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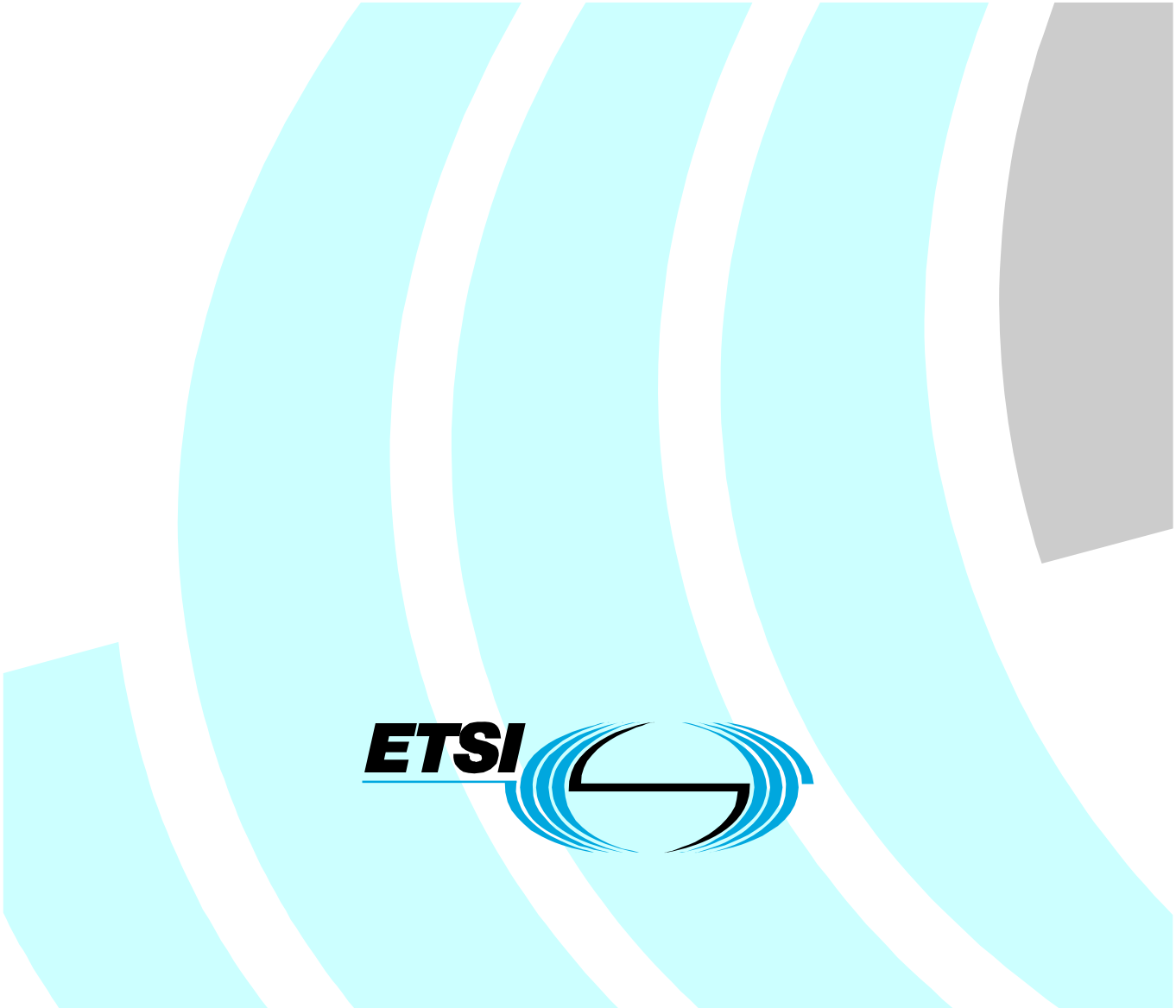
Technical Specification

Terrestrial Trunked Radio (TETRA);
Voice plus Data (V+D);
Part 3: Interworking at the Inter-System Interface (ISI);
Sub-part 8: Generic Speech Format Implementation



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Contents

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Terrestrial Trunked Radio (TETRA).

The present document is part 3, sub-part 8 of a multi-part deliverable covering Voice plus Data (V+D), as identified below:

EN 300 392-1: "General network design";

EN 300 392-2: "Air Interface (AI)";

EN 300 392-3: "Interworking at the Inter-System Interface (ISI)";

EN 300 392-3-1: "General design";

EN 300 392-3-2: "Additional Network Feature Individual Call (ANF-ISIIC)";

EN 300 392-3-3: "Additional Network Feature Group Call (ANF-ISIGC)";

EN 300 392-3-4: "Additional Network Feature Short Data Service (ANF-ISISDS)";

EN 300 392-3-5: "Additional Network Feature Mobility Management (ANF-ISIMM)";

TS 300 392-3-6: "Speech Format Implementation for circuit mode transmission";

TS 300 392-3-7: "Speech Format Implementation for Packet Mode Transmission";

TS 300 392-3-8: "Generic Speech Format Implementation";

ETS 300 392-4: "Gateways basic operation";

TS 100 392-5: "Peripheral Equipment Interface (PEI)";

TS 100 392-7: "Security";4

EN 300 392-9: "General requirements for supplementary services";

EN 300 392-10: "Supplementary services stage 1";

TS 100 392-11: "Supplementary services stage 2";

TS 100 392-12: "Supplementary services stage 3";

ETS 300 392-13: "SDL model of the Air Interface (AI)";

ETS 300 392-14: "Protocol Implementation Conformance Statement (PICS) proforma specification";

TS 100 392-15: "TETRA frequency bands, duplex spacings and channel numbering";

TS 100 392-16: "Network Performance Metrics";

TR 100 392-17: "TETRA V+D and DMO specifications";

TS 100 392-18: "Air interface optimized applