the FIC data carried by the ETI.

FL: A part of ETI(LI) giving information about the Frame Length.

FP: A part of ETI(LI) containing Frame Phase information.

frame: An ETI Frame carries data representing a 24 ms period of the DAB ensemble.

FRPD: A part of ETI(LI) containing FRame PaDding.

FSYNC: The synchronizing field of ETI(NI, G.703) or ETI(NI, V11) frames.

G.703: An ITU-T Recommendation giving information about the physical characteristics of telecommunication interfaces.

G.704 frame: A framing structure of 32 8-bit timeslots as defined in G.704 (for 2 Mbit/s interfaces).

G.704: An ITU-T Recommendation defining telecommunication framing structures.

GF(28): A mathematical entity (a Gallois Field of 256 entries) used in the process of producing Reed-Solomon error protection bytes.

interleaving array: An array used in the conceptual description of ETI(NA, G.704).

LIDATA field: A part of ETI(LI) which carries the data describing the DAB transmitted signal.

Logical Interface (LI): A definition of the ETI which contains all the elements to be carried by the interface, but has no physical manifestation.

MID: A part of ETI(LI) giving information about the DAB Mode IDentity.

MNSC: A part of ETI(LI) carrying a Multiplex Network Signalling Channel.

mode: The DAB signal described in ETS 300 401 [1] is able to operate in four different modes (I to IV) to suit different applications.

MSC: The Main Service Channel, a part of the DAB signal described in ETS 300 401 [1].

MST: A part of ETI(LI) carrying Main STream information, destined for the MSC and FIC fields of the DAB ensemble.

multiframe: A composite frame structure used in ETI(NA, G.704) to map the 24 ms time-frame of ETI(LI) onto the elemental G.704 frames.

NASC: A part of ETI(NA, G.704) carrying a Network Adapted Signalling Channel.

Network Adaptation (NA): The process of adapting ETI(LI) to suit the characteristics of a particular network.

Network Independent (NI): A physical form of the ETI interface which is not adapted to any particular network but can be used for a local connection between equipment.

NST: A part of ETI(LI) giving information about the Number of STreams being carried.

OFDM generator: The equipment which is the final recipient of the ETI signal and which applies the DAB channel encoding.

Plesiochronous Digital Hierarchy (PDH): A telecommunications network structure having a number of different hierarchical levels.

Reed-Solomon: A form of coding which allows the correction of transmission errors.

$SSTC_n$: A part of ETI(LI) which defines the Sub-channel STream Characteristics of data stream n.

Status Field (STAT): A part of the ETI(LI) which carries status information about the LIDATA field. The STAT field can be modified by physical interfaces to allow status information to be updated as the signal is carried through the distribution network.

STC: A part of ETI(LI) which carries information about the characteristics of the sub-channel data streams.

STL: A part of ETI(LI) which gives the STream Length of an uncoded sub-channel stream.

stream: In ETI(LI) a data stream is associated with a DAB sub-channel and carries the data which will eventually be carried in the associated sub-channel of the DAB ensemble.

superblock: One of the components of an ETI(NA, G.704) multiframe consisting of 8 blocks. Each superblock comprises 2 048 bytes.

SYNC: A part of ETI(NI, G.703) and ETI(NI, V11). The SYNChronization field carries status information and signifies the start of the frame.

timeslot: A part of the frame structure defined in G.704 comprising 8 bits.

timestamp: Data which carries timing information intended to define the "delivery time" of the frame carrying the timestamp.

TIST: A part of ETI(LI) comprising a 24-bit TImeSTamp.

transmission network provider: The provider of the DAB Transmission Network. The ETI links the Multiplexer of the Ensemble Provider with the transmitters of the Transmission Network Provider.

Transmitter Identification Information (TII): TII is a label unique to each transmitter in a DAB network. Provision is made for each transmitter to radiate its own TII label during the synchronization symbols of the transmitted signal.

V.11: An ITU-T recommendation defining an electrical interface using balanced lines.

word: A word consists of 4 bytes (32 bits).

3.2 Abbreviations

For the purposes of this ETS, the abbreviations of ETS 300 401 [1] and the following abbreviations apply:

ASS	frame ASynchronous Signalling
BER	Bit Error Rate
COFDM	Coded Orthogonal Frequency Division Multiplex
CRC	Cyclic Redundancy Checksum
CRC_h	header CRC
DAB	Digital Audio Broadcasting
EOF	End Of Frame
EOH	End Of Header
ERR	Error Status
ETI	Ensemble Transport Interface
FC	Frame Characterization
FCT	Frame Count
FIC	Fast Information Channel
FICF	Fast Information Channel Flag
FL	Frame Length
FP	Frame Phase
FSS	Frame Synchronous Signalling
FSYNC	Frame SYNC
GrNb	Number of Groups
LI	Logical Interface
LIDATA	ETI(LI) DATA field
MID	Mode IDentity

MNSC	Multiplex Network Signalling Channel
MST	Main Stream
NA	Network Adaptation
NASC	Network Adapted Signalling Channel
NI	Network Independent
NST	Number of Audio or Data Streams
PDH	Plesiochronous Digital Hierarchy
RF	Radio Frequency
SAD	Sub-channel Start Address
SB	Signalling Byte
Sbch	Sub-channel ordinal number
SCID	Sub-channel Identifier
SFN	Single Frequency Network
$SSTC_n$	Sub-channel Stream Characterization (For stream n)
STAT	ETI(LI) Status Field
STC	Stream Characterization
STI	Service Transport Interface
STL	Stream Length (as a multiple of 64 bits)
SYNC	Synchronization field
TIST	Timestamp
TPL	Type and Protection Level
TSC	Transmitter Set-up and Control information

3.3 Symbols

For the purposes of this ETS, the following mathematical symbols apply:

3.3.1 Numerical ranges

[m..n]	denotes the numerical range m, m+1, m+2,..., n, where m and n are positive integers with n > m.
X_{16}	the subscript "16" is used to denote hexadecimal numbers.

3.3.2 Bit and byte numbering

b_n	denotes bit number *n. n* is usually in the range [0..7].
$B_{m,f}$	denotes byte number *m* in frame number *f*.
$B_{m,f}(b_n)$	denotes bit number *n* of byte *m* in frame *f*.
x	is used to denote an arbitrary binary value (0 or 1).

NOTE: *f* may sometimes be omitted where no ambiguity results.

3.3.3 Arithmetic operators

+	Addition.
$\times$	Multiplication.
m DIV p	denotes the quotient part of the division of m by p (m and p are positive integers).
m MOD p	denotes the remainder of the division of m by p (m and p are positive integers).
$\sum_{i=p}^{q} f(i)$	denotes the sum: $f(p) + f(p+1) + f(p+2) \ldots + f(q)$.
$\prod_{i=p}^{q} f(i)$	denotes the product: $f(p) \times f(p+1) \times f(p+2) \ldots \times f(q)$.

3.3.4 Logical operators

AND	Logical AND function.
OR	Logical OR function.
XOR	Exclusive-OR function

3.4 Ordering of bytes and bits for transmission

The bytes of each ETI frame shall be transmitted sequentially with the lowest numbered byte being transmitted first e.g. byte $B_{0,f}$ is transmitted before byte $B_{1,f}$ and so on. The highest numbered byte of frame *f* shall be transmitted earlier than the lowest numbered byte of frame $f + 1$.

The bits of each byte shall be transmitted sequentially with the lowest numbered bit being transmitted first e.g. $B_{0,1}(b_0)$ is transmitted before byte $B_{0,1}(b_1)$, and so on.

Unless otherwise stated in the associated text, data shall be carried with its Most Significant bit (MSb) in the lowest numbered bit of the lowest numbered byte. The next most significant bit shall be carried in the next lowest numbered bit of the lowest numbered byte, and so on. This implies that the MSb of any data byte shall be received earlier than the Least Significant bit (LSb).

3.5 Reserved bits

In some fields of the ETI, unused bits may be found. These are designated as:

Rfa: Reserved for future addition. The future use of Rfa bits is not expected to modify the usage of other bits in the same field as the Rfa bits.

Rfu: Reserved for future use. The future use of Rfu bits can modify the usage of other bits in the same field as the Rfu bits.

Unless otherwise specified, the values of bits designated as either Rfa or Rfu shall be set to zero.

4 Overview of the Ensemble Transport Interface (ETI) definition

4.1 The Layered approach to the ETI

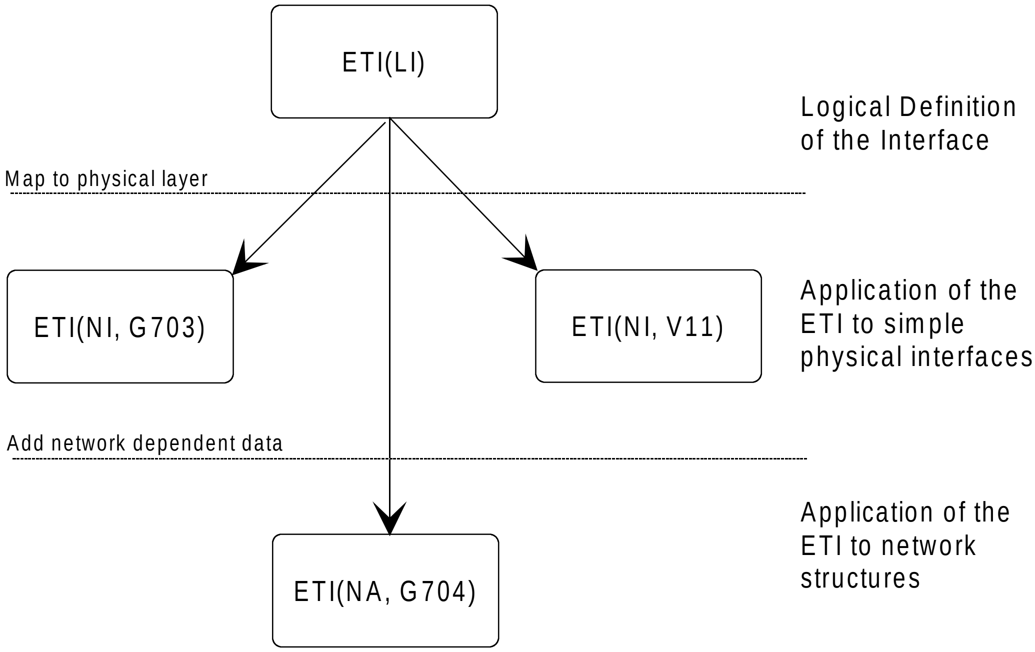


Figure 2: The layers of the ETI

The Ensemble Transport Interface is an interface signal which allows DAB signals to be routed between the Ensemble provider and the Transmission Network provider (see figure 1). The physical characteristics of the various transmission links will differ and a universal interface standard is not appropriate. The approach adopted in this ETS is to define the ETI in a number of different layers as shown in figure 2.

The **Logical Interface (LI)**, called ETI(LI), is the basic definition of the interface at its simplest level. It defines all the data which are needed to implement the functionality required of the ETI but has no physical manifestation. ETI(LI) contains sufficient information to specify precisely each element of the DAB signal to be generated, so that two OFDM generators fed with the same ETI inputs shall also have identical outputs (with the exception of the TII symbol).

The simplest physical manifestation of the interface is a mapping of ETI(LI) onto basic standard interfaces. These are called **Network Independent (NI)** layers. The Network Independent layers are suitable for use as interconnections between local equipment. However, since they contain only rudimentary error detection, they should not be used for transporting DAB over data networks unless the network is known to have an adequate performance. This can occur, for instance, on a satellite circuit where a satellite modem applies forward error correction appropriate to the characteristics of the satellite path. The Network Independent layer provides an interface signal to the satellite modem.

The different NI layers are designated as ETI(NI, X) where "X" signifies the appropriate type of local interface.

A **Network Adaptation** (NA) of the Logical Interface is also defined. Network Adaptation implies a mapping of the Logical Interface onto a physical signal suitable for transportation on the type of network envisaged. The Network Adaptation will include a definition of a physical interface as well as incorporating additional data in order to mitigate the characteristics of the transport network e.g. forward error correction bytes to allow correction or detection of network errors.

The different network adapted versions of the ETI are designated as ETI(NA, X) where "X" signifies the particular type of network to which the NA version is suited. ETI(NA) is sometimes used to make a generic reference applicable to all NA Layers.

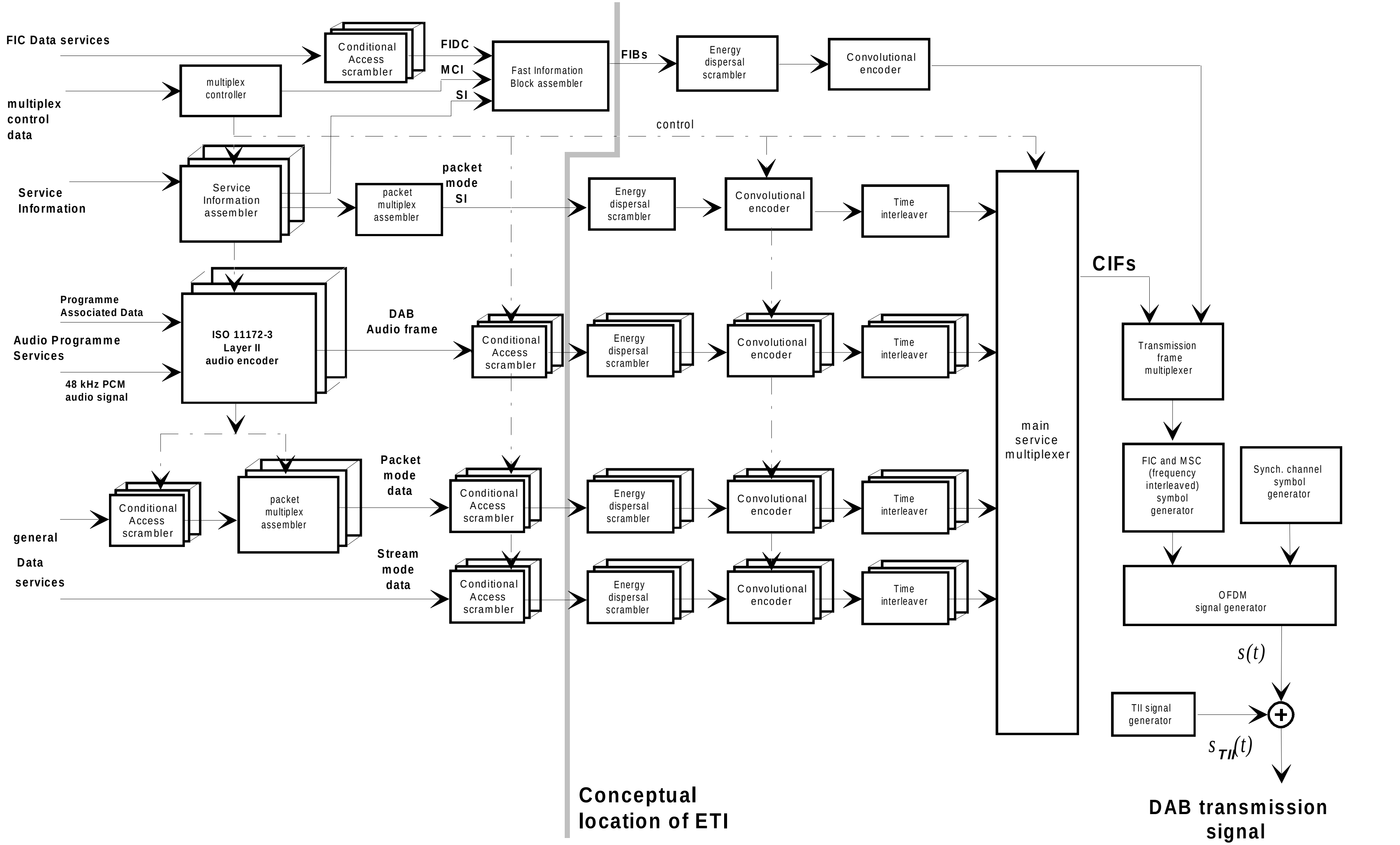


Figure 3: Conceptual DAB emission block diagram showing the location of the ETI

In some applications it may be convenient to produce the ETI in one physical form at a point in the Distribution Network and to convert to another physical form elsewhere in the network. Conceptually, at least, the conversion process between one physical form and another should include the re-generation of the logical, ETI(LI), level.

Figure 3 is copied from ETS 300 401 [1] and shows the conceptual block diagram of the emission part of the DAB system. The conceptual location of the ETI is shown on the diagram.

4.2 ETI data capacity

The transmission capacity of the MSC (including channel coding) is 2 304 kbit/s and is independent of the transmission mode.

The transmission capacity of the FIC (including channel coding) is 96 kbit/s in modes I, II and IV and 128 kbit/s in mode III.

In order that the ETI can be transported via networks with a capacity of 2 Mbit/s or less, DAB channel coding shall not be applied at the ETI source. Instead, DAB channel coding shall be applied at the ETI destination (by the Transmission Network provider).

Since the amount of channel coding applied in the DAB ensemble is variable, then the data capacity required of the ETI is also variable. An overview to the channel coding rates which are applied to different parts of the DAB ensemble (together with their associated uncoded data rates) is given in table 1.

Table 1: Channel coding rates in DAB

	"protection level" (note 1)	code rate	data rate per sub-channel before coding
FIC	fixed	1/3	32 kbit/s (modes I/II/IV) 42,67 kbit/s (mode III)
sub-channels with equal error protection profiles ("Option" = 000) (note 1)	1-A 2-A 3-A 4-A	1/4 3/8 1/2 3/4	n × 8 kbit/s
sub-channels with equal error protection profiles ("Option" = 001) (note 1)	1-B 2-B 3-B 4-B	4/9 4/7 4/6 4/5	n × 32 kbit/s
sub-channels with unequal error protection profiles	1 2 3 4 5	0,34 av. 0,43 av. 0,50 av. 0,6 av. 0,75 av.	32 kbit/s .. 384 kbit/s (note 2)
NOTE 1: "Option" and "protection level" refer to parameters used, in ETS 300 401 [1], to denote the channel coding rate applied to the data. NOTE 2: Unequal error protection profiles are only available for certain data rates within this range.			

4.3 Minimum requirement for ETI equipment

The minimum requirement for any equipment producing or accepting an ETI signal is that it shall generate or accept a signal with the ETI(NI, G.703) format.

5 Logical definition of ETI(LI)

The ETI(LI) layer is the logical definition of the ETI and shall be composed of logical frames. Each logical frame shall contain the information needed to generate a 24 ms period of the DAB signal. The LI layer shall consist of a status and a data field as shown in figure 4.

The status field shall give information about the quality of the transport network and may be changed by any physical layer of the ETI.

The data field shall carry information that is transparent to all physical layers of the ETI and its content shall not be changed by other layers in an error free transmission.

Status field (STAT)	Data field (LIDATA)

Figure 4: The structure of an ETI(LI) frame

5.1 General structure

The ETI(LI) shall be composed of logical frames that consist of a variable number of bytes, (FL × 4 + 13), where FL is the Frame Length as defined in subclause 5.3.6. The basic frame structure is illustrated in figure 5 and shall consist of:

- a status field of 1 byte, STAT, which shall consist of an 8-bit error status field ERR; and
- a data field, LIDATA, which comprises:
    - a frame characterization field, FC, of 4 bytes;
    - a stream characterization field, STC, of variable size (up to 256 bytes);
    - an End-Of-Header field, EOH, of 4 bytes;
    - a Main STream data field, MST, of variable size;
    - an end of frame field, EOF, of 4 bytes;
    - a time stamp field, TIST, of 4 bytes.

5.2 Error field (ERR)

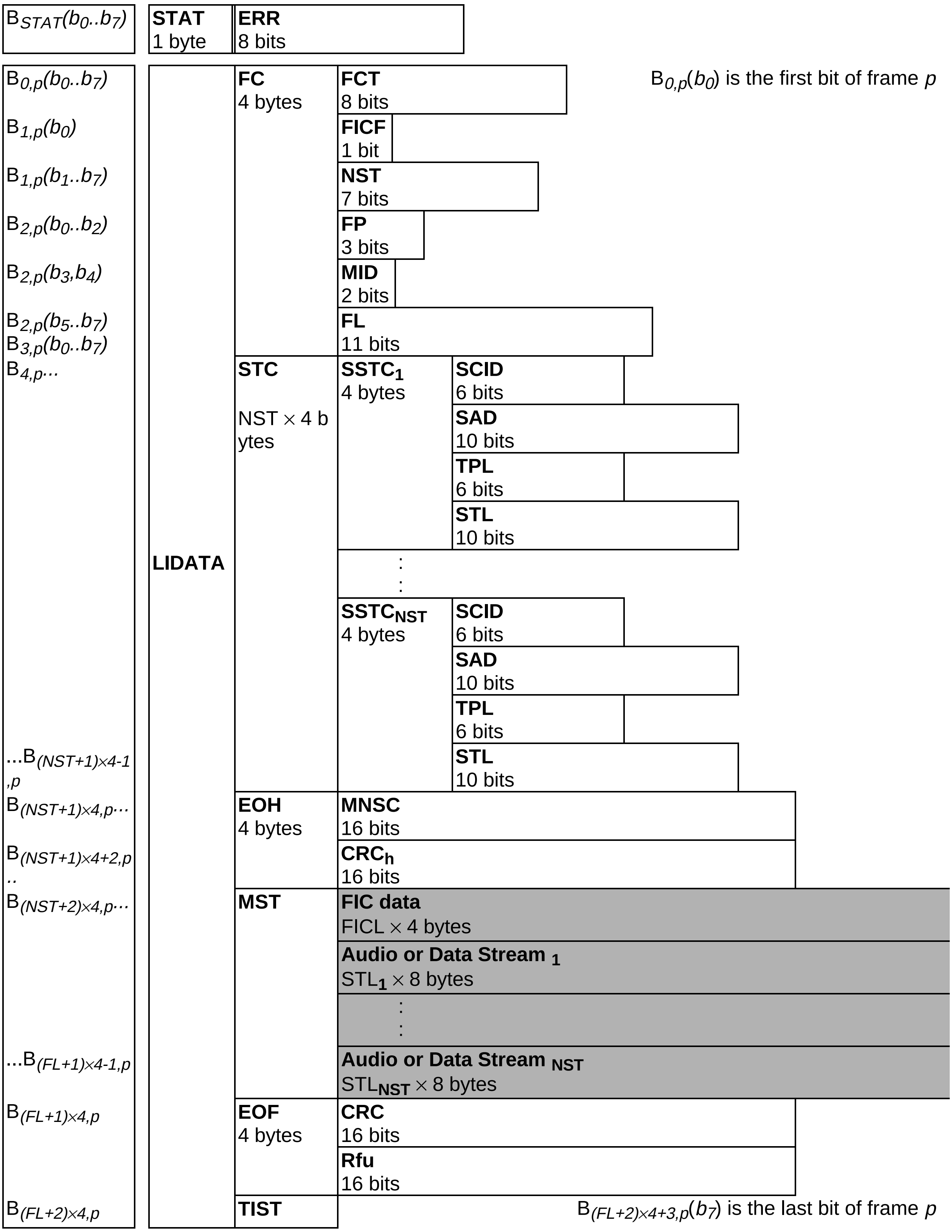
The ERR byte may contain information which conveys information about the error status of the following data of the same ETI(LI) frame p. This field may be filled by error information derived from the ETI(NI) or ETI(NA) layer. Four levels of errors shall be defined as given in table 2.

Table 2: Definition of error status

b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7	**Error status**
1	1	1	1	1	1	1	1	Error level 0
1	1	1	1	0	0	0	0	Error level 1
0	0	0	0	1	1	1	1	Error level 2
0	0	0	0	0	0	0	0	Error level 3

The definition of the Error Levels will depend on the specific implementation but the following general guidelines should be used.

Error level 0: LIDATA contains no detectable errors (which shall be the default state, set at the origin of LIDATA).
Error level 1: LIDATA contains errors which can be ignored by the processing equipment.
Error level 2: LIDATA contains errors which should not be ignored by the processing equipment but which may be mitigated by additional processing within that equipment, for example by using header information from previous frames.
Error level 3: LIDATA is not valid and the processing equipment should mute.



The shaded part indicates data which will be radiated as part of the DAB Ensemble

The un-shaded fields are ETI(LI) management data.

Figure 5: The structure of an ETI(LI) 24 ms logical frame

5.3 Frame Characterization field (FC)

The frame characterization field shall carry common data characteristics that apply to the whole logical frame.

The FC for frame *p* shall be carried in bytes, $B_{[0..3],p}$. It shall contain an 8-bit frame count field, a 1-bit field indicating whether or not the FIC is present, a 7-bit field giving the number of streams of data being carried, a 3-bit frame phase field, a 2-bit DAB mode identity field, and an 11-bit field containing the frame length.

5.3.1 Frame Count (FCT)

The FCT shall be carried in $B_{0,p}(b_0..b_7)$. FCT shall take values from 0 to 249 and shall be given by the lower part of CIFcount [0..249], see ETS 300 401 [1].

FCT shall increment once every 24 ms and shall have an overall periodicity of six seconds.

5.3.2 Fast Information Channel Flag (FICF)

The FIC Flag shall be carried in $B_{1,p}(b_0)$.

When set to 0 it shall indicate that no FIC information is carried in the Main Stream field. This implies that the FIC information shall be inserted at some later stage, usually before the ETI(LI) is received by a COFDM generator.

When set to 1 it shall indicate that the Main Stream field carries the uncoded FIC data.

The length of the FIC data field, FICL, shall be determined by the DAB mode and the FIC Flag according to table 3.

Table 3: Relationship between DAB mode, FICF and FICL

DAB mode	FICF	FICL (words)
I,II, III or IV	0	0
I, II or IV	1	24
III	1	32

5.3.3 Number of Streams (NST)

The NST field shall give information about the number of data streams for which information shall be carried in the stream characterization and Main STream data fields. It shall be carried as a 7-bit number in $B_{1,p}(b_1..b_7)$. NST shall be calculated as follows:

NST[0..64] = *sub-channels*,

where *sub-channels* shall be the number of DAB audio or data sub-channels for which information shall be carried.

Except for the case given below, the value of NST shall be in the range 1 to 64.

In the 15-frame period immediately preceding a multiplex re-configuration, NST can take the value 0 (see annex E).

5.3.4 Frame Phase (FP)

The FP information shall be carried in $B_{2,p}(b_0..b_2)$. It shall be a modulo 8 count, incremented once per frame and shall be used to signal to the COFDM generator when to insert Transmitter Identification Information (TII) into the null symbol of the transmitted DAB signal. The two bits $B_{2,p}(b_1,b_2)$ shall be used as a byte-pair counter for the Multiplex Network Signalling Channel (see subclause 5.5.1).

There shall be a fixed relationship between FP and the DAB Common Interleaved Frame Counter, *CIFcount*. FP shall be set to zero when *CIFcount* = 0.

Table 4 gives the relationship between FP, the mode I frame quarter (or the mode IV frame half) and the information contained in the associated null symbol. Some CIF count values are given as examples.

Table 4: Relationship between TII symbol generation and FP bits ($b_0..b_2$)

DAB mode	b_0	b_1	b_2	Null symbol information	DAB frame part	CIF count (possible values)
I	0	0	0	TII included	1st quarter	00; 08..248..4 992
I	0	0	1	TII included	2nd quarter	01; 09..249..4 993
I	0	1	0	TII included	3rd quarter	02; 10..250..4 994
I	0	1	1	TII included	4th quarter	03; 11..251..4 995
I	1	0	0	No TII	1st quarter	04; 12..252..4 996
I	1	0	1	No TII	2nd quarter	05; 13..253..4 997
I	1	1	0	No TII	3rd quarter	06; 14..254..4 998
I	1	1	1	No TII	4th quarter	07; 15..255..4 999
II or III	x	0	0	TII included	not relevant	00; 04..248..4 996
II or III	x	0	1	No TII	not relevant	01; 05..249..4 997
II or III	x	1	0	TII included	not relevant	02; 06..250..4 998
II or III	x	1	1	No TII	not relevant	03; 07..251..4 999
IV	x	0	0	TII included	1st half	00; 04..248..4 996
IV	x	0	1	TII included	2nd half	01; 05..249..4 997
IV	x	1	0	No TII	1st half	02; 06..250..4 998
IV	x	1	1	No TII	2nd half	03; 07..251..4 999

5.3.5 Mode Identity (MID)

The MID field should instruct the COFDM generator on the DAB mode to be used to code data carried in the frame. It shall be carried in $B_{2,p}(b_3, b_4)$ and shall be coded as given in table 5.

Table 5: Coding of MID

b_3	b_4	DAB mode
0	1	Mode I
1	0	Mode II
1	1	Mode III
0	0	Mode IV

The MID combined with FICF shall be used also to indicate the length of the FIC data stream carried in the MST (see also subclause 5.3.2).

5.3.6 Frame Length (FL)

The FL field shall carry information about the length of the three fields: stream characterization (STC), End-Of-Header (EOH) and Main STream (MST). It shall be an 11-bit count which shall give the total number of words included in all three fields.

The value of FL in words is given by:

For NST = 0, $FL = 1 + FICL$;

For NST ≠ 0, $FL = NST + 1 + FICL + \sum_{Sbch=1}^{NST} \left[STL_{Sbch} \times 2 \right]$.

where:

- *Sbch* shall be the ordinal number of the sub-channel in the MST (i.e. 1 for the first sub-channel, 2 for the second, and so on).
- STL_{Sbch} shall be the stream length of the sub-channel whose ordinal number is *Sbch*. See subclause 5.4.1.4 for the definition of STL.
- FICL shall be the length of the FIC data in words as defined in the subclause 5.3.2.

The FL for frame p shall be carried in bytes $B_{2,p}(b_5..b_7)$ and $B_{3,p}(b_0..b_7)$.

5.4 Stream Characterization (STC)

Provided that NST ≠ 0, bytes $B_{[4..(NST+1)\times 4-1],p}$ shall carry information about the characteristics of the sub-channel data streams.

5.4.1 Sub-channel Stream Characterization ($SSTC_n$)

Within the STC, information characterizing each audio or data sub-channel shall be carried. A single word (32 bits) shall be used for each sub-channel, giving a 6-bit sub-channel identifier, a 10-bit start address, a 6-bit protection level code and a 10-bit number giving the length of the associated data carried in the Main STream.

5.4.1.1 Sub-Channel Identifier (SCID)

Each sub-channel stream shall be associated with a 6-bit number, SCID.

Each SCID value shall be unique.

The identifier shall be carried in $B_{Sbch\times 4,p}(b_0..b_5)$.

The SCID can be the same as *SubChId*, used in ETS 300 401 [1].

The order in which data for the sub-channels are transmitted in the MST need not be governed by SCID.

The SSTC field and the sub-channel payload data in MST shall have the same ordinal value, Sbch.

The SCID should be used in DAB transmissions as a logical link number when a new frame organization occurs.

5.4.1.2 Sub-channel Start Address (SAD)

A 10-bit sub-channel start address shall be carried in $B_{Sbch\times 4,p}(b_6,b_7)$ and $B_{Sbch\times 4+1,p}$. This shall take a value between 0 and 863 (inclusive) and shall give the start address, in DAB capacity units, of the position in which the associated MST sub-channel shall be placed in the DAB frame.

If needed, SAD can be used as a link between DAB frame signalling (carried in the FIC) and the ETI(LI) frame.

5.4.1.3 Sub-channel Type and Protection Level (TPL)

TPL shall be a 6-bit number giving information about the type and protection level of the MST sub-channel data. The TPL shall be carried in $B_{Sbch \times 4+2,p}(b_0..b_5)$ allocated as given in table 6.

Table 6: Coding of TPL

b_0	b_1	b_2	b_3	b_4	b_5
0 = Unequal Error Protection	Rfu, set to 1	Table switch	UEP index (MSb..LSb)		
1 = Equal Error Protection	Option(MSb..LSb)			Protection level(MSb..LSb)	

The values of "Table switch", "Option" and "Protection level" shall define the coding to be applied to the sub-channel. They are defined in ETS 300 401 [1].

"UEP index" also defines the coding to be applied to the sub-channel. It is related to the desired protection level [1..5] as follows:

"UEP index" = *desired protection level* - 1.

5.4.1.4 Sub-channel Stream Length (STL)

$B_{Sbch \times 4+2,p}(b_6..b_7)$ and $B_{Sbch \times 4+3,p}$ shall carry STL_{Sbch}, a 10-bit number. STL_{Sbch} shall give the length of the uncoded sub-channel stream, with ordinal number *Sbch*, carried in the Main STream, MST. The length shall be given as a multiple of 64 bits. This may be calculated as follows:

STL_{Sbch} = Sub-channel uncoded data rate (in kbit/s) × (3/8).

STL_{Sbch} may have the value 0, i.e. no sub-channels are transmitted.

STL_{Sbch} shall have values in the range 0 to 684.

5.5 End-Of-Header data (EOH)

The End-Of-Header data shall consist of four bytes. Two bytes shall be reserved for signalling purposes and two bytes shall carry a Cyclic Redundancy Check over the ETI(LI) header data fields.

5.5.1 Multiplex Network Signalling Channel (MNSC)

Bytes $B_{(NST+1) \times 4,p}$ and $B_{(NST+1) \times 4+1,p}$ shall carry a low rate signalling channel between ETI source and destination equipment. The 16-bit MNSC field constitutes a byte pair in each frame which can be used for Frame Synchronous Signalling (FSS) or frame Asynchronous Signalling (ASS). Frame synchronous signalling implies that the signalling data shall be linked to the frames carrying the data. Asynchronous data need not be linked to any particular frame.

The byte pairs of four consecutive frames shall be grouped together to form an 8-byte signalling group. The signalling group beginning in frame *q* are identified as $SB_{[0..7],q}$. Frame phase bits, $B_{2,p}(b_1,b_2)$, (see table 4) shall be used to identify the byte pairs as shown in table 7.

Table 7: Use of FP to determine the signalling byte index

Frame count, *p*	$B_{2,p}(b_1)$	$B_{2,p}(b_2)$	$B_{(NST+1) \times 4, p}$	$B_{(NST+1) \times 4+1, p}$
q	0	0	$SB_{0,q}$	$SB_{1,q}$
q+1	0	1	$SB_{2,q}$	$SB_{3,q}$
q+2	1	0	$SB_{4,q}$	$SB_{5,q}$
q+3	1	1	$SB_{6,q}$	$SB_{7,q}$

Tables 8 and 9 give information about the formatting of the signalling bytes. Annex A gives detailed coding information for the different signalling message types.

Table 8: General formatting of MNSC signalling bytes

$SB_{0,q}$			$SB_{1,q}$	$SB_{2,q}$	$SB_{[3..6],q}$	$SB_{7,q}$
(b_0,b_1)	(b_2,b_3)	$(b_4..b_7)$	$(b_0..b_7)$	$(b_0..b_7)$	$(b_0..b_7)$	$(b_0..b_7)$
00	Rfu	FSS type identifier	Rfu	FSS (MSb)	..	FSS (LSb)
01	Rfa	Rfa	Rfa	Rfa	Rfa	Rfa
10	Rfa	Rfa	Rfa	Rfa	Rfa	Rfa
11	Rfu	ASS field identifier	Rfu	ASS (MSb)	..	ASS (LSb)

Table 9: Coding of MNSC FSS type and ASS field identifier

$SB_{0,q}(b_4..b_7)$ identifier	$SB_{0,q}(b_0,b_1) = 00$ FSS type	$SB_{0,q}(b_0,b_1) = 11$ ASS field
0000	Time information group	Start group
0001	Rfa	Rfa
0010	Rfa	Rfa
0011	Rfa	Continuation group
0100	Rfa	Rfa
0101	Rfa	Rfa
0110	Rfa	Rfa
0111	Rfa	Rfa
1000	User definable group	Rfa
1001	User definable group	Rfa
1010	User definable group	Rfa
1011	User definable group	Rfa
1100	User definable group	End group
1101	User definable group	Rfa
1110	User definable group	Rfa
1111	User definable group	Padding group

Annex A gives more details about the coding of the MNSC signalling groups.

5.5.2 Header Cyclic Redundancy Checksum (CRC_h)

Bytes $B_{(NST+1)\times4+2,p}$ and $B_{(NST+1)\times4+3,p}$ shall carry a cyclic redundancy checksum carried out on the contents of the Frame Characterization, Stream Characterization and MNSC fields, bytes $B_{[0..(NST+1)\times4+1],p}$. The calculation shall use the method given in annex D.

5.6 Main Stream data (MST)

Bytes $B_{(NST+2)\times4,p}$ to $B_{(FL+1)\times4-1,p}$ shall carry NST *sub-channel*s of the DAB frame, i.e. data for the FIC and MSC audio or data sub-channels.

NOTE: In a cascaded multiplexer architecture, MST can be assembled sequentially.

If the FICF bit in FC is set to 1 then the first 96 or 128 bytes (as set by the DAB mode) of the MST shall carry the uncoded FIC data which is then followed by uncoded MSC audio or data sub-channel data.

At the last stage, i.e. the input of COFDM, each sub-channel stream is associated with one DAB sub-channel of the MSC by means of the SCID carried in the stream characterization field. There may be up to 64 sub-channels which shall follow the same ordering as that in the Stream Characterization field. The length of each audio or data stream shall be a multiple of 64 bits.

5.7 End Of Frame (EOF)

End of frame information shall be inserted into bytes $B_{(FL+1)\times 4,p}$ and $B_{(FL+1)\times 4+3,p}$.

5.7.1 Cyclic Redundancy Checksum (CRC)

Bytes $B_{(FL+1)\times 4,p}$ and $B_{(FL+1)\times 4+1,p}$ shall carry a cyclic redundancy checksum, which shall be carried out on the contents of the Main Stream data field. The CRC calculation shall use the method outlined in annex D.

5.7.2 Reserved bytes

Bytes $B_{(FL+1)\times 4+2,p}$ and $B_{(FL+1)\times 4+3,p}$ shall be reserved for future use. They shall be set to $FFFF_{16}$.

5.8 ETI(LI) Time Stamp (TIST)

The four bytes $B_{(FL+2)\times 4,p}$ to $B_{(FL+2)\times 4+3,p}$ shall be used for an ETI(LI) time stamp. The time stamp coding and bit allocation are described in annex C.

5.9 Null transmissions

In the case of no data transmission then the Frame Characterization (FC) field shall be set to FFFF $FFFF_{16}$. All other data bytes can be set to FF_{16}.

5.10 Total number of bytes carrying information

The following calculations may be used to determine the total number of bytes per logical frame which shall be transmitted transparently by any physical layer.

$$Total\_number\_of\_bytes\_in\_24ms = STAT\_Bytes\_Used\_in\_24ms + LI\_DATA\_Bytes\_Used\_in\_24\_ms\,;$$

where:

$$STAT\_Bytes\_Used\_in\_24ms = 1\,;$$

and:

For NST = 0: $LI\_DATA\_Bytes\_Used\_in\_24ms = 16 + (4 \times FICL)$;

For NST ≠ 0: $LI\_DATA\_Bytes\_Used\_in\_24ms = 16 + (4 \times FICL) + \sum_{i=1}^{NST} (3 \times Rate_i + 4)$.

where: $Rate_i$ is the information rate of the sub-channel in kbit/s.

5.11 Maximum size of ETI(LI)

The maximum size of ETI(LI) occurs for mode III with 56 subchannels of 32 kbit/s (coded at the lowest protection level 4/5) and 6 subchannels of 8 kbit/s (coded with a protection level of 3/4).

According to the relation given in subclause 5.10, and with an FICL of thirty-two words, the maximum capacity of ETI(LI) is 5 913 bytes per logical frame (or, when converted to ETI(NI), a physical data rate of 1 971 kbit/s).

6 Network Independent layer for G.703 interfaces, ETI(NI) or ETI(NI, G.703)

6.1 General

The purpose of the ETI(NI, G.703) is to provide a physical form to the ETI(LI) logical frame structure for local connections and test purposes. The ETI(NI, G.703) layer shall also be called ETI(NI) layer. Any equipment producing or accepting an ETI signal shall generate or accept a signal with the ETI(NI, G.703) format.

ETI(NI, G.703) uses G.703-HDB3 line coding (see ITU-T Recommendation G.703 [4]), carrying data and clock on the same 2 048 kbit/s serial connection. No additional protection of ETI(LI) is provided by this ETI(NI, G.703) physical adaptation.

ETI(NI, G.703) should not be applied directly to standard telecommunication networks. ETI(NA**,** G.704) described later should be used instead. The principal difficulty, apart from the lack of error protection, is that network monitoring equipment may interpret the frame padding field (or any other data field containing long strings of ones) as an Alarm Indication Signal (AIS). The network monitoring may require disabling if the ETI(NI, G.703) is to be passed.

The ETI(NI, G.703) adaptation process is presented in figure 6.

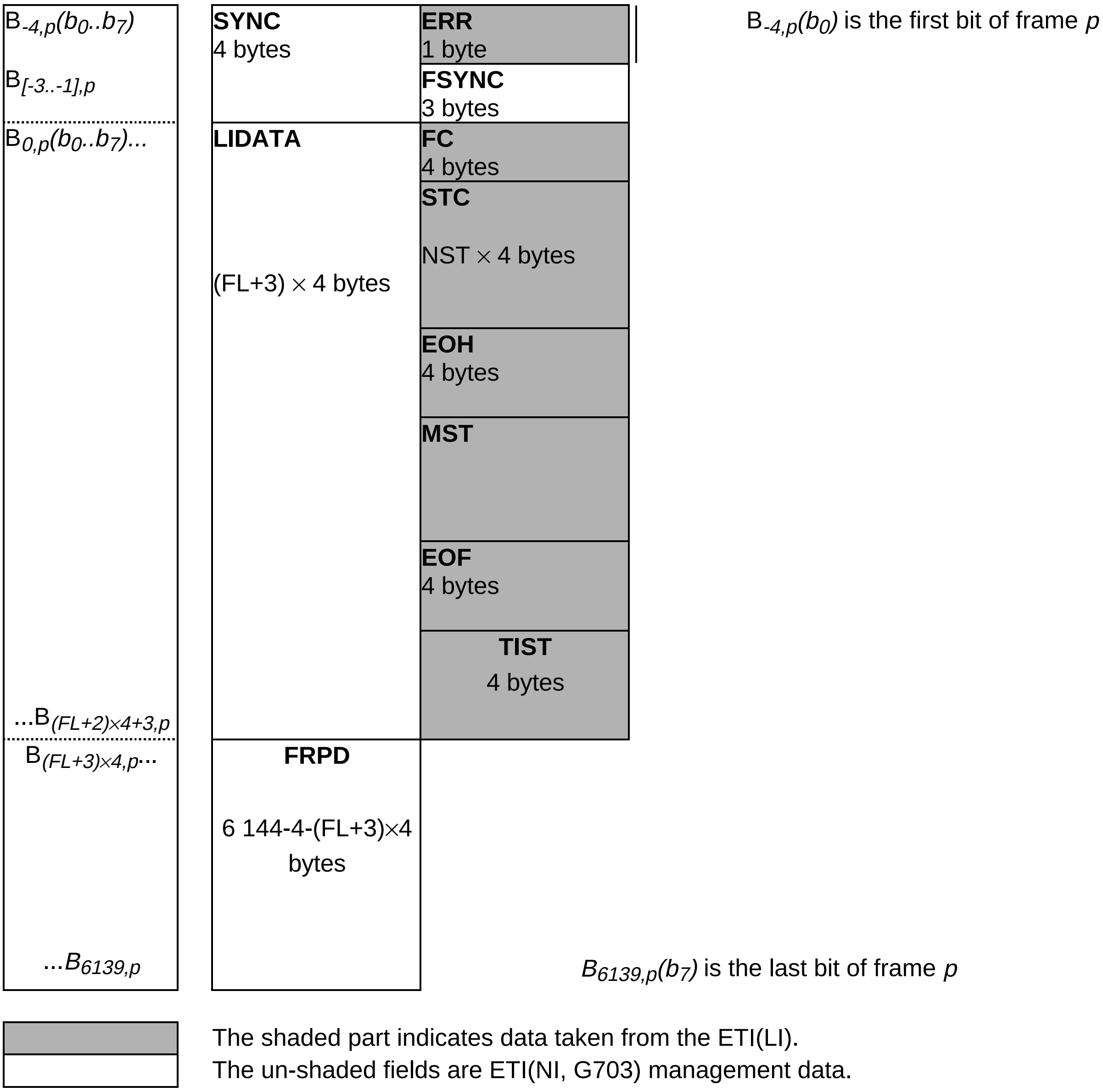


Figure 6: Mapping of ETI(LI) to ETI(NI, G.703)

6.2 Adaptation of the logical layer

ETI(NI, G.703) shall be organized as an uniform stream of 6 144 bytes every 24 ms which represents a net bitrate of 2 048 kbit/s.

The ETI(NI, G.703) shall comprise of 3 fields: SYNC, LIDATA, FRPD.

The SYNC field at the beginning of the frame carries frame synchronization and status information. The status information shall be derived from the ETI(LI) STAT field.

The LIDATA field shall be inserted after the SYNC field. The first bit of LIDATA is inserted in the ETI(NI, G.703) bit $B_{0,p}(b_0)$.

Any unused tail bytes of the ETI(NI, G.703) frame shall be filled with padding bytes (FRPD).

The first ETI(NI, G.703) byte of frame *p* shall be denoted as $B_{-4,p}$ and the last transmitted byte shall be $B_{6139,p}$.

The first ETI(NI, G.703) bit of frame *p* shall be denoted as $B_{-4,p}(b_0)$ and the last transmitted bit shall be $B_{6139,p}(b_7)$.

6.2.1 Synchronization Field (SYNC)

The frame synchronization field shall contain two data fields; an 8-bit ETI(LI) STAT field and a 24-bit field for frame synchronization.

6.2.1.1 Error Status (ERR)

Byte $B_{-4,p}$ shall carry the ETI(LI) STAT field.

The ETI(NI, G.703) receiver can modify the ERR field to indicate the error status associated with the use of the ETI(NI, G.703) layer.

The STAT field shall take one of four levels, 0 to 3, as defined in subclause 5.2.

In addition, the level of STAT can be increased by the ETI(NI, G.703) receiver when CRC violations are detected according to the rules given in table 10.

Table 10: Setting of error levels at the NI Layer

CRC violated	Action
None	Current error level retained
EOF only	Error level may be increased to 1
EOH only	Error level may be increased to 2
EOF and EOH	Error level may be increased to 3

The ETI(NI, G.703) receiving equipment shall not decrease the error level of the STAT field.

6.2.1.2 Frame Synchronization Field (FSYNC)

Bytes $B_{[-3..-1],p}$ shall carry 24 ms frame synchronization bits. FSYNC shall be one's complemented on successive frames between the two patterns $073AB6_{16}$ and $F8C549_{16}$. The byte values for FSYNC are given in table 11.

Table 11: FSYNC definition for ETI(NI, G.703)

FSYNC bytes	FSYNC0	FSYNC1
$B_{-3,p}(b_0..b_7)$	07_{16}	$F8_{16}$
$B_{-2,p}(b_0..b_7)$	$3A_{16}$	$C5_{16}$
$B_{-1,p}(b_0..b_7)$	$B6_{16}$	49_{16}

The value of FSYNC may be synchronized to the value of FP such that FSYNC0 always appears in the frame with FP set to zero.

With FSYNC0 set to $073AB6_{16}$ and FSYNC1 set to $F8C549_{16}$, ETI(LI) synchronization should be obtained when:

either:

FSYNC0 is present in frame p;
AND FSYNC1 is present in frame p + 1;
AND FSYNC0 is present in frame p + 2.

or:

FSYNC1 is present in frame p;
AND FSYNC0 is present in frame p + 1;
AND FSYNC1 is present in frame p + 2.

Synchronization should be lost if two consecutive synchronization words are incorrectly received.

6.2.2 ETI(LI) Data Field (LIDATA)

The LIDATA field of the frame *p*, from $B_{0,p}$ up to $B_{(FL+2)\times4+3,p}$, shall be inserted in the ETI(NI, G.703) frame into the bytes $B_{0,p}$ to $B_{(FL+2)\times4+3,p}$.

6.2.3 Frame Padding Field (FRPD)

The padding information should be inserted at the end of the ETI(LI) logical frame. The value of the padding bytes shall be 55_{16}.

The FRPD field shall be inserted into bytes $B_{(FL+3)\times4,p}$ to $B_{6139,p}$.

FRPD may be used to carry user specific data. The format and protocol used in that case are not subject to standardization. Moreover, the FRPD field can be modified in case of further adaptation or cascading of equipment.

6.3 Physical interface

The physical parameters of ETI(NI, G.703) shall conform to the requirement of the ITU-T Recommendation G.703 [4] for 2 048 kbit/s interfaces. The minimum requirement shall be a 75 Ω female BNC connector fitted to the equipment.

7 Network Independent Layer for V.11 interfaces, ETI(NI, V11)

7.1 General

The purpose of ETI(NI, V11) is to provide a physical interface suitable for local connections, or distant connections via telecommunication networks or through modems using ITU-T Recommendation X.24/ITU-T Recommendation V.11 interfaces [5, 6]. Any equipment producing or accepting an ETI signal may generate or accept a signal with the ETI(NI, V11) format.

The ETI(NI, V11) interface offers a junction having a net bitrate of N × 64 kbit/s. Clock and data signals are produced separately.

Compared to ETI(NI, G.703), the ETI(NI, V11) interface provides an interface with a flexible range of bit rates which can be higher or lower than 2 048 kHz.

No specific protection shall be provided by the ETI(NI, V11) adaptation layer.

The ETI(NI, V11) adaptation process is presented in figure 7:

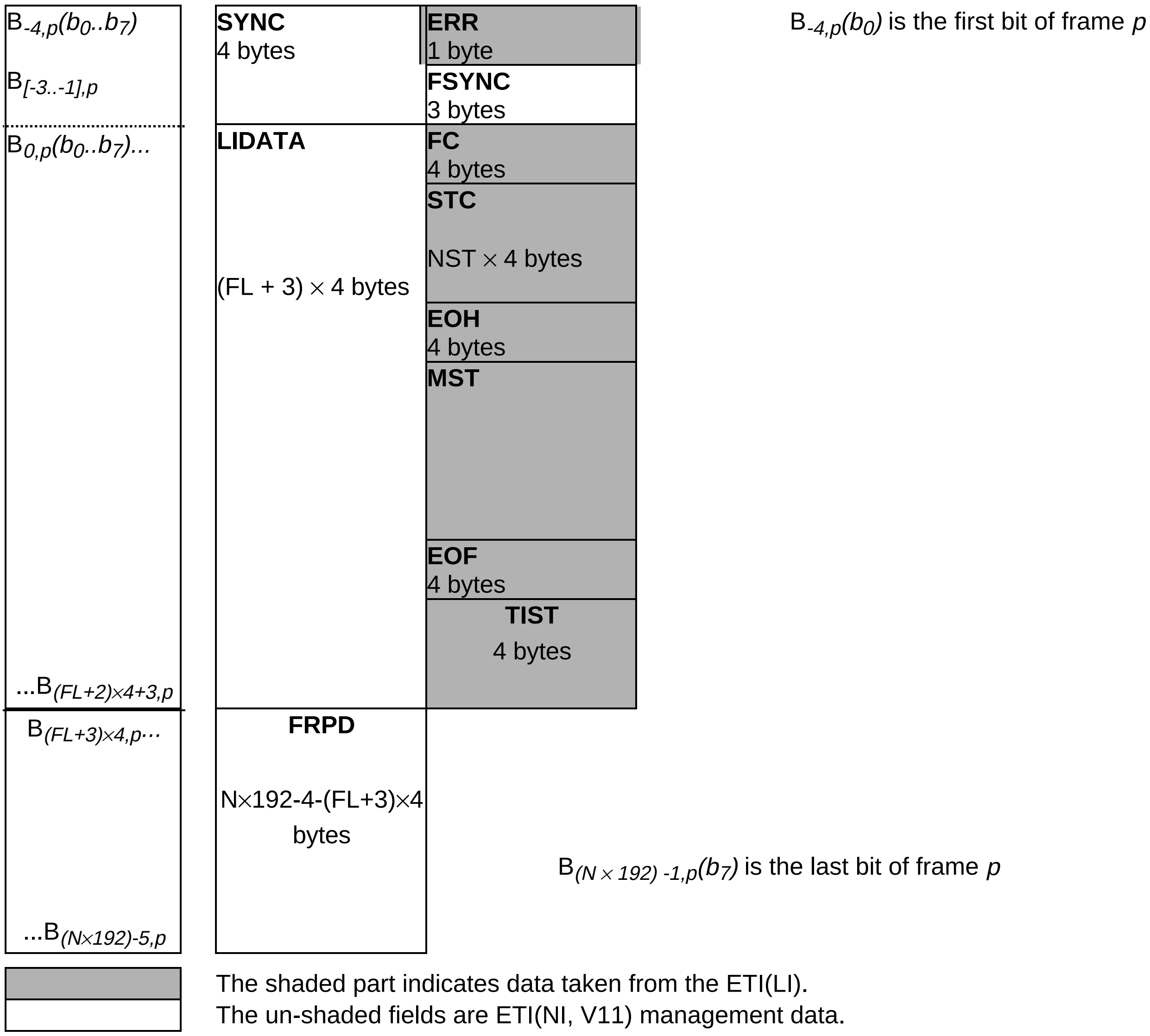


Figure 7: Mapping of ETI(LI) to ETI(NI, V11)

7.2 Adaptation of the logical layer

ETI(NI, V11) shall be organized as a uniform stream of $N \times 192$ bytes every 24 ms, corresponding to a data-rate of $N \times 64$ kbit/s. For example, for N = 32, 6 144 bytes per 24 ms or 2 Mbit/s are available.

The ETI(NI, V11) shall comprise 3 fields: SYNC, LIDATA, FRPD.

The SYNC field at the beginning of the frame carries frame synchronization and status information. The status information shall be derived from the ETI(LI) STAT field.

The LIDATA field shall be inserted after the SYNC field. The first bit of LIDATA is inserted in the ETI(NI, V11) bit $B_{0,p}(b_0)$. Any unused tail bytes of the ETI(NI, V11) frame shall be filled with padding bytes (FRPD).

The first byte of ETI(NI, V11) frame *p* shall be $B_{-4,p}$ and the last transmitted byte shall be $B_{N\times192-5,p}$.

The first bit of ETI(NI, V11) frame p shall be $B_{-4,p}(b_0)$ and the last transmitted bit shall be $B_{N\times192-5,p}(b_7)$.

7.2.1 Synchronization Field (SYNC)

The frame synchronization field shall contain two data fields; an 8-bit ETI(LI) STAT field and a 24-bit field for frame synchronization.

7.2.1.1 Error Status (ERR)

Byte $B_{-4,p}$ shall carry the ETI(LI) STAT field.

The ETI(NI, V11) receiver can modify the ERR field to indicate the error status associated with the use of the ETI(NI, V11) layer.

The STAT field shall take one of four levels, 0 to 3, as defined in subclause 5.2.

In addition, the level of STAT can be increased by the ETI(NI, V11) receiver when CRC violations are detected according to the rules given in table 12.

Table 12: Setting of error levels at the NI layer

CRC violated	Action
None	Current error level retained
EOF only	Error level may be increased to 1
EOH only	Error level may be increased to 2
EOF and EOH	Error level may be increased to 3

The ETI(NI, V11) receiving equipment shall not decrease the error level of the STAT field.

7.2.1.2 Frame Synchronization Field (FSYNC)

Bytes $B_{[-3..-1],p}$ shall carry 24 ms frame synchronization bits. FSYNC shall be one's complemented on successive frames between the two patterns 07 $3AB6_{16}$ and F8 $C549_{16}$. The byte values for FSYNC are given in table 13.

Table 13: FSYNC definition for ETI(NI, V11)

FSYNC bytes	FSYNC0	FSYNC1
$B_{-3,p}(b_0..b_7)$	07_{16}	$F8_{16}$
$B_{-2,p}(b_0..b_7)$	$3A_{16}$	$C5_{16}$
$B_{-1,p}(b_0..b_7)$	$B6_{16}$	49_{16}

The value of FSYNC may be synchronized to the value of FP such that FSYNC0 always appears in the frame with FP set to zero.

With FSYNC0 set to 07 $3AB6_{16}$ and FSYNC1 set to F8 $C549_{16}$, ETI(LI) synchronization should be obtained when:

either:

FSYNC0 is present in frame p;
AND FSYNC1 is present in frame p + 1;
AND FSYNC0 is present in frame p + 2;

or:

FSYNC1 is present in frame p;
AND FSYNC0 is present in frame p + 1;
AND FSYNC1 is present in frame p + 2.

Synchronization should be lost if two consecutive synchronization words are incorrectly received.

7.2.2 ETI(LI) Data Field (LIDATA)

The LIDATA field of the frame *p*, from $B_{0,p}$ up to $B_{(FL+2)\times 4+3,p}$, shall be inserted in the ETI(NI, V11) frame into the bytes $B_{0,p}$ to $B_{(FL+2)\times 4+3,p}$.

7.2.3 Frame Padding Field (FRPD)

The padding information should be inserted at the end of the ETI(LI) logical frame. The value of the padding bytes shall be 55_{16}.

FRPD field contains padding bytes inserted into bytes $B_{(FL+3)\times 4,p}$ up to $B_{(N\times 192)-5,p}$.

FRPD may be used to carry user specific data. The format and protocol used in that case are not subject to standardization. Moreover, the FRPD field can be modified in case of further adaptation or cascading of equipment.

7.3 Physical interface

The physical characteristics of ETI(NI, V11) shall comply with the general requirements of ITU-T Recommendations V.11 and X.24 [6, 5] and shall have the following specific attributes:

equipment connector:	D-Sub 15, female, connections as defined in table 14.
circuit connections:	X.24, clock and data only.
clock/data timing:	as defined in ITU-T Recommendations X.24 [5].
electrical levels:	as defined in ITU-T Recommendations V.11 [6].
bitrate:	$N \times 64$ kbit/s, N shall be chosen to provide sufficient network capacity to exceed the maximum envisaged size of the ETI(LI) layer.

Table 14: Pin allocations for ETI(NI, V11)

Pin number	Signal			Pin number	Signal		
1	Frame ground	FG					
2	Transmit data +	T+	(output)	9	Transmit data -	T-	(output)
3	Transmit clock +	X+	(output)	10	Transmit clock -	X-	(output)
4	Receive data +	R+	(input)	11	Receive data -	R-	(input)
5	n/c			12	n/c		
6	Receive clock +	S+	(input)	13	Receive clock -	S-	(input)
7	n/c			14	n/c		
8	Signal ground	SG		15	n/c		
NOTE: n/c = no connection to pin							

The Transmit clock circuit should be the exact echo of the Receive clock circuit.

8 Network Adaptation for G.704 networks, ETI(NA, G.704)

8.1 General

For a local connection between an Ensemble multiplexer and a COFDM generator, or in the case of a simple network connection, the information contained in the ETI(LI) data stream, as described in clause 5, will not need any further protection to be transported reliably to its destination. In this case, the NI adaptation layers described in clauses 6 and 7 can be used.

In the more general case, some additional network adaptation may be required to allow the ETI to be carried reliably across the chosen transport medium. This protection may be provided within the network (e.g. convolutional coding applied in a satellite modem) in which case the NI adaptation layers may still be suitable. In some cases, the additional protection shall be applied before the connection to the transporting network. This is the case in particular for G.704 networks. The Network Adaptation described in this clause is suited to such networks. Any equipment producing or accepting an ETI signal may generate or accept a signal with the ETI(NA, G.704) format.

The ETI(NA, G.704) layer is suitable for use on networks based on the first level of the PDH (2 048 kbit/s) as defined in ITU-T Recommendation G.704 [7]. As well as catering for the reserved G.704 signalling and synchronization bytes, ETI(NA, G.704) includes time stamps to permit compensation for the effect of differential network delays. It also uses Reed-Solomon forward error coding to allow transport network errors to be corrected.

NOTE: Annex J outlines a method of adapting ETI(NA, G.704) for use in countries whose PDH networks use a first level of 1 544 kbit/s.

ETI(NA, G.704) has two variants: ETI(NA, G.704)$_{5592}$ and ETI(NA, G.704)$_{5376}$. The two differ in the balance between their data capacity and the number of bytes which are reserved for forward error correction.

In the G.704 frame structure, 1 920 kbit/s are available to carry user data, the remaining 128 kbit/s are reserved by the G.704 network for its framing, signalling and monitoring bytes.

In each 24 ms multiframe, ETI(NA, G.704)$_{5592}$, has the capacity to carry 5 760 bytes allocated as follows:

- 5 592 bytes of LIDATA (a data capacity of 1 864 kbit/s);
- 120 bytes (40 kbit/s) for forward error correction;
- 48 bytes (16 kbit/s) for management and signalling.

In each 24 ms multiframe, ETI(NA, G.704)$_{5376}$, has the capacity to carry 5 760 bytes allocated as follows:

- 5 376 bytes of LIDATA (a data capacity of 1 792 kbit/s);
- 336 bytes (112 kbit/s) for forward error correction;
- 48 bytes (16 kbit/s) for management and signalling.

8.2 Transparency of ETI(NA, G.704) layer to ETI(LI)

8.2.1 Transparency of ETI(NA, G.704)$_{5592}$ layer to ETI(LI)

ETI(NA, G.704)$_{5592}$ is able to carry up to 5 592 bytes of LIDATA, $B_{[0..5591]}$. When LIDATA has less than 5 592 bytes, i.e. (FL + 3) $\times$ 4 $\leq$ 5 592, padding bytes should be added to fill up the remaining bytes.

The padding bytes should be set to FF_{16}. The number of padding bytes shall be positive, or zero, and shall have the value 5 592 - ((FL + 3) $\times$ 4).

ETI(NA, G.704)$_{5592}$ is also able to carry the ETI(LI) STAT field but the content of this field may be amended by ETI(NA, G.704) receiving equipment.

8.2.2 Transparency of ETI(NA, G.704)$_{5376}$ layer to ETI(LI)

ETI(NA, G.704)$_{5376}$ is able to carry up to 5 376 bytes of LIDATA, $B_{0..5375}$. When LIDATA has less than 5 376 bytes, i.e. (FL + 3) $\times$ 4 $\leq$ 5 376, padding bytes should be added to fill up the remaining bytes.

The padding bytes should be set to FF_{16}. The number of padding bytes shall be positive, or zero, and shall have the value 5 376 - ((FL + 3) $\times$ 4).

ETI(NA, G.704)$_{5376}$ is also able to carry the ETI(LI) STAT field but the content of this field may be amended by ETI(NA, G.704) receiving equipment.

8.3 ETI(NA, G.704) structure

The purpose of the ETI(NA, G.704) multiframe structure is to map the ETI(LI) data field onto the G.704 frame structure. In the G.704 recommendation, the 2 048 kbit/s data stream is organized into frames. Each frame has a nominal duration of 125 µs and is made up of 256 bits organized into thirty-two timeslots. Each timeslot carries one byte of data or frame management information. Two of the timeslots are reserved for G.704 synchronization and signalling. The remaining thirty time slots are available to carry user data.

The ETI(NA, G.704) multiframe shall have a frame length of 24 ms. It shall consist of 192 G.704 frames, equivalent to 6 144 timeslots, or bytes.

NOTE: This text uses the word "byte" where a strict adherence to G.704 terminology would require the use of "timeslot".

The multiframe structure is illustrated in figure 8 and shall consist of:

- 3 superblocks ($s_{[0..2]}$) of 2 048 bytes each;
- each superblock shall consist of 8 blocks ($bl_{[0..7]}$) of 256 bytes each;
- each block shall consist of 8 G.704 frames ($f_{[0..7]}$) of 32 bytes each;
- each G.704 frame shall consist of 32 timeslots ($ts_{[0..31]}$) of 1 byte each;
- each timeslot shall consist of 8 bits ($b_{[0..7]}$).

Table 15 summarizes the relation of elements within a multiframe.

Table 15: Relation of elements within a multiframe

	Superblocks	Blocks	G.704 frames	Timeslots	Bits
Multiframe	3	24	192	6 144	49 152
Superblock	1	8	64	2 048	16 384
Block		1	8	256	2 048
G.704 frame			1	32	256
Timeslot				1	8

8.3.1 G.704 reserved bytes

The following bytes of an ETI(NA, G.704) multiframe shall be reserved for G.704 frame control:

- ts_0 in each G.704 frame for the G.704 synchronization byte, G_0;
- ts_{16} in each G.704 frame for the G.704 supervision byte, G_1.

8.3.2 ETI(NA, G.704) reserved bytes

The following bytes of each multiframe are reserved by the ETI(NA, G.704) layer:

- ts_1 of f_0 in each block for a multiframe management byte, $M_{bl,s}$;
- ts_2 of f_0 in each block for a multiframe supervision byte, $S_{bl,s}$,

where *bl* and *s* shall be the block and superblock numbers of the multiframe. Each multiframe shall have 24 management and 24 supervision bytes.

8.3.2.1 Multiframe management byte, $M_{bl,s}$

The bits of $M_{bl,s}$ shall be assigned as follows:

$M_{bl,s}(b_{0..2})$:	a block counter containing the binary value *bl* (MSb in b_0 and LSb in b_2);
$M_{bl,s}(b_{3,4})$:	a superblock counter containing the binary value *s* (MSb in b_3 and LSb in b_4);
$M_{bl,s}(b_5)$:	a timestamp bit;
$M_{bl,s}(b_6)$:	a frame signalling bit;
$M_{bl,s}(b_7)$:	Rfa.

The block and superblock counters should be used for synchronization of the ETI multiframe. The synchronization method shall not assume that there is any fixed relationship between the G.704 synchronization byte, G_0, and the multiframe synchronization counters.

During the course of a multiframe, the 24-bit word formed by the timestamp bits carried in $M_{bl,s}(b_5)$ shall form a word carrying time information relevant to that frame. The MSb of the word shall be carried in $M_{0,0}(b_5)$ whilst the LSb shall be found in $M_{7,2}(b_5)$.

Information on the coding and use of timestamp data is given in annex C.

The 24-bit word formed by the signalling bits in each frame, shall carry signalling information. The MSb of the signalling word shall be carried in $M_{0,0}(b_6)$ whilst the LSb shall be found in $M_{7,2}(b_6)$. Table 16 summarizes the pre-defined signalling functions.

Table 16: Use of multiframe signalling bits

Bytes $M_{x,0}$	b_6	**Signalled information**
$M_{0,0}$	1	LI layer input contains CRC violations
	0	No CRC violations in the LI layer input
$M_{1,0}$	1	ETI(NA, G.704)$_{5376}$ in use
	0	ETI(NA, G.704)$_{5592}$ in use
$M_{[2..7],0}$	0	Rfa
Bytes $M_{x,1}$		
$M_{0,1}$	x	First bit, b_0, of ETI(LI) STAT field
$M_{[1..6],1}$	x	Bits $b_1..b_6$ of ETI(LI) STAT field
$M_{7,1}$	x	Last bit, b_7, of ETI(LI) STAT field
Bytes $M_{x,2}$		
$M_{[0..7],2}$	0	Rfa

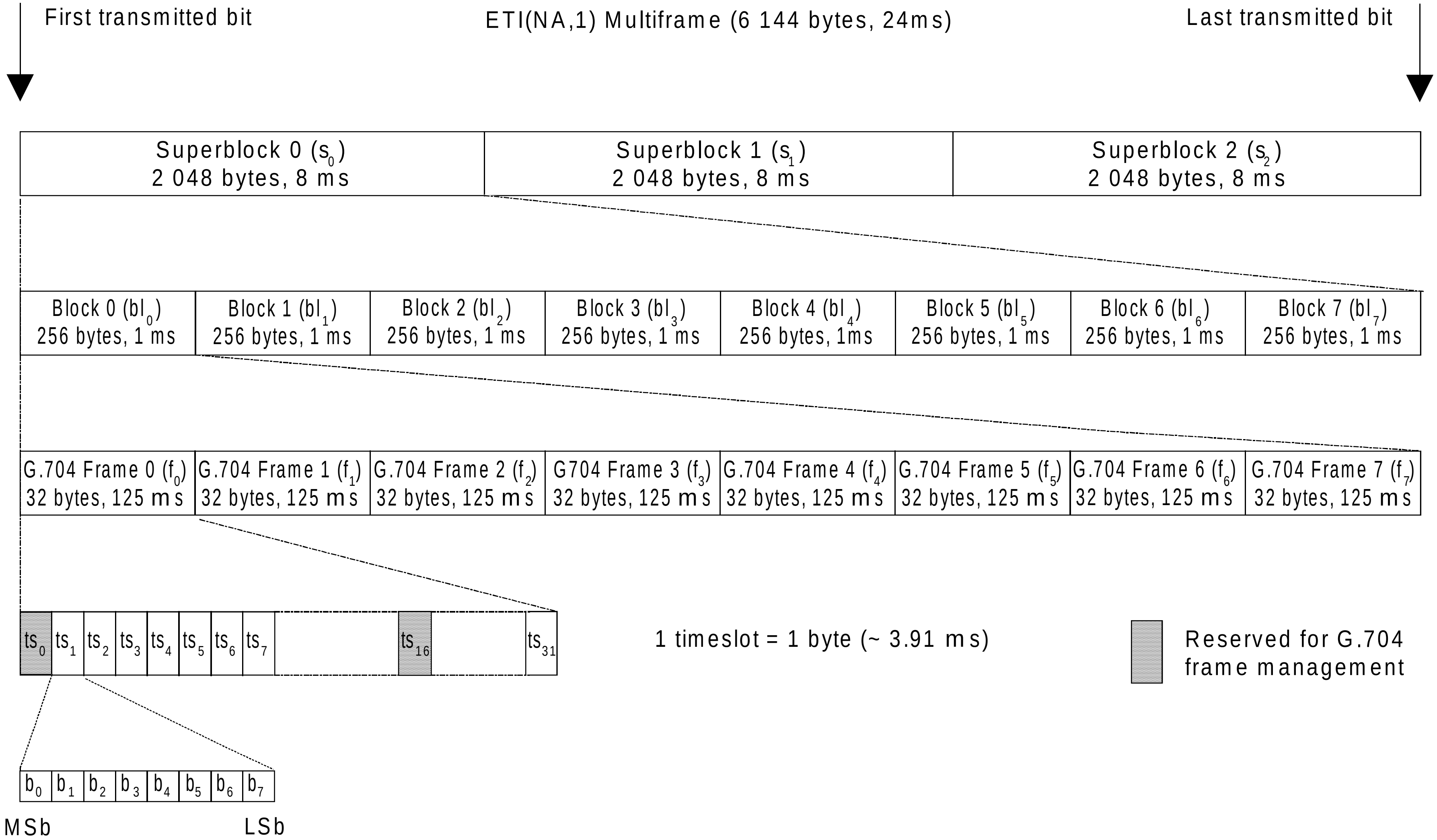


Figure 8: ETI(NA, G.704) multiframe structure

8.3.2.2 Multiframe supervision byte, $S_{bl,s}$

The $S_{bl,s}$ byte shall be used to provide a signalling channel in the NA layer, called the NASC (Network Adapted Signalling Channel), which is analogous to the MNSC in the logical interface (see subclause 5.5.1).

24 bytes per multiframe are available: $S_{[0..7],[0..2]}$. They shall be arranged as three eight-byte signalling groups. Each group shall start with byte $S_{0,s}$ followed by $S_{1,s}$ etc., ending with $S_{7,s}$.

Table 17 gives details of the formatting of the NASC channel, the coding for the NASC FSS type or ASS field identifier is given in table 18. The formatting used in both tables is very similar to that used for the MNSC (see tables 8 and 9). Annex B contains details of pre-defined message types.

Table 17: General formatting of NASC signalling bytes

$S_{0,s}$			$S_{1,s}$	$S_{2,s}$	$S_{[3..6],s}$	$S_{7,s}$
(b_0,b_1)	(b_2,b_3)	$(b_4..b_7)$	$(b_0..b_7)$	$(b_0..b_7)$	$(b_0..b_7)$	$(b_0..b_7)$
00	Rfu	FSS type identifier	Rfu	FSS (MSb)	..	FSS (LSb)
01	Rfa	Rfa	Rfa	Rfa	Rfa	Rfa
10	Rfa	Rfa	Rfa	Rfa	Rfa	Rfa
11	Rfu	ASS field identifier	Rfu	ASS (MSb)	..	ASS (LSb)

Table 18: Coding of NASC FSS type and ASS field identifier

$S_{0,s}(b_4..b_7)$ identifier	$S_{0,s}(b_0,b_1) = 00$ FSS type	$S_{0,s}(b_0,b_1) = 11$ ASS field
0000	Rfa	Start group
0001	Rfa	Rfa
0010	Rfa	Rfa
0011	Rfa	Continuation group
0100	Rfa	Rfa
0101	Rfa	Rfa
0110	Rfa	Rfa
0111	Rfa	Rfa
1000	User definable group	Rfa
1001	User definable group	Rfa
1010	User definable group	Rfa
1011	User definable group	Rfa
1100	User definable group	End group
1101	User definable group	Rfa
1110	User definable group	Rfa
1111	User definable group	Padding group

8.4 ETI(NA, G.704) multiframe generation

8.4.1 General description

The specific details of the multiframe generation vary with the particular variant of the ETI(NA, G.704) layer in use. The general principles are described in this subclause. Detailed information appears in the following subclauses and figures 9 and 10.

The first stage in producing the ETI(NA, G.704) multiframe is to copy the bytes of the ETI(LI) LIDATA field into a coding array, C. Padding bytes are also added when the size of the LIDATA field is less than the capacity available to carry data in the particular ETI(NA, G.704) variant. The rows of the array are only partially filled by LIDATA and padding bytes.

The next step is to form the multiframe management and signalling bytes from the appropriate information source which includes the ETI(LI) STAT field. These are then written into the appropriate positions in the coding array.

The array is filled by adding error-protection bytes. The bytes are calculated so that each row in the array forms a complete Reed-Solomon codeword.

The coding array, C, is then mapped into a single row interleaving array I, with elements $I_{[0..5759]}$. The depth of the interleaving is eight rows of the coding array which means that the interleaving is confined within one superblock.

Finally, the interleaved data, together with the G.704 reserved bytes, are mapped into another single row array O, with elements $O_{[0..6143]}$. O contains a full set of data corresponding to a 24 ms ETI(NA, G.704) multiframe.

8.4.2 Error coding and interleaving for ETI(NA, G.704)$_{5592}$

8.4.2.1 Coding array formation

The elements of the coding array, $C_{[0..23],[0..239]}$, shall be filled by the information bytes, $B_{[0..5591]}$, together with 24 multiframe management bytes, $M_{[0..7],[0..2]}$, 24 multiframe supervision bytes, $S_{[0..7],[0..2]}$, and the error protection bytes $R_{[0..23],[235..239]}$.

$B_{[0..(FL+2)\times 4+3]}$ are copied from the correspondingly numbered bytes of the ETI(LI) LIDATA field.

$B_{[(FL+3)\times 4..5591]}$ should be set to FF_{16}.

The position of bytes in the coding array, C, is defined by:

$$C_{i,j} = \begin{cases} M_{k,l} & (i \text{ MOD } 8) = 0 \text{ AND } (j \text{ MOD } 30) = 0 \\ S_{k,l} & (i \text{ MOD } 8) = 1 \text{ AND } (j \text{ MOD } 30) = 0 \\ B_r & (i \text{ MOD } 8) < 2 \text{ AND } (j \text{ MOD } 30) \neq 0 \text{ AND } j \leq 234 \\ B_s & (i \text{ MOD } 8) \geq 2 \text{ AND } j \leq 234 \\ R_{i,j} & 235 \leq j \leq 239 \end{cases}$$

where:

- $C_{i,j}$ shall be the elements of C with row index i [0..23] and column index j [0..239].
- $M_{k,l}$ shall be the multiframe management byte of bl_k of s_l with $k = j$ DIV 30 and $l = i$ DIV 8.
- l shall be the superblock index.
- $S_{k,l}$ shall be the multiframe supervision byte of bl_k of s_l, the values of k and l are as given for $M_{k,l}$
- B_r shall be the rth information byte with:

  $r = (i \text{ DIV } 8) \times 1\,864 + (i \text{ MOD } 2) \times 227 - (j \text{ DIV } 30) + (j - 1)$.

- B_s shall be the sth information byte with:

  $s = (i \text{ DIV } 8) \times 1\,864 + (i \text{ MOD } 8) \times 235 + (j - 16)$.

- $R_{i,[235..239]}$ shall be the 5 parity check bytes calculated for the information bytes $C_{i,[0..234]}$.The check bytes shall be calculated using the RS(235, 240) code described in subclause 8.5.

8.4.2.2 Interleaving

The interleaving shall be performed by mapping the elements of the coding array, $C_{[0..23],[0..239]}$, into the single row array I. The mapping shall be given by:

$I_p = C_{i,j}$

where: I_p shall be the elements of the Interleaving array with index p given by:

$$p = 1\,920 \times (i \text{ DIV } 8) + 8 \times j + (i \text{ MOD } 8)$$

8.4.2.3 Output array formation

The elements of the output array, $O_{[0..6143]}$, shall be mapped from the interleaving array elements, $I_{[0..5759]}$, as follows:

$$O_q = \begin{cases} G_0 & (q \text{ MOD } 32) = 0 \\ G_1 & (q \text{ MOD } 32) = 16 \\ I_p & (q \text{ MOD } 32) \neq 0 \text{ AND } (q \text{ MOD } 32) \neq 16 \end{cases}$$

where:

- G_0 shall be a G.704 synchronizing byte;
- G_1 shall be a G.704 signalling byte;
- q shall be the index [0..6 143] of the output array given by:
  $q = p + (p \text{ DIV } 15) + 1$

The formation of the output data shall be as illustrated in figure 9.

8.4.3 Error coding and interleaving for ETI(NA, G.704)$_{5376}$

8.4.3.1 Coding array formation

The elements of the coding array, $C_{[0..23],[0..239]}$, shall be filled by the information bytes, $B_{[0..5375]}$, together with 24 multiframe management bytes, $M_{[0..7],[0..2]}$, 24 multiframe supervision bytes, $S_{[0..7],[0..2]}$, and the error protection bytes $R_{[0..23],[226..239]}$.

$B_{[0..(FL+2)\times 4+3]}$ are copied from the correspondingly numbered bytes of the ETI(LI) LIDATA field.

$B_{[(FL+3)\times 4..5375]}$ should be set to FF_{16}.

The position of bytes in the coding array, C, shall be defined by:

$$C_{i,j} = \begin{cases} M_{k,l} & (i \text{ MOD } 8) = 0 \text{ AND } (j \text{ MOD } 30) = 0 \\ S_{k,l} & (i \text{ MOD } 8) = 1 \text{ AND } (j \text{ MOD } 30) = 0 \\ B_r & (i \text{ MOD } 8) < 2 \text{ AND } (j \text{ MOD } 30) \neq 0 \text{ AND } j \leq 225 \\ B_s & (i \text{ MOD } 8) \geq 2 \text{ AND } j \leq 225 \\ R_{i,j} & 226 \leq j \leq 239 \end{cases}$$

where:

- $C_{i,j}$ shall be the elements of C with row index i [0..23] and column index j [0..239].
- $M_{k,l}$ shall be the multiframe management byte of bl_k of s_l with $k = j$ DIV 30 and $l = i$ DIV 8.
- l is the superblock index.
- $S_{k,l}$ shall be the multiframe supervision byte of bl_k of s_l, the values of k and l are as given for $M_{k,l}$
- B_r shall be the rth information byte with:
  $r = (i \text{ DIV } 8) \times 1\,792 + (i \text{ MOD } 2) \times 218 - (j \text{ DIV } 30) + (j - 1)$.
- B_s shall be the sth information byte with:
  $s = (i \text{ DIV } 8) \times 1\,792 + (i \text{ MOD } 8) \times 226 + (j - 16)$.

- $R_{i,[235..239]}$ shall be the 14 parity check bytes calculated for the information bytes $C_{i,[0..225]}$. The check bytes shall be calculated using the RS(226, 240) code described in subclause 8.5.

8.4.3.2 Interleaving

This process shall be exactly the same as that for ETI(NA, G.704)$_{5592}$ as presented in subclause 8.4.2.2.

8.4.3.3 Output array formation

This process shall be exactly the same as that for ETI(NA, G.704)$_{5592}$ as presented in subclause 8.4.2.3. The formation of the output data is illustrated in figure 10.

8.5 Order of data transmission

Data shall be transmitted by reading out the elements of the output array $O_{[0..6143]}$. The bytes shall be read in sequence starting with O_0. The lowest numbered bit of the byte with the lowest address shall come first.

8.6 Error protection code

In both variants of ETI(NA, G.704), Reed-Solomon coding shall be used to provide data which may be analysed by the interface receiving equipment to detect and correct errors occurring on the Transport Network.

The Reed-Solomon code uses symbols from GF(2^8), and shall be generated by the polynomial:

$$P(x) = x^8 + x^7 + x^2 + x + 1 .$$

The polynomial generator of the code shall be:

$$G(x) = \prod_{i=120}^{119+R} \left(x - \alpha^i\right).$$

For ETI(NA, G.704)$_{5592}$, R = 5 resulting in an RS(235,240) code.

For ETI(NA, G.704)$_{5376}$, R = 14 resulting in an RS(226,240) code.

8.7 Synchronization

8.7.1 Synchronization of G.704 frames

The synchronization of G.704 frames is described in ITU-T Recommendation G.706 [8]. Frame synchronization should be achieved in f_n if:

G_0 is present in f_n;

AND it is absent in f_{n+1};

AND b_1 of ts_0 in f_{n+1} is set to 1;

AND G_0 is present in f_{n+2}.

Synchronization should be lost if three consecutive synchronization bytes are incorrectly received.

NOTE: There is no fixed phase relationship specified between the G.704 framing bytes, G_0 and G_1, and the ETI(NA, G.704) multiframe framing bytes.

8.7.2 Synchronization of ETI(NA, G.704) multiframes

The synchronization of the ETI(NA, G.704) multiframe shall be achieved using $b_{0..4}$ of the multiframe management byte.

Multiframe synchronization should be achieved in multiframe m when:

G.704 synchronization is achieved in f_n;

AND the block count in $M_{bl,s}(b_{0..2})$ in f_{n+a+8} is an increment of 1 (modulo 8) above the count in f_{n+a} (a is incremented from 0 to 7);

AND the block count in $M_{bl,s}(b_{0..2})$ in f_{n+a+16} is an increment of 1 (modulo 8) above the count in f_{n+a+8}.

Data decoding should commence with the beginning of the next complete multiframe, *m*+1.

ETI multiframe synchronization should be lost if the count sequence of the block and superblock counter is lost in three consecutive positions.

8.8 Physical interface

In physical characteristics of both variants of ETI(NA, G.704) shall conform to the requirements of ITU-T Recommendation G.703 for a 2 048 kbit/s interface.

There shall be a 75 Ω female BNC connector fitted to the equipment.

8.9 Modifying the ETI(LI) STAT field

The ETI(NA, G.704) layer can modify the ETI(LI) STAT field to indicate the error status associated with the use of the ETI(NA, G.704) layer.

The STAT field shall take one of four levels, 0 to 3, as defined in subclause 5.2. The STAT field shall be carried through the NA Layer by mapping the STAT field onto eight bits of the multiframe management byte as described in table 16. At the receiving equipment the appropriate bits of the multiframe management byte shall be re-mapped onto the output ETI(LI) logical frame.

In addition, the level of STAT can be increased during the re-mapping in the receiver according to the following rules:

The Error Level may be increased to 1 if the NA equipment detects:

either: a CRC violation of the EOF field of the recovered LIDATA;
or: LIDATA contains errors which have been corrected by the Reed-Solomon decoder.

The Error Level may be increased to 2 if the NA equipment detects:

either: a CRC violation of the EOH field of the recovered LIDATA;
or: LIDATA contains uncorrected errors.

The Error Level may be increased to 3 if the NA equipment is unable to synchronize to the incoming data.

The NA equipment shall not decrease the error level of the STAT field.

Step 1: Formation of the coding array, C (Only elements $C_{[0..7],[0..239]}$ and $C_{[8],[0..239]}$ are shown)																		
Index		*j*																
		0	**1..29**	**30**	**31..59**	**60**	**61..89**	**90**	**91..119**	**120**	**121..149**	**150**	**151..179**	**180**	**181..209**	**210**	**211..234**	**235..239**
i	**0**	$M_{0,0}$	$B_{0}..B_{28}$	$M_{1,0}$	$B_{29}..B_{57}$	$M_{2,0}$	$B_{58}..B_{86}$	$M_{3,0}$	$B_{87}..B_{115}$	$M_{4,0}$	$B_{116}..B_{14}$	$M_{5,0}$	$B_{145}..B_{17}$	$M_{6,0}$	$B_{174}..B_{20}$	$M_{7,0}$	$B_{203}..B_{22}$	$R_{0,235..23}$
	1	$S_{0,0}$	$B_{227}..B_{25}$	$S_{1,0}$	$B_{256}..B_{28}$	$S_{2,0}$	$B_{285}..B_{31}$	$S_{3,0}$	$B_{314}..B_{34}$	$S_{4,0}$	$B_{343}..B_{37}$	$S_{5,0}$	$B_{372}..B_{40}$	$S_{6,0}$	$B_{401}..B_{42}$	$S_{7,0}$	$B_{430}..B_{45}$	$R_{1,235..23}$
	2	B_{454}	B_{455}..	B_{484}	B_{485}..	B_{514}	B_{515}..	B_{544}	B_{545}..	B_{574}	B_{575}..	B_{604}	B_{605}..	B_{634}	B_{635}..	B_{664}	..B_{688}	$R_{2,235..23}$
	3	B_{689}	B_{690}..	B_{719}	B_{720}..	B_{749}	B_{750}..	B_{779}	B_{780}..	B_{809}	B_{iii}..	B_{839}	B_{840}..	B_{869}	B_{870}..	B_{899}	..B_{923}	$R_{3,235..23}$
	4	B_{924}	B_{925}..	B_{954}	B_{955}..	B_{984}	B_{985}..	B_{1014}	B_{1015}..	B_{1044}	B_{1045}..	B_{1074}	B_{1075}..	B_{1104}	B_{1105}..	B_{1134}	..B_{1158}	$R_{4,235..23}$
	5	B_{1159}	B_{1160}..	B_{1189}	B_{1190}..	B_{1219}	B_{1220}..	B_{1249}	B_{1250}..	B_{1279}	B_{1280}..	B_{1309}	B_{1310}..	B_{1339}	B_{1340}..	B_{1369}	..B_{1393}	$R_{5,235..23}$
	6	B_{1394}	B_{1395}..	B_{1424}	B_{1425}..	B_{1454}	B_{1455}..	B_{1484}	B_{1485}..	B_{1514}	B_{1515}..	B_{1544}	B_{1545}..	B_{1574}	B_{1575}..	B_{1604}	..B_{1628}	$R_{6,235..23}$
	7	B_{1629}	B_{1630}..	B_{1659}	B_{1660}..	B_{1689}	B_{1690}..	B_{1719}	B_{1720}..	B_{1749}	B_{1750}..	B_{1779}	B_{1780}..	B_{1809}	B_{1810}..	B_{1839}	..B_{1863}	$R_{7,235..23}$
	8	$M_{0,1}$	B_{1864}..	$M_{1,1}$	B_{1893}..	$M_{2,1}$	B_{1922}..	$M_{3,1}$	B_{1951}..	$M_{4,1}$	B_{1980}..	$M_{5,1}$	B_{2009}..	$M_{6,1}$	B_{2038}..	$M_{7,1}$	..B_{2090}	$R_{8,235..23}$

Step 2: Formation of the Interleaving array, I (Only part shown)																				
p	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**..**	**1919**	**..**
	$M_{0,0}$	$S_{0,0}$	B_{454}	B_{689}	B_{924}	B_{1159}	B_{1394}	B_{1629}	B_{0}	B_{227}	B_{455}	B_{690}	B_{925}	B_{1160}	B_{1395}	B_{1630}	B_{1}	B_{228}	..	$R_{7,239}$	..

Step 3: Formation of the Output array, O (Only part shown)																				
q	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**..**	**2047**	**..**
	G_{0}	$M_{0,0}$	$S_{0,0}$	B_{454}	B_{689}	B_{924}	B_{1159}	B_{1394}	B_{1629}	B_{0}	B_{227}	B_{455}	B_{690}	B_{925}	B_{1160}	B_{1395}	G_{1}	B_{1630}	..	$R_{7,239}$	..

Figure 9: Steps in the formation of $ETI(NA, G.704)_{5592}$

Step 1: Formation of the coding array, C (Only elements $C_{[0..7],[0..239]}$ and $C_{[8],[0..239]}$ are shown)																		
Index		*j*																
		0	**1..29**	**30**	**31..59**	**60**	**61..89**	**90**	**91..119**	**120**	**121..149**	**150**	**151..179**	**180**	**181..209**	**210**	**211..225**	**226..239**
i	**0**	$M_{0,0}$	$B_{0}..B_{28}$	$M_{1,0}$	$B_{29}..B_{57}$	$M_{2,0}$	$B_{58}..B_{86}$	$M_{3,0}$	$B_{87}..B_{115}$	$M_{4,0}$	$B_{116}..B_{14}$	$M_{5,0}$	$B_{145}..B_{17}$	$M_{6,0}$	$B_{174}..B_{20}$	$M_{7,0}$	$B_{203}..B_{21}$	$R_{0,226..23}$
	1	$S_{0,0}$	$B_{218}..B_{24}$	$S_{1,0}$	$B_{247}..B_{27}$	$S_{2,0}$	$B_{276}..B_{30}$	$S_{3,0}$	$B_{305}..B_{33}$	$S_{4,0}$	$B_{334}..B_{36}$	$S_{5,0}$	$B_{363}..B_{39}$	$S_{6,0}$	$B_{392}..B_{42}$	$S_{7,0}$	$B_{421}..B_{43}$	$R_{1,226..23}$
	2	B_{436}	B_{437}..	B_{466}	B_{467}..	B_{496}	B_{497}..	B_{526}	B_{527}..	B_{556}	B_{557}..	B_{586}	B_{587}..	B_{616}	B_{617}..	B_{646}	..B_{661}	$R_{2,226..23}$
	3	B_{662}	B_{663}..	B_{692}	B_{693}..	B_{722}	B_{723}..	B_{752}	B_{753}..	B_{782}	B_{783}..	B_{812}	B_{813}..	B_{842}	B_{843}..	B_{872}	..B_{887}	$R_{3,226..23}$
	4	B_{888}	B_{889}..	B_{918}	B_{919}..	B_{948}	B_{949}..	B_{978}	B_{979}..	B_{1008}	B_{1009}..	B_{1038}	B_{1039}..	B_{1068}	B_{1069}..	B_{1098}	..B_{1113}	$R_{4,226..23}$
	5	B_{1114}	B_{1115}..	B_{1144}	B_{1145}..	B_{1174}	B_{1175}..	B_{1204}	B_{1205}..	B_{1234}	B_{1235}..	B_{1264}	B_{1265}..	B_{1294}	B_{1295}..	B_{1324}	..B_{1339}	$R_{5,226..23}$
	6	B_{1340}	B_{1341}..	B_{1370}	B_{1371}..	B_{1400}	B_{1401}..	B_{1430}	B_{1431}..	B_{1460}	B_{1461}..	B_{1490}	B_{1491}..	B_{1520}	B_{1521}..	B_{1550}	..B_{1565}	$R_{6,226..23}$
	7	B_{1566}	B_{1567}..	B_{1596}	B_{1597}..	B_{1626}	B_{1627}..	B_{1656}	B_{1657}..	B_{1686}	B_{1687}..	B_{1716}	B_{1717}..	B_{1746}	B_{1747}..	B_{1776}	..B_{1791}	$R_{7,226..23}$
	8	$M_{0,1}$	B_{1792}..	$M_{1,1}$	B_{1821}..	$M_{2,1}$	B_{1850}..	$M_{3,1}$	B_{1879}..	$M_{4,1}$	B_{1908}..	$M_{5,1}$	B_{1937}..	$M_{6,1}$	B_{1966}..	$M_{7,1}$	..B_{2009}	$R_{8,226..23}$

Step 2: Formation of the Interleaving array, I (Only part shown)																				
p	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**..**	**1919**	**..**
	$M_{0,0}$	$S_{0,0}$	B_{436}	B_{662}	B_{888}	B_{1114}	B_{1340}	B_{1566}	B_{0}	B_{218}	B_{437}	B_{663}	B_{889}	B_{1115}	B_{1341}	B_{1567}	B_{1}	B_{219}	..	$R_{7,239}$	..

Step 3: Formation of the Output array, O (Only part shown)																				
q	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**..**	**2047**	**..**
	G_{0}	$M_{0,0}$	$S_{0,0}$	B_{436}	B_{662}	B_{888}	B_{1114}	B_{1340}	B_{1566}	B_{0}	B_{218}	B_{437}	B_{663}	B_{889}	B_{1115}	B_{1341}	G_{1}	B_{1567}	..	$R_{7,239}$	..

Figure 10: Steps in the formation of ETI(NA, G.704)$_{5376}$

8.10 Illustration of the capacity of ETI(NA, G.704)

The two variants of ETI(NA, G.704) layer carry either 5 592 or 5 376 LIDATA bytes. The LIDATA capacity used is made up of a fixed part (which can include the FIC) and a variable part which depends on the number and size of the data streams being carried, see table 19.

Table 19: ETI(NA, G.704) capacity per 24 ms

DAB mode	Capacity type	$ETI(NA, G.704)_{5592}$		$ETI(NA, G.704)_{5376}$	
I, II, IV	Fixed	112 bytes max.	(37,33 kbit/s)	112 bytes max.	(37,33 kbit/s)
	Variable	5 480 bytes max.	(1 826,67 kbit/s)	5 264 bytes max.	(1 754,67 kbit/s)
III	Fixed	144 bytes max.	(48,00 kbit/s)	144 bytes max.	(48,00 kbit/s)
	Variable	5 448 bytes max.	(1 816,00 kbit/s)	5 232 bytes max.	(1 744,00 kbit/s)

Table 20 shows the total number of equal sized sub-channels which may be carried by ETI(NA, G.704).

NOTE: The capacity of the DAB ensemble may be lower, depending on the values of TPL defined for each sub-channel.

Table 20: Number of equal sized sub-channels which may be carried by ETI(NA, G.704)

	DAB MODE I, II, IV							
	$ETI(NA, G.704)_{5592}$				$ETI(NA, G.704)_{5376}$			
Sub-channel data-rate	Number of sub-channels	LIDATA - MST bytes	MST bytes	Frame Padding bytes	Number of sub-channels	LIDATA - MST bytes	MST bytes	Frame Padding bytes
256 kbit/s	7	44	5 472	76	6	40	4 704	632
224 kbit/s	8	48	5 472	72	7	44	4 800	532
192 kbit/s	9	52	5 280	260	9	52	5 280	44
128 kbit/s	14	72	5 472	48	13	68	5 088	220
64 kbit/s	27	124	5 280	188	26	120	5 088	168
32 kbit/s	54	232	5 280	80	52	224	5 088	64

	DAB MODE III							
	$ETI(NA, G.704)_{5592}$				$ETI(NA, G.704)_{5376}$			
Sub-channel data-rate	Number of sub-channels	LIDATA - MST bytes	MST bytes	Frame Padding bytes	Number of sub-channels	LIDATA - MST bytes	MST bytes	Frame Padding bytes
256 kbit/s	7	44	5 504	44	6	40	4 736	600
224 kbit/s	8	48	5 504	40	7	44	4 832	500
192 kbit/s	9	52	5 312	228	9	52	5 312	12
128 kbit/s	14	72	5 504	16	13	68	5 120	188
64 kbit/s	27	124	5 312	156	26	120	5 120	136
32 kbit/s	54	232	5 312	48	52	224	5 120	32

Annex A (normative): Coding of MNSC Data

A.1 Introduction

This annex gives detailed information about the coding of the signalling groups used to carry information in the MNSC of the ETI(LI) layer (see subclause 5.5.1). The bytes used for MNSC data are designated as $SB_{[0..7],q}$. The coding differs between Frame Synchronous Signalling (FSS) and Frame Asynchronous Signalling (ASS).

A.2 Frame Synchronous Signalling (FSS)

A.2.1 FSS messages structure

For FSS, only one group per message shall be used. The FSS group structure shall be as given in table A.1.

Table A.1: FSS group structure

$SB_{0,q}$ $(b_0..b_7)$	$SB_{1,q}$ $(b_0..b_7)$	$SB_{2,q}$ $(b_0..b_7)$	$SB_{3,q}$ $(b_0..b_7)$	$SB_{4,q}$ $(b_0..b_7)$	$SB_{5,q}$ $(b_0..b_7)$	$SB_{6,q}$ $(b_0..b_7)$	$SB_{7,q}$ $(b_0..b_7)$
00xxxxxx	Rfu	(MSB)...		FSS message			...(LSB)

The FSS identifier is given by $SB_{0,q}(b_4..b_7)$ as defined in subclause 5.5.1. FSS message types may be pre-assigned (with $SB_{0,q}(b_4) = 0$) or user defined (with $SB_{0,q}(b_4) = 1$) as specified in subclause A.2.2.

A.2.2 Pre-assigned FSS message types

Only the pre-assigned coding for the time information group (FSS type 0) is defined by this ETS. This shall be as given in table A.2.

Table A.2: Coding of time information message

Time information message	Function	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b 1
$SB_{0,q}$	Type identifier	0	0	Rfu	Rfu	0	0	0	0	0
$SB_{1,q}$	Rfa									
$SB_{2,q}$	Second [0..59]	0 = time accuracy is 1µs or better 1 = time accuracy worse than 1µs	0..5			0..9				
$SB_{3,q}$	Minute [0..59]	0 = no synchronization to frame 1 = time applies to $B_{0,p}(b_0)$ of the ETI(LI) frame which contains $SB_{0,q}$	0..5			0..9				
$SB_{4,q}$	Hour [0..23]	0	0	0..2		0..9				
$SB_{5,q}$	Day [1..31]	0	0	0..3		0..9				
$SB_{6,q}$	Month [1..12]	0	0	0	0,1	0..9				
$SB_{7,q}$	Year [0..99]	0..9				0..9				

A.3 Frame Asynchronous Signalling (ASS)

A.3.1 ASS messages structure

ASS messages shall consist of a sequence of signalling groups.

Groups shall be defined as start, continuation, end or padding groups:

- each ASS message shall commence with a single start group which shall define the message type and the number of continuation groups which are present in the ASS message;
- continuation groups shall carry ASS message data;
- padding groups shall carry null padding information;
- each ASS message shall end with a single end group which shall contain CRC check fields.

The coding of the different group types shall be as given in table 23.

Table 23: Coding of different ASS group types

ASS group type	$SB_{0,q}$ ($b_0..b_7$)	$SB_{1,q}$ ($b_0..b_7$)	$SB_{2,q}$ ($b_0..b_7$)	$SB_{3,q}$ ($b_0..b_7$)	$SB_{4,q}$ ($b_0..b_7$)	$SB_{5,q}$ ($b_0..b_7$)	$SB_{6,q}$ ($b_0..b_7$)	$SB_{7,q}$ ($b_0..b_7$)
Start	11xx0000	Rfu	Message type	*GrNb*	Message byte	Message byte	Message byte	Message byte
Continuation	11xx0011	Rfu	Message byte	Message byte	Message byte	Message byte	Message byte	Message byte
End	11xx1100	Rfu	Message byte	Message byte	Message byte	Message byte	CRC byte (MSB)	CRC byte (LSB)
Padding	11xx1111	FF_{16}	FF_{16}	FF_{16}	FF_{16}	FF_{16}	FF_{16}	FF_{16}

$SB_{2,q}$ of the start group shall define the message type. Pre-assigned types shall have $SB_{2,q}(b_0)$ set to 0. User definable types shall have $SB_{2,q}(b_0)$ set to 1.

GrNb shall have values in the range 0 to 255 and shall represent the number of continuation groups in the ASS message. Padding groups shall not be included in this count. The overall total number of groups which constitutes the ASS message (including the start, continuation and end Groups) shall be given by:

Number of groups in message = *GrNb* + 2.

The CRC bytes shall contain the product of a cyclic redundancy check performed on the ASS message content from the first byte of the start group ($SB_{0,q}$) to the last message byte in the End Group ($SB_{5,q+x}$), excluding any padding groups.

CRC calculations shall use the method defined in annex D.

A.3.2 Pre-assigned ASS message types

Only pre-assigned message type 0 is defined by this ETS. This is used for signalling transmitter control information including values of individual transmitter TII codes and offset delays.

A.3.2.1 ASS message type 0: Transmitter Set-up and Control Information (TSC)

There are two attributes of each transmitter in a Single Frequency Network (SFN) which may be unique to a given transmitter. These are the TII code and the offset delay (see annex F).

TII codes and offset delay values can also be present in the transmitted DAB multiplex, as part of the Service Information. In this case the data is part of the global package destined for the DAB receiver and radiated by each transmitter. It is generated at the DAB multiplexer, located with the Ensemble provider rather than the Transmitter Network provider.

NOTE: TII codes and offset delay values are both signalled in Extension 22 of FIG type 0 as defined in ETS 300 401 [1] (which refers to Time Delay (TD) and not offset delay).

ASS Message type 0 allows the DAB multiplexer to communicate individual TII and offset delay values to each transmitter in the network. Provision is also made for additional, user-specific, transmitter control information.

Message type 0 shall be used to transmit a scrolling list of transmitter set-up and control information. The Transmitter Network provider and the Ensemble provider should agree on a unique 16-bit address code for each transmitter in the network. TSC messages may then be used to convey individual values of TII code, offset delay and control information to each transmitter. The coding that shall be used for TSC messages shall be as given in table A.4.

Table A.4: Coding of TSC messages (ASS type 0)

TSC messages	$SB_{0,q}$ $(b_0..b_7)$	$SB_{1,q}$ $(b_0..b_7)$	$SB_{2,q}$ $(b_0..b_7)$	$SB_{3,q}$ $(b_0..b_7)$	$SB_{4,q}$ $(b_0..b_7)$	$SB_{5,q}$ $(b_0..b_7)$	$SB_{6,q}$ $(b_0..b_7)$	$SB_{7,q}$ $(b_0..b_7)$
Start	11xx0000	Rfu	00000000 (= TSC message)	*GrNb*	address of transmitter T MSb..LSb		16 control flags for transmitter T MSb..LSb	
Continuation	11xx0011	Rfu	Rfa					
End	11xx1100	Rfu	Offset delay for transmitter T MSb..LSb		TII code for transmitter T MSb..LSb		CRC Byte (MSB)	CRC Byte (LSB)

Each TSC message shall comprise a start group which defines the transmitter address and 16 control flags. The function of these control flags may be defined by the user.

A number of continuation groups may be included in the message. These are designated as Rfa.

The message shall be terminated by an end group which contains the TII code and offset delay values for the relevant transmitter. In the end group, $SB_{2,q}(b_0..b_7)$ and $SB_{3,q}(b_0..b_7)$ shall carry the offset delay value coded as an 11-bit unsigned binary number (0..2 047), giving the required offset delay in multiples of 1 μs. The offset delay shall be as given in table A.5.

Table A.5: Coding of offset delay

$SB_{2,q}$								$SB_{3,q}$							
b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7
Rfa (set to 1)					2^{10} MSb					Offset delay					2^0 LSb

$SB_{4,q}(b_0..b_7)$ and $SB_{5,q}(b_0..b_7)$ shall carry the TII value coded as *MainId* (7 bits) and *SubId* (5 bits) as given in table A.6. *MainId* and *SubId* are unsigned binary numbers as defined in ETS 300 401 [1].

Table A.6: Coding of TII

$SB_{4,q}$								$SB_{5,q}$							
b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7
Rfa (=1)	2^6 MSb			*MainId*			2^0 LSb	Rfa (set to 111)			2^4 MSb		*SubId*		2^0 LSb

$SB_{6,q}(b_0..b_7)$ and $SB_{7,q}(b_0..b_7)$ shall carry a CRC check for the TSC message as described in annex D.

Annex B (normative): Coding of NASC Data

B.1 General

This annex gives detailed information about the coding of the signalling groups used to carry information in the ETI(NA, G.704) signalling channel (NASC). The method of coding employed is very similar to that used for the MNSC (see annex A). NASC shall be carried in the signalling bytes $S_{[0..7],q}$.

The coding differs between Frame Synchronous Signalling (FSS) and frame Asynchronous Signalling (ASS).

B.2 Frame Synchronous Signalling (FSS)

The general coding of FSS messages types shall be as defined in subclause 8.3.2.2.

B.3 Asynchronous Signalling (ASS)

ASS messages shall consist of a sequence of signalling groups. Groups shall be defined as start, continuation, end or padding groups. The start group shall define the ASS message type, and the number of groups in the message. The end group shall contain CRC check fields. The coding of the different group types shall be as given in table B.1.

Table B.1: Coding of different ASS group types

ASS	$S_{0,s}$	$S_{1,s}$	$S_{2,s}$	$S_{3,s}$	$S_{4,s}$	$S_{5,s}$	$S_{6,s}$	$S_{7,s}$
Start	11xx0000	Rfu	Message	*GrNb*	Message	Message	Message	Message
Continuation	11xx0011	Rfu	Message	Message	Message	Message	Message	Message
End	11xx1100	Rfu	Message	Message	Message	Message	CRC byte	CRC byte
Padding	11xx1111	FF_{16}	FF_{16}	FF_{16}	FF_{16}	FF_{16}	FF_{16}	FF_{16}

The general coding of ASS messages types shall be as defined in subclause 8.3.2.2. $S_{2,s}$ of the start group shall define the ASS message type. Pre-assigned types shall have $S_{2,s}(b_0)$ set to 0, $S_{2,s}(b_0)$ shall be set to 1 for user definable types.

GrNb shall give the number of continuation groups in the ASS message. Padding groups shall not be included in this count. The overall total number of groups which constitutes the ASS message shall be given by:

Number of groups in message = *GrNb* + 2.

The CRC bytes in the end group shall contain the product of a cyclic redundancy check performed on the ASS Message content from the first byte of the start group ($S_{0,s}$) to the last message byte in the end group ($S_{5,s+x}$), excluding any padding groups.

CRC calculations shall use the method defined in annex D.

Annex C (normative): Coding of timestamps

C.1 General

This annex gives detailed information about the coding of timestamp information carried in ETI(LI) and ETI(NA, G.704).

C.2 Timestamp coding

The timestamp shall be coded as a 24-bit unsigned binary integer giving the timestamp value as a multiple of 16,384 MHz clock periods (approximately 61 ns). The coding of the 24 bits shall be as given in table C.1.

Table C.1: Coding of timestamps

Bit number	b_0(MSb)..b_6	b_7..b_9	b_{10}..b_{17}	b_{18}..b_{20}	b_{21}..b_{23}(LSb)
Timestamp level	1	2	3	4	5
Valid range	[0..124], 127	[0..7]	[0..255]	[0..7]	[0..7]
Approximate time resolution	8 ms	1 ms	3,91 µs	488 ns	61 ns

C.2.1 Expected range of timestamp values

The timestamp value, expressed as a hexadecimal number shall lie between 0 and F9 $FFFF_{16}$ (giving time values between 0 and 999,999 939 ms).

C.2.2 Null timestamp

The timestamp value FF $FFFF_{16}$ may also be allowed and shall be used as a null timestamp value. This shall be interpreted as meaning that there is no timestamp information available.

C.2.3 Reserved timestamp values

Timestamp values between FA 0000_{16} and FF $FFFE_{16}$ shall be reserved for future use.

C.2.4 Timestamp levels

Not all applications will require a timestamp value to be specified to a resolution of 61 ns. For this reason a number of different timestamp levels are specified (1 to 5). The different levels allow timestamps to be specified with different resolutions e.g. use of timestamps to level 2 allow a time resolution of 1 ms which should suffice in many applications. The timestamp values at levels higher than those used shall be set to 0, except in the specific case of transmission of a null timestamp.

C.3 Mapping to ETI(LI) timestamp bits

The mapping of the timestamp into the ETI(LI) layer shall be as given in table C.2.

Table C.2: Mapping of the timestamp into the ETI(LI) layer

ETI(LI) byte	$B_{(FL+2)\times 4,p}$	$B_{(FL+2)\times 4+1,p}$	$B_{(FL+2)\times 4+2,p}$	$B_{(FL+2)\times 4+3,p}$
Bit index	0..7	0..7	0..7	0..7
Timestamp bit	Rfa, set to FF_{16}.	b_0..b_7	b_8..b_{15}	b_{16}..b_{23}

C.4 Mapping to ETI (NA, G.704) timestamp bits

The mapping of the timestamp into $M_{bl,s}(b_5)$ of the ETI(NA, G.704) layer shall be as given in table C.3.

Table C.3: Mapping of the timestamp into $M_{bl,s}(b_5)$ of the ETI(NA, G.704) layer

$M_{bl,s}(b_5)$		*bl*							
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
s	**0**	b_0(MSb)	b_1	b_2	b_3	b_4	b_5	b_6	b_7
	1	b_8	b_9	b_{10}	b_{11}	b_{12}	b_{13}	b_{14}	b_{15}
	2	b_{16}	b_{17}	b_{18}	b_{19}	b_{20}	b_{21}	b_{22}	b_{23}(LSb)

C.5 Interpretation of timestamp value

The timestamp carried within a 24 ms ETI frame (which can be either an LI logical frame or an NA multiframe) defines the starting time of the first bit, $B_{0,p}(b_0)$, of the ETI(LI) frame associated with that frame (see figure 5). The start time is specified as an offset value (always positive) from a time reference point derived from a time reference signal.

The time reference signal, from which the timestamp offset is measured, shall be available at both the originating point of the timestamp in the ETI frame and at the "delivery point" of the frame.

Suitable time references may be derived from the Global Positioning Satellite system (as a 1 pulse per second reference) or from a satellite video channel (as a 20 ms reference).

NOTE: Although the timestamp allows time resolutions down to 61 ns, the accuracy of signal timing is likely to be determined largely by the accuracy of the time reference.

C.6 Use of timestamps in LI and NA layers

The use of the timestamp is largely system dependant and depends on the network configuration, ETI transport mechanism, etc.

The time given by the timestamp in the LI layer should define the "notional delivery time" of the first bit $B_{0,p}(b_0)$ of the ETI(LI) frame at the input of the channel encoder, (see figure 3).

The time given by the timestamp in the NA layer should define the "notional delivery time" of the first bit $B_{0,p}(b_0)$ of ETI(LI) frame at the output of an ETI(NA) to ETI(NI) or ETI(LI) converter. This timestamp can be used, for example, to re-time the ETI(NA) sections in a cascaded network.

Annex D (normative): Calculation of CRC words in the ETI

A CRC code is defined by its generator polynomial of degree *n*:

$$G(x) = \sum_{i=0}^{n} g_i x^i$$

with $n \geq 1$
and g_j = 0 or 1 except that $g_0 = 1$, $g_n = 1$.

The CRC calculation may be performed by means of a shift register containing *n* register stages, equivalent to the degree of the polynomial (see figure D.1). The stages are denoted by $b_0 \ldots b_{n-1}$, where b_0 corresponds to x^0, b_1 to x^1, b_2 to x^2, ..., b_{n-1} to x^{n-1}. The shift register is tapped by inserting XORs at the input of those stages, where the corresponding coefficients g_i of the polynomial are "1".

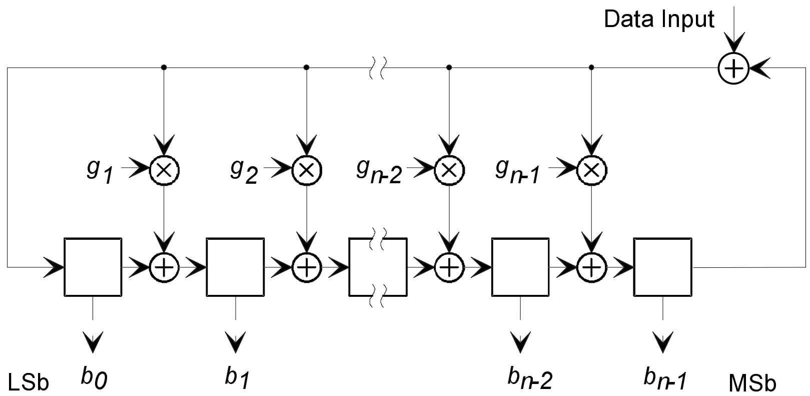


Figure D.1: General CRC block diagram

At the beginning of the CRC calculation, the register stage contents are initialized to all ones. After applying the first bit of the data block (MSb first) to the input, the shift clock causes the register to shift its content by one stage towards the MSb stage (b_{n-1}), while loading the tapped stages with the result of the appropriate XOR operations. The procedure is then repeated for each data bit. Following the shift after applying the last bit (LSb) of the data block to the input, the shift register contains the CRC word which is then read out.

The CRC word shall be inverted prior to transmission. At the receiving end, an error free transmission shall give a CRC result of $1D0F_{16}$.

The CRC code used in the ETI shall use the following polynomial:

$$G(x) = x^{16} + x^{12} + x^5 + 1 .$$

Annex E (normative): Behaviour of the ETI during re-configuration

E.1 Background

The DAB Multiplex is very flexible, allowing broadcasters to change dynamically the mixture of its components. The following changes are possible:

- a sub-channel may be added or removed from the transmission frame;
- the size of a sub-channel may be modified due to a change in data-rate or protection level;
- the position of the sub-channel may change.

The channel encoders shall realize these changes under the control of the Ensemble multiplexer.

The modulation technique used in the channel encoder uses time interleaving. The information from any sub-channel is spread out over a period of 16 frames. The net effect of the time-interleaving, and the dis-interleaving in the DAB receiver, is to delay each sub-channel by this amount.

The multiplex re-configuration is defined as taking place at a specific instant of time. The behaviour of the transmitted ensemble during a re-configuration time, and its relation to the notional re-configuration time, is defined in ETS 300 401 [1]. This clause defines how this behaviour is mirrored by the ETI.

E.2 Multiplex reconfiguration

The ETI(LI) header (the STC field in particular) is a command file for the channel encoder and defines, on a frame-by-frame basis, the contents of the signal to be radiated.

There shall be no frame delay between the signalling information carried in the STC and the sub-channel data carried in the MST. The STC (SSTC) field in frame p for a particular sub-channel shall be used to define the encoding algorithm to be used for that sub-channel in frame p.

The examples below illustrate the relationships between the behaviour of the transmitted signal (COFDM) and the signalling carried by ETI(LI). The re-configuration time is defined with respect to r, the Common Interleaved Frame (CIF) time index, as defined in ETS 300 401 [1]. It is assumed that the multiplex re-configuration occurs between CIFs of time index r_0 -1 and r_0.

The examples always illustrate the signalling for the sub-channel under consideration. Other sub-channels may also be affected because their position in the data stream may change.

case a) Sub-channel translation

COFDM A sub-channel's position is changed at $r = r_0$; the convolutional encoder is not affected.

ETI(LI) The new SAD of the sub-channel shall be inserted at frame $p = r_0$.

case b) New sub-channel

COFDM If a new sub-channel, which did not exist at $r = r_0 - 1$, appears at $r = r_0$ then the convolutional encoder uses the corresponding protection profile for $r \geq r_0$.

ETI(LI) The new (additional) SSTC shall be inserted at frame $p = r_0$.

case c) Sub-channel removed

COFDM If a sub-channel, which exists at $r = r_0 - 1$, disappears at $r = r_0$ then the convolutional encoder ceases encoding at $r = r_0 - 15$.

ETI(LI) The SSTC of the sub-channel shall be removed at frame $p = r_0 - 15$.

case d)	***Increase Sub-channel size***
COFDM	If a sub-channel increases its size between CIFs of time index $r = r_0 - 1$ and $r = r_0$, then the convolutional encoder uses the new protection profile for $r \geq r_0$.
ETI(LI)	The new SSTC of the sub-channel shall be inserted at frame $p = r_0$.

case e)	***Decrease Sub-channel size***
COFDM	If a sub-channel decreases its size between CIFs of time index $r = r_0 - 1$ and $r = r_0$, then the convolutional encoder uses the new protection profile for $r \geq r_0 - 15$;
ETI(LI)	The new SSTC of the sub-channel shall be inserted at frame $p = r_0 - 15$.

case f)	***Modification of the sub-channel protection profile***
COFDM	If a sub-channel changes its protection profile between $r = r_0 - 1$ and $r = r_0$, but its coded bit-rate remains unchanged, then the convolutional encoder uses the new protection profile for $r \geq r_0$.
ETI(LI)	The new SSTC of the sub-channel shall be inserted at frame $p = r_0$.

Annex F (informative): Managing delay in the Ensemble Transport network

F.1 General

Each transmitter in a Single Frequency Network (SFN), shall radiate:

- the same information;
- on the same frequency (within an accuracy of about 1 % of the inter-carrier spacing);
- at the same time (within an accuracy of about 10 % of the guard interval).

The required timing accuracy is of the order of a few micro-seconds which requires careful management of all the delays in the distribution network from the Ensemble multiplexer to each transmitter's radiated output.

Figure F.1 shows the general structure of the Single Frequency Network. The ETI signal produced by the Ensemble multiplexer (and its associated Network adapter), is carried to the transmitter site where channel encoding and modulation (COFDM) is performed before the signal is amplified and radiated.

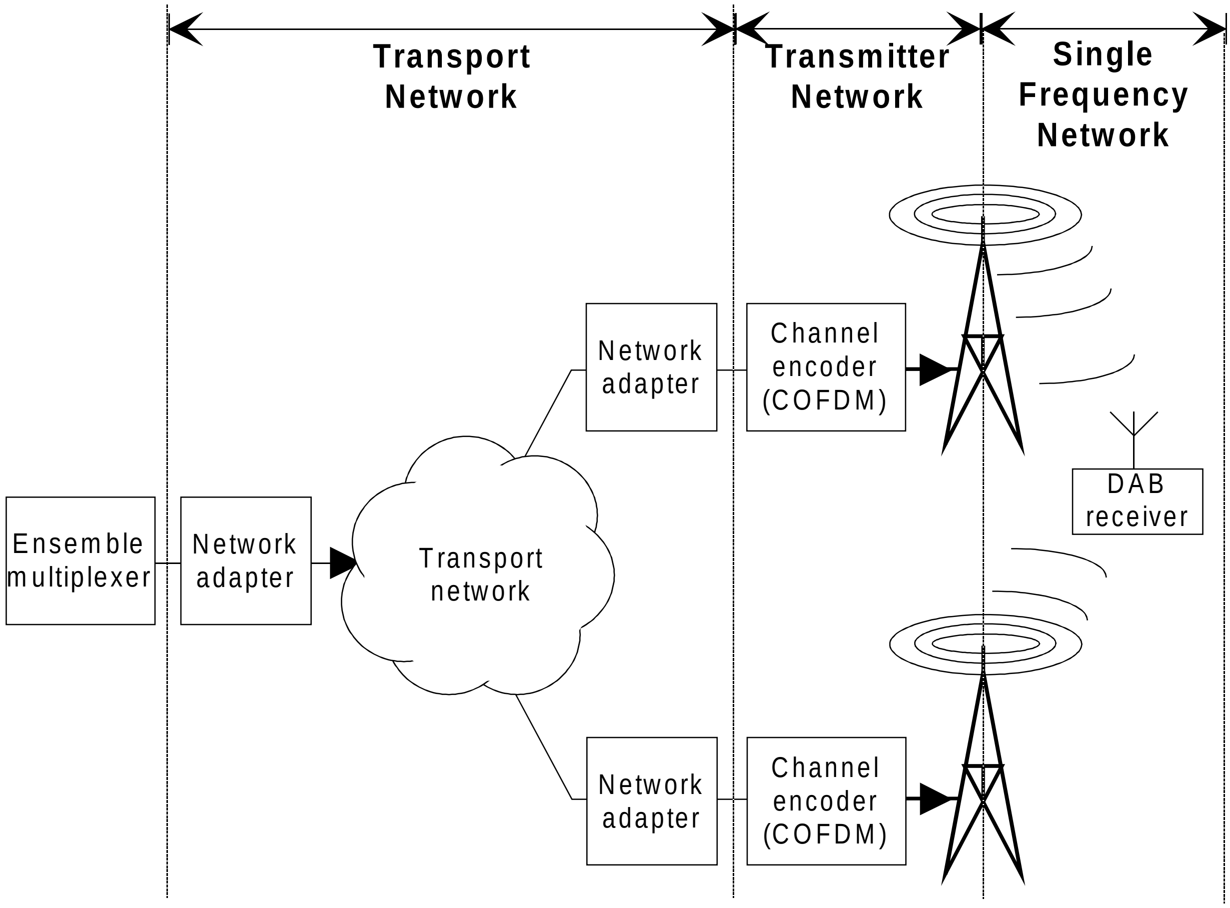


Figure F.1: General structure of Single Frequency Networks (SFN)

In such a network, several kind of delays may be identified and these is to all be managed so that they remain constant and known. Figure F.2 identifies the different delay blocks.

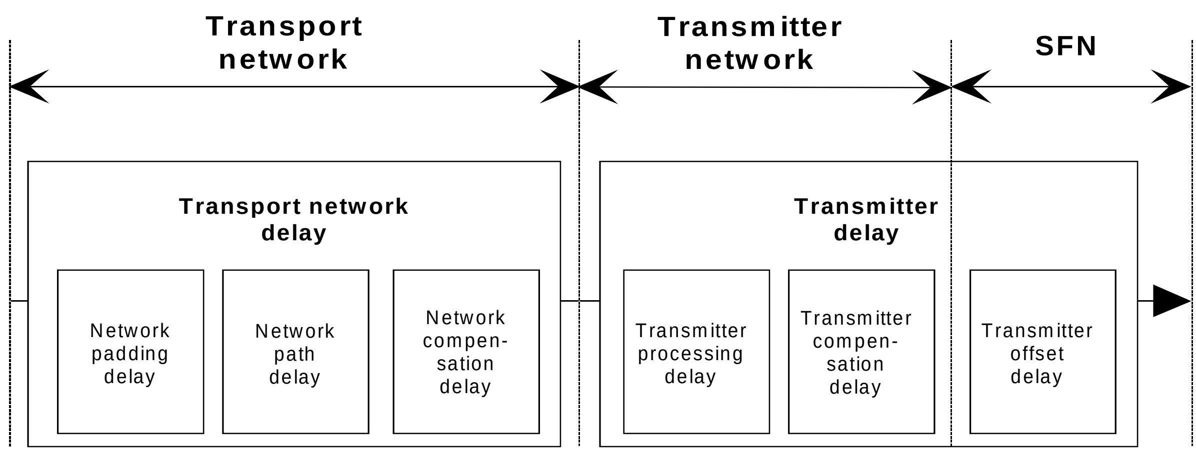


Figure F.2: Distribution and transmission network delays

The different delays are:

network padding delay: This delay is used by the broadcaster, or network operator, to trim the overall delay of the network to a required value. For instance, to make the delay through the whole network equal to an integer number of seconds or to equalize the overall delay of the DAB network with that of another network such as digital television. This delay can also be used to equalize the delay with respect to other DAB networks so that all DAB ensembles are radiated with co-timed synchronizing symbols. This may allow speedier locking of DAB receivers.

network path delay: This is the delay to which the ETI signal is subject on its way through the transporting network.

network compensation delay: This delay is a compensating delay which, when added to the Network path delay, ensures that the overall delay is constant and of known value. The value of the compensating delay is set by examining the incoming timestamps with reference to a local time standard. The value of the compensating delay is adjusted so that frame carrying the timestamp is delivered at the correct time.

transmitter processing delay: This delay represents delay incurred in channel encoding and RF modulation. It also includes any RF processing delays in the amplifier and any associated filtering. Different equipment or system implementations will have different processing delays, which will typically fall in the range of 200 to 500 ms.

transmitter compensation delay: This delay allows the transmitter processing delay to be equalized for each transmitter in the network.

transmitter offset delay: After equalizing the transmitter delays, small offsets are still permitted in a SFN and may be desirable to optimize SFN coverage. The transmitter offset delay may be used for this purpose and can be set via information carried in the ETI signalling channel (MNSC).

F.2 Dynamic delay compensation

The method used by the ETI to manage the variable network path delay is based on the use of a timestamp which allows the delivery time of ETI frames to be synchronized at different locations. This method requires the use of a common time reference available to the Ensemble multiplexer and at all transmitters.

The timestamp source marks all its generated ETI frames with a timestamp which defines the instant at which the frames should be delivered to the channel encoder. This timestamp is the sum of the time as determined by the local time reference and an offset value which allows for the longest path through the network. It determines the total network transit delay which is the sum of the network path delay and the network compensation delay (including equipment processing delays).

The ETI receiving equipment has to delay the received frames until the defined delivery time is reached. In this way, the network transit delay is consumed partly in the transport network and partly in the receiving equipment.

In order that the delay compensation functions normally, the period of the time reference signal has to be greater than the variability in network path delay, and shall also be greater than the delay difference between the longest and shortest path through the network. In the latter case, additional static delay may be added to the network compensation delay to equalize the different path delays. Typically, this delay would be required when a large network of cascaded multiplexers, or a time reference with a very short periodicity, is contemplated.

Annex G (informative): Network testing and monitoring

G.1 General

This ETS allows many variants of the DAB transport network (or distribution network) to be implemented. The ETI signal delivered to each transmitter is potentially the result of several processing segments, including telecommunication adapters or multiplexers. This annex proposes some methods for network testing and quality monitoring.

The methods described are all based on the use of a Pseudo Random Binary Sequence (PRBS) to make Bit Error Rate (BER) measurements.

Three ways to inject and use the PRBS are suggested:

Full channel measurement: This method can be used during the installation phase of the network. For this measurement, the usual ETI payload is replaced by a PRBS.

Single sub-channel measurement: This method can be used both during the installation and the operational phase of the network. It uses a normal DAB sub-channel and carries the PRBS in place of a standard audio or data component.

Telecommunication line measurement: This method can be applied when ETI(NA, G.704) is used. It uses time-slot 16 (ts_{16}) of the G.704 frame to monitor the quality of a point to point digital telecommunication link.

G.2 Pseudo Random Binary Sequence (PRBS)

G.2.1 PRBS generator

The PRBS is defined as the output of a feedback shift register. Many generator polynomials are possible but the following is preferred for DAB network testing:

$$G(x) = x^{20} + x^{17} + 1$$

This polynomial generates a PRBS which is longer than the maximum length of the ETI(LI) frame.

Figure G.1 shows the logical structure of a suitable PRBS generator.

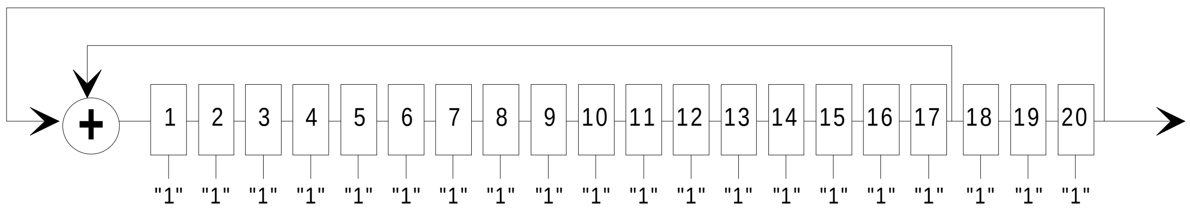


Figure G.1: PRBS generator

To avoid the generation of a null sequence, each cell of the shift register should be pre-set to a logical 1 at the beginning of the sequence.

The output of the PRBS generator shall be inserted directly in the relevant payload container, i.e. the full DAB channel, a single DAB sub-channel or G.704-ts_{16}. There is no need to synchronize the start of the PRBS sequence with the beginning of the relevant container.

The PRBS generator should only be clocked during the duration of the PRBS container (see clause G.3), i.e. the last bit of the container related to a frame $B_{x,q}(b_7)$ and the first bit of the container related to following frame $B_{y,q+1}(b_0)$ should carry successive bits produced by the PRBS generator.

G.2.2 PRBS extractor

The equipment used in the DAB network can provide an output of the PRBS (extracted from the relevant container) to feed standard PRBS analysis equipment. The physical implementation of the PRBS extractor should provide separate clock and data signals at suitable interface levels.

As the continuous PRBS is spread over the PRBS containers of several frames, the PRBS extractor shall provide a gated clock that corresponds to the position of the payload of the PRBS container in each frame. The PRBS data output of the PRBS extractor need not be gated.

G.3 PRBS containers

G.3.1 Full DAB channel

The PRBS container is the full payload of the ETI frame. This method permits the whole of the DAB transport network to be tested during its installation phase. It is unable to monitor the quality during normal operation. Due to its high bit-rate, this approach allows an overall view of the network quality to be obtained in a very short period of time.

The PRBS container is mapped on the ETI(LI) as shown in the figure G.2. The ERR, FC and TIST fields are retained.

The ETI(LI) FC field is set to FFFF $FFFF_{16}$ to signal a null transmission frame.

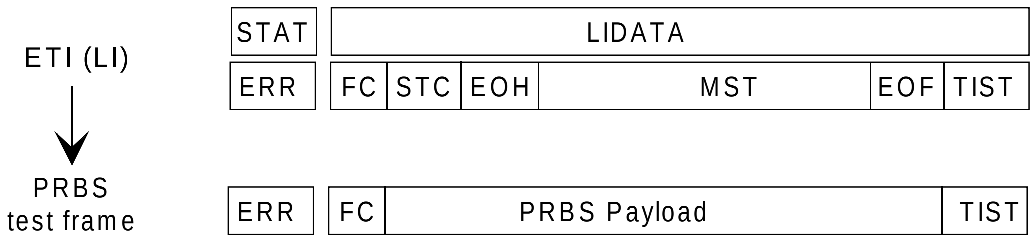


Figure G.2: Full DAB channel container

The rest of the LIDATA field is replaced by the bytes of the PRBS. If 5 367 PRBS bytes are inserted, the complete LI frame comprises 5 376 bytes which is exactly the capacity of the ETI(NA, $G.704)_{5376}$ frame.

Equipment for adaptation from ETI(LI) to ETI(NI, G.703) or ETI(NI, V11) is able to process such a frame using only a minimum of organizational overhead, i.e. the FSYNC, ERR, FC and TIST fields. The ETI(NI, X) FSYNC field is kept to allow equipment in the transport network to detect the physical frame.

Equipment for adaptation from ETI(LI) or ETI(NI, X) to ETI(NA,G.704) is able to transmit or to receive such a frame through the telecommunication network, which corresponds to the minimum ETI(NA, G.704) capacity (i.e. the maximum error protection).

NOTE: In some cases it may be desirable to disable the Reed-Solomon error correction, at the receive side of the telecommunication network, in order to determine the intrinsic quality of the line. Error correction at intermediate points in the network would give optimistic results for an end-to-end measurement.

G.3.2 Single DAB sub-channel

The PRBS container consists of one DAB sub-channel. The method can be used both for a check while installing the DAB network and for monitoring its quality whilst in normal operation.

The bit-rate used for the PRBS sub-channel shall comply with one of the options permitted by ETS 300 401 [1].

This PRBS container can be injected at the source side of the DAB network, extracted at any level of the transmission chain including at the output of the DAB receiver.

NOTE: This method allows the quality of the radio channel between transmitter and receiver to be determined.

G.3.3 G.704 ts_{16} measurement

In this method, the PRBS container is timeslot 16 (ts_{16}) of each G.704 frame. The data rate available for the PRBS is 64 kbit/s.

This method can be used to monitor the quality of a G.704 segment of the network. It may be used whilst the network is in its normal operating mode and does not require normal DAB data capacity to be sacrificed.

Annex H (informative): Cascading in the Ensemble Transport network

H.1 General

In the network model shown in figure 1, the Ensemble multiplexer which is operated by the Ensemble provider, is represented as a single centralized entity.

There are situations where the Ensemble provider may wish to operate in a distributed fashion. Figure H.1 shows such a network where all regions receive a common basic ensemble and two regions (A and B) add local programmes using a cascaded multiplexer. In this case, the output of the central Ensemble multiplexer is fed into another Ensemble multiplexer rather than a COFDM generator. The second multiplexer also receives a local service which it combines with the common, basic, ensemble.

NOTE: In this analysis, the complications of generating and managing the FIC information when Ensemble multiplexers are cascaded are ignored.

H.2 Management of the overall delay to allow SFN operation

To allow SFN operation in a DAB network, the overall transport network delay shall remain constant, irrespective of the equipment and the transport media used in the network (see annex F).

As a consequence, the timestamp that defines the notional delivery time of the ETI input of the first DAB specific stage of the COFDM encoder shall be retained through the whole network. This implies that cascaded telecommunication adapters and Ensemble multiplexers should pass on this timestamp without modification.

Due to the concatenation of equipment in the network, the longest path delay may have a value greater than the period of the time reference used. In this case, static delay should be added in the shorter paths of the transport network to avoid timing ambiguities (see annex F). In the example of figure H.1, the telecommunication adapters feeding the other regions may need to provide this static delay.

H.3 Testing and monitoring in a cascaded network

Annex G proposes three different approaches to DAB network testing and monitoring; full channel measurement, measurement using a single DAB sub-channel and telecommunication line measurement using ts_{16} of the G.704 network adaptation layer.

If full channel measurements are employed in a cascaded network, all of the equipment in the network should be transparent to a PRBS sequence. One method for ensuring this is for the cascaded multiplexer to switch to a transparent mode (passing on the received data stream unmodified) should it detect a null transmission frame (see subclause 5.9).

In the case of a measurement based on using a single DAB sub-channel, the Ensemble multiplexer provider should ensure that the chosen sub-channel will not be overwritten by any stage in the cascade of multiplexers.

Using telecommunication line measurement method it is only possible to test and monitor G.704 network adapted sections of the network, an end-to-end check is not possible in a cascaded network.

NOTE: All the PRBS test methods proposed in annex G preserve timestamp data. This allows the transport network delay compensation to remain operational while PRBS tests are performed.

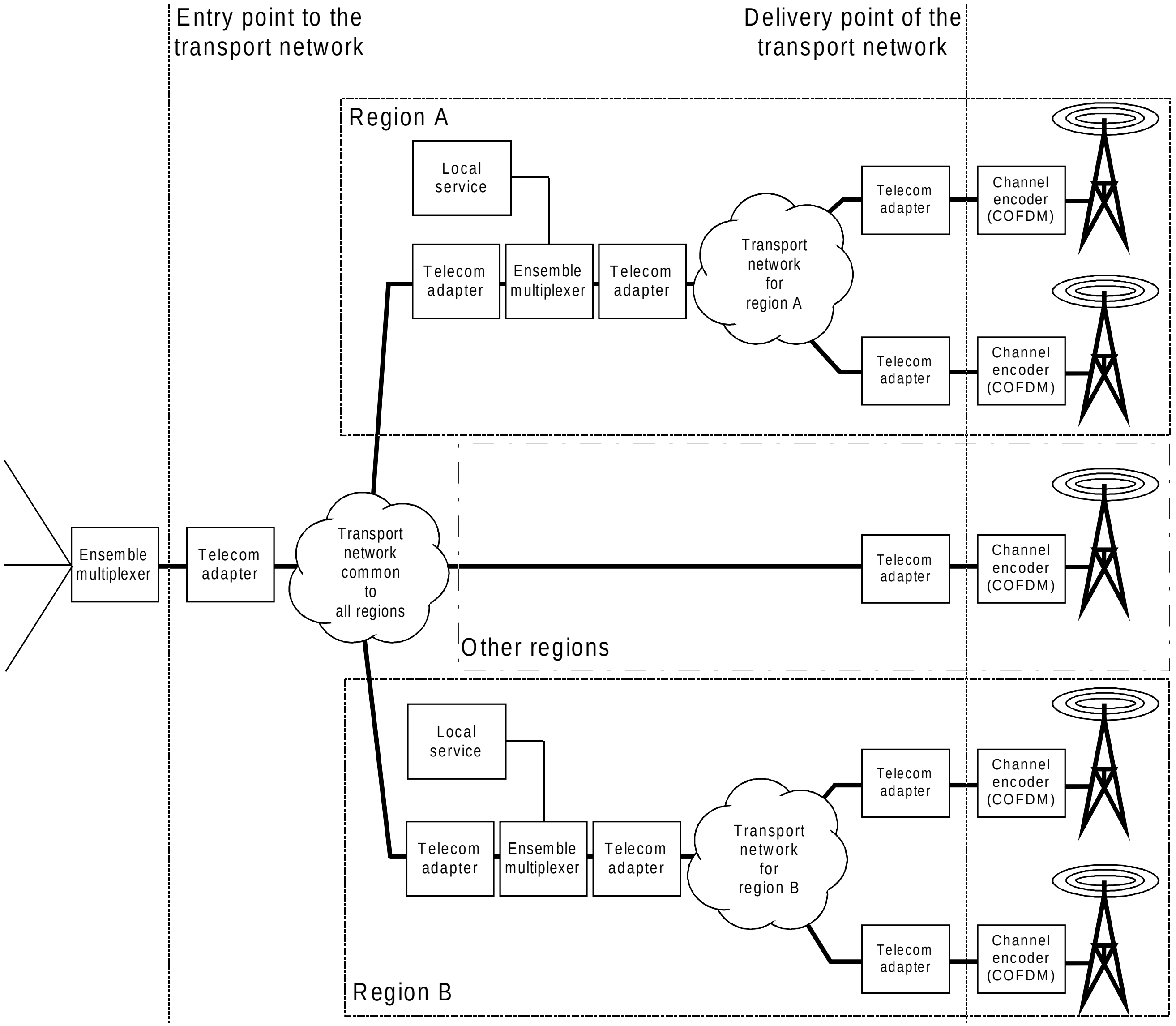


Figure H.1: An example of a cascaded network

Annex J (informative): Carrying ETI on 1 544 kbit/s links

J.1 Introduction

ETI(NA, G.704), see clause 8, has been designed for use with telecommunication network hierarchies which are based on 2 048 kbit/s networks. However, the DAB system will also be used in countries which have a hierarchy based on 1 544 kbit/s (often referred to as G.704-T1).

This annex gives some guidelines for transporting an ETI(LI) on such telecommunication networks and includes a suggestion for a suitable G.704 adaptation, ETI(NA, G.704-T1).

J.2 General outline of ETI(NA, G.704-T1)

The Network Adaptation ETI(NA, G.704-T1) layer described in this clause is suitable for use on networks based on the first level of the PDH (1 544 kbit/s) as defined by the ITU-T in Recommendation G.704 [7]. As well as the G.704 signalling and synchronization bytes, ETI(NA, G.704-T1) includes timestamps to permit compensation for the effect of differential network delays. It also uses Reed-Solomon forward error coding to allow the correction of transport network errors.

ETI(NA, G.704-T1) has two variants: ETI(NA, G.704-T1)$_{4464}$ and ETI(NA, G.704-T1)$_{4320}$. The two differ in the balance between their data capacity and the number of bytes which are reserved for forward error correction.

In the G.704-T1 frame structure, 1 536 kbit/s are available to carry user data, the remaining 8 kbit/s are reserved by the G.704-T1 network.

In each 24 ms multiframe, ETI(NA, G.704-T1)$_{4464}$, has the capacity to carry 4 608 bytes allocated as follows:

- 4 464 bytes of LIDATA (a data capacity of 1 488 kbit/s);
- 96 bytes (32 kbit/s) for forward error correction;
- 48 bytes (16 kbit/s) for management and signalling.

In each 24 ms multiframe, ETI(NA, G.704-T1)$_{4320}$, has the capacity to carry 4 608 bytes allocated as follows:

- 4 320 bytes of LIDATA (a data capacity of 1 440 kbit/s);
- 240 bytes (80 kbit/s) for forward error correction;
- 48 bytes (16 kbit/s) for management and signalling.

J.3 Transparency of ETI(NA, G.704-T1) layer to ETI(LI)

J.3.1 Transparency of ETI(NA, G.704-T1)$_{4464}$ layer to ETI(LI)

ETI(NA, G.704-T1)$_{4464}$ can carry up to 4 464 bytes of the ETI(LI) data frame, from $B_{[0..4463]}$. When LIDATA has less than 4 464 bytes, i.e. $(FL + 3) \times 4 \leq 4\,464$, padding bytes may be added to fill the remaining bytes.

The padding bytes should be set to FF_{16}. The number of padding bytes should be positive or null and will have the value $4\,464 - ((FL + 3) \times 4)$.

The remaining byte of the ETI(LI) STAT field may be also carried transparently by the NA Layer in a manner similar to that adopted for ETI(NA, G.704), see subclause 8.3.2.1.

J.3.2 Transparency of ETI(NA, G.704-T1)$_{4320}$ layer to ETI(LI)

ETI(NA, G.704-T1)$_{4320}$ can carry up to 4 320 bytes of the ETI(LI) data frame, from $B_{[0..4319]}$. When LIDATA has less than 4 320 bytes, i.e. $(FL + 3) \times 4 \leq 4\,320$, padding bytes shall be added to fill the remaining bytes.

The padding bytes should be set to FF_{16}. The number of padding bytes should be positive or null and will have the value 4 320 - ((FL + 3) × 4).

The remaining byte of the ETI(LI) STAT field can also be carried transparently by the NA Layer in a manner similar to that adopted for ETI(NA, G.704), see subclause 8.3.2.1.

J.4 ETI(NA, G.704-T1) structure

The purpose of the ETI(NA, G.704-T1) multiframe structure is to map the ETI(LI) data stream onto the G.704 frame structure. In the G.704 Recommendation, the 1 544 kbit/s data stream is organized into frames. Each frame has a nominal duration of 125 µs and is made up of 193 bits organized into 24 1-byte timeslots plus 1 signalling bit which is used by G.704. All 24 timeslots per 125 µs frame are available to carry user data.

The ETI(NA, G.704-T1) multiframe has a frame length of 24 ms. It consists of 192 G.704 frames, equivalent to 4 608 timeslots, or bytes. The multiframe structure is illustrated in figure J.1 and consists of:

- 3 superblocks ($s_{[0..2]}$) of 1 536 bytes each;
- each superblock consists of 8 blocks ($bl_{[0..7]}$) of 192 bytes each;
- each block consists of 8 G.704 frames ($f_{[0..7]}$) of 24 bytes each;
- each G.704 frame consists of 24 timeslots ($ts_{[0..23]}$) of 1 byte each;
- each timeslot consists of 8 bits ($b_{[0..7]}$).

Table J.1 summarizes the relation of elements within a multiframe.

Table J.1: Relation of elements within an ETI(NA, G.704-T1) multiframe

	Superblocks	Blocks	G.704 frames	Timeslots	Bits
Multiframe	3	24	192	4 608	36 864
Superblock	1	8	64	1 536	12 288
Block		1	8	192	1 536
G.704 frame			1	24	192
Timeslot				1	8

Figures 18 and 19 show the method used to build the coding array. The general method follows the outline given in clause 8.

J.5 Error protection for ETI(NA, G.704-T1)

In both variants of ETI(NA, G.704-T1), Reed-Solomon coding may be used to provide data which may be analysed by the interface receiving equipment to detect and correct errors occurring on the Transport Network.

The Reed-Solomon code should use the same general scheme described in subclause 8.6 but with the codeword length shortened from 240 bytes to 192 bytes.

Using the terminology of subclause 8.6:

For ETI(NA, G.704-T1)$_{4464}$, R = 4 resulting in an RS(188,192) code.

For ETI(NA, G.704-T1)$_{4320}$, R = 10 resulting in an RS(182,192) code.

J.6 Illustration of the capacity of ETI(NA, G.704-T1)

The two variants of ETI(NA, G.704-T1) layer carry either 4 464 or 4 320 LIDATA bytes. The LIDATA capacity used is made up of a fixed part (which can include the FIC) and a variable part which depends on the number and size of the data streams being carried, see table J.2.

Table J.2: ETI(NA, G.704-T1) capacity per 24 ms

DAB mode	Capacity type	ETI(NA, G.704)$_{4464}$		ETI(NA, G.704)$_{4320}$	
I, II, IV	Fixed	112 bytes max.	(37,33 kbit/s)	112 bytes max.	(37,33 kbit/s)
	Variable	4 352 bytes max.	(1 450,67 kbit/s)	4 208 bytes max.	(1 402,67 kbit/s)
III	Fixed	144 bytes max.	(48,00 kbit/s)	144 bytes max.	(48,00 kbit/s)
	Variable	4 320 bytes max.	(1 440,00 kbit/s)	4 176 bytes max.	(1 392,00 kbit/s)

The total number of equal sized sub-channels which may be carried by ETI(NA, G.704-T1) is shown in table J.3.

NOTE: The capacity of the DAB ensemble may be lower, depending on the values of TPL defined for each sub-channel.

Table J.3: Number of equal sized sub-channels which may be carried by ETI(NA, G.704)

	DAB MODE I, II, IV							
	ETI(NA, G.704)$_{4464}$				ETI(NA, G.704)$_{4320}$			
Sub-channel data-rate	Number of sub-channels	LIDATA - MST bytes	MST bytes	Frame Padding bytes	Number of sub-channels	LIDATA - MST bytes	MST bytes	Frame Padding bytes
256 kbit/s	5	36	3 936	492	5	36	3 936	348
224 kbit/s	6	40	4 128	296	6	40	4 128	152
192 kbit/s	7	44	4 128	292	7	44	4 128	148
128 kbit/s	11	60	4 320	84	10	52	3 936	328
64 kbit/s	22	104	4 320	40	21	100	4 128	92
32 kbit/s	43	188	4 224	52	42	184	4 128	8

	DAB MODE III							
	ETI(NA, G.704)$_{4464}$				ETI(NA, G.704)$_{4320}$			
Sub-channel data-rate	Number of sub-channels	LIDATA - MST bytes	MST bytes	Frame Padding bytes	Number of sub-channels	LIDATA - MST bytes	MST bytes	Frame Padding bytes
256 kbit/s	5	36	3 968	460	5	36	3 968	316
224 kbit/s	6	40	4 160	264	6	40	4 160	120
192 kbit/s	7	44	4 160	260	7	44	4 160	116
128 kbit/s	11	60	4 352	52	10	56	3 968	296
64 kbit/s	22	104	4 352	8	21	100	4 160	60
32 kbit/s	43	188	4 256	20	41	180	4 064	76

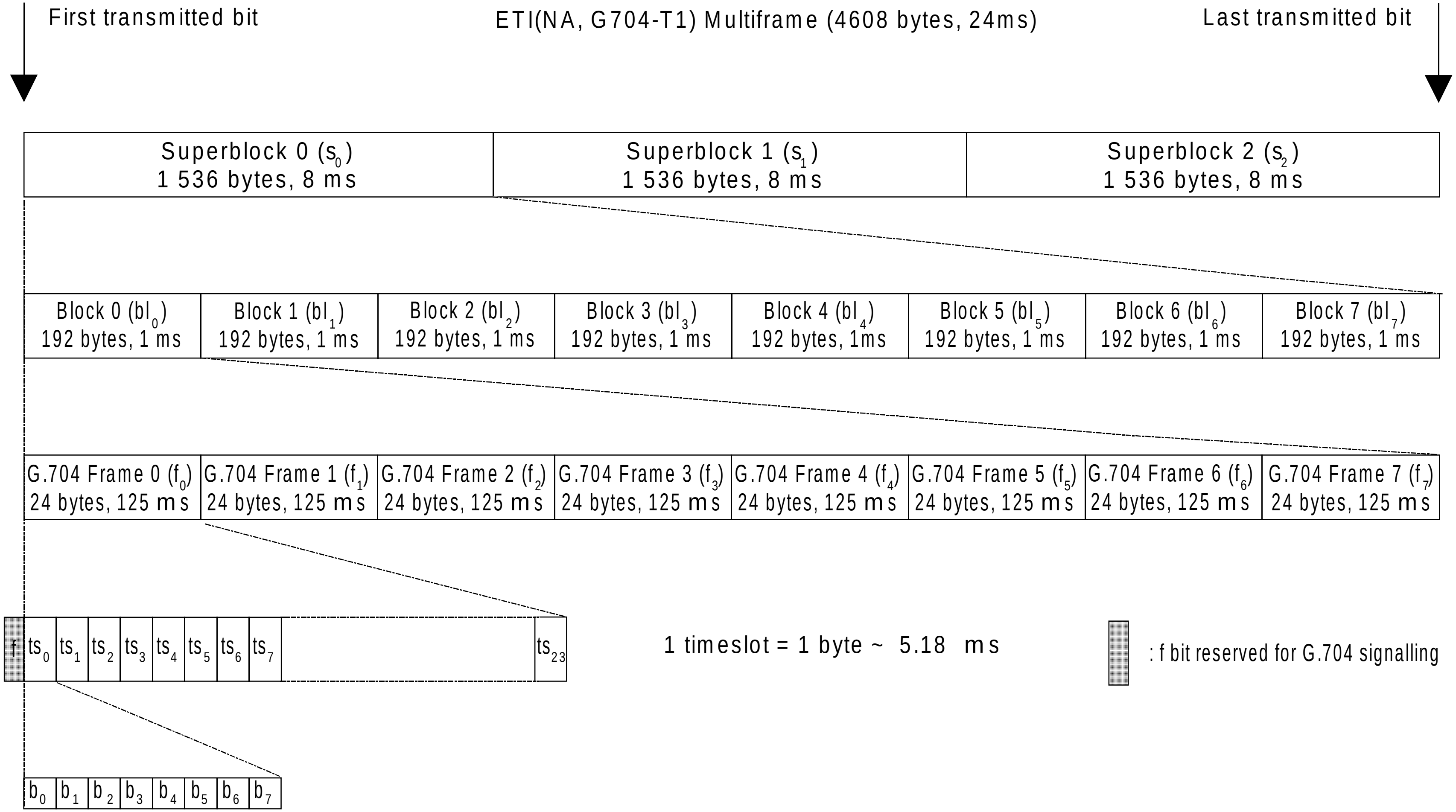


Figure J.1: ETI(NA, G.704-T1) multiframe structure

Step 1: Formation of the coding array, C (Only elements $C_{[0..7],[0..191]}$ and $C_{[8],[0..191]}$ are shown)																		
Index		*j*																
		0	**1..23**	**24**	**25..47**	**48**	**49..71**	**72**	**73..95**	**96**	**97..119**	**120**	**121..143**	**144**	**145..167**	**168**	**169..187**	**188..191**
i	**0**	$M_{0,0}$	$B_0..B_{22}$	$M_{1,0}$	$B_{23}..B_{45}$	$M_{2,0}$	$B_{46}..B_{68}$	$M_{3,0}$	$B_{69}..B_{91}$	$M_{4,0}$	$B_{92}..B_{114}$	$M_{5,0}$	$B_{115}..B_{13}$	$M_{6,0}$	$B_{138}..B_{16}$	$M_{7,0}$	$B_{161}..B_{17}$	$R_{0,188..19}$
	1	$S_{0,0}$	$B_{180}..B_{20}$	$S_{1,0}$	$B_{203}..B_{22}$	$S_{2,0}$	$B_{226}..B_{24}$	$S_{3,0}$	$B_{249}..B_{27}$	$S_{4,0}$	$B_{272}..B_{29}$	$S_{5,0}$	$B_{295}..B_{31}$	$S_{6,0}$	$B_{318}..B_{34}$	$S_{7,0}$	$B_{341}..B_{35}$	$R_{1,188..19}$
	2	B_{360}	$B_{361}..$	B_{384}	$B_{385}..$	B_{408}	$B_{409}..$	B_{432}	$B_{433}..$	B_{456}	$B_{457}..$	B_{480}	$B_{481}..$	B_{504}	$B_{505}..$	B_{528}	$B_{529}..$	$R_{2,188..19}$
	3	B_{548}	$B_{549}..$	B_{572}	$B_{573}..$	B_{596}	$B_{597}..$	B_{620}	$B_{621}..$	B_{644}	$B_{645}..$	B_{668}	$B_{669}..$	B_{692}	$B_{693}..$	B_{716}	$B_{717}..$	$R_{3,188..19}$
	4	B_{736}	$B_{737}..$	B_{760}	$B_{761}..$	B_{784}	$B_{785}..$	B_{808}	$B_{809}..$	B_{832}	$B_{833}..$	B_{856}	$B_{857}..$	B_{880}	$B_{881}..$	B_{904}	$B_{905}..$	$R_{4,188..19}$
	5	B_{924}	$B_{925}..$	B_{948}	$B_{949}..$	B_{972}	$B_{973}..$	B_{996}	$B_{997}..$	B_{1020}	$B_{1021}..$	B_{1044}	$B_{1045}..$	B_{1068}	$B_{1069}..$	B_{1092}	$B_{1093}..$	$R_{5,188..19}$
	6	B_{1112}	$B_{1113}..$	B_{1136}	$B_{1137}..$	B_{1160}	$B_{1161}..$	B_{1184}	$B_{1185}..$	B_{1208}	$B_{1209}..$	B_{1232}	$B_{1233}..$	B_{1256}	$B_{1257}..$	B_{1280}	$B_{1281}..$	$R_{6,188..19}$
	7	B_{1300}	$B_{1301}..$	B_{1324}	$B_{1325}..$	B_{1348}	$B_{1349}..$	B_{1372}	$B_{1373}..$	B_{1396}	$B_{1397}..$	B_{1420}	$B_{1421}..$	B_{1444}	$B_{1445}..$	B_{1468}	$..B_{1487}$	$R_{7,188..19}$
	8	$M_{0,1}$	$B_{1488}..$	$M_{1,1}$	$B_{1511}..$	$M_{2,1}$	$B_{1534}..$	$M_{3,1}$	$B_{1557}..$	$M_{4,1}$	$B_{1580}..$	$M_{5,1}$	$B_{1603}..$	$M_{6,1}$	$B_{1626}..$	$M_{7,1}$	$..B_{1667}$	$R_{0,188..19}$

Step 2: Formation of the Interleaving array, I (Only part shown)																				
p	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**..**	**1535**	**..**
	$M_{0,0}$	$S_{0,0}$	B_{360}	B_{548}	B_{736}	B_{924}	B_{1112}	B_{1300}	B_0	B_{180}	B_{361}	B_{549}	B_{737}	B_{925}	B_{1113}	B_{1301}	B_1	B_{181}	..	$R_{7,191}$	..

Figure J.2: Steps in the formation of ETI(NA, G.704-T1)$_{4464}$

Step 1: Formation of the coding array, C (Only elements $C_{[0..7],[0..191]}$ and $C_{[8],[0..191]}$ are shown)																		
Index		*j*																
		0	**1..23**	**24**	**25..47**	**48**	**49..71**	**72**	**73..95**	**96**	**97..119**	**120**	**121..143**	**144**	**145..167**	**168**	**169..181**	**182..191**
i	**0**	$M_{0,0}$	$B_{0}..B_{22}$	$M_{1,0}$	$B_{23}..B_{45}$	$M_{2,0}$	$B_{46}..B_{68}$	$M_{3,0}$	$B_{69}..B_{91}$	$M_{4,0}$	$B_{92}..B_{114}$	$M_{5,0}$	$B_{115}..B_{13}$	$M_{6,0}$	$B_{138}..B_{16}$	$M_{7,0}$	$B_{161}..B_{17}$	$R_{0,188..19}$
	1	$S_{0,0}$	$B_{174}..B_{19}$	$S_{1,0}$	$B_{197}..B_{21}$	$S_{2,0}$	$B_{220}..B_{24}$	$S_{3,0}$	$B_{243}..B_{26}$	$S_{4,0}$	$B_{266}..B_{28}$	$S_{5,0}$	$B_{289}..B_{31}$	$S_{6,0}$	$B_{312}..B_{33}$	$S_{7,0}$	$B_{335}..B_{34}$	$R_{1,188..19}$
	2	B_{348}	B_{349}..	B_{372}	B_{373}..	B_{396}	B_{397}..	B_{420}	B_{421}..	B_{444}	B_{445}..	B_{468}	B_{469}..	B_{492}	B_{493}..	B_{516}	B_{517}..	$R_{2,188..19}$
	3	B_{530}	B_{531}..	B_{554}	B_{555}..	B_{578}	B_{579}..	B_{602}	B_{603}..	B_{626}	B_{627}..	B_{650}	B_{651}..	B_{674}	B_{675}..	B_{698}	B_{699}..	$R_{3,188..19}$
	4	B_{712}	B_{713}..	B_{736}	B_{737}..	B_{760}	B_{761}..	B_{784}	B_{785}..	B_{808}	B_{809}..	B_{832}	B_{833}..	B_{856}	B_{857}..	B_{880}	B_{881}..	$R_{4,188..19}$
	5	B_{894}	B_{895}..	B_{918}	B_{919}..	B_{942}	B_{943}..	B_{966}	B_{967}..	B_{990}	B_{991}..	B_{1014}	B_{1015}..	B_{1038}	B_{1039}..	B_{1062}	B_{1063}..	$R_{5,188..19}$
	6	B_{1076}	B_{1077}..	B_{1100}	B_{1101}..	B_{1124}	B_{1125}..	B_{1148}	B_{1149}..	B_{1172}	B_{1173}..	B_{1196}	B_{1197}..	B_{1220}	B_{1221}..	B_{1244}	B_{1245}..	$R_{6,188..19}$
	7	B_{1258}	B_{1259}..	B_{1282}	B_{1283}..	B_{1306}	B_{1307}..	B_{1330}	B_{1331}..	B_{1354}	B_{1355}..	B_{1378}	B_{1379}..	B_{1402}	B_{1403}..	B_{1426}	..B_{1439}	$R_{7,188..19}$
	8	$M_{0,1}$	B_{1440}..	$M_{1,1}$	B_{1463}..	$M_{2,1}$	B_{1486}..	$M_{3,1}$	B_{1509}..	$M_{4,1}$	B_{1532}..	$M_{5,1}$	B_{1555}..	$M_{6,1}$	B_{1578}..	$M_{7,1}$	..B_{1613}	$R_{0,188..19}$

Step 2: Formation of the Interleaving array, I (Only part shown)																				
p	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**..**	**1535**	**..**
	$M_{0,0}$	$S_{0,0}$	B_{348}	B_{530}	B_{712}	B_{894}	B_{1076}	B_{1258}	B_{0}	B_{174}	B_{349}	B_{531}	B_{713}	B_{895}	B_{1077}	B_{1259}	B_{1}	B_{175}	..	$R_{7,191}$	..

Figure J.3: Steps in the formation of $ETI(NA, G.704\text{-}T1)_{4320}$

Annex K (informative): Bibliography

- European Broadcasting Union BPN 002 (revision 1, November 1995): "Digital Audio Broadcasting System - Definition of the Ensemble Transport Interface".

- EBU Recommendation R79 (1994): "Recommended system for digital sound broadcasting to mobile, portable and fixed receivers in the appropriate frequency bands in the range 30 MHz to 3 GHz".

- ITU-R Recommendation BS.774 (March 1994): "Digital sound broadcasting to vehicular, portable and fixed receivers using terrestrial transmitters in the VHF/UHF bands".

- ITU-R Recommendation BO.789 (March 1994): "Digital sound broadcasting to vehicular, portable and fixed receivers for BSS (sound) bands in the frequency range 500 - 3 000 MHz".

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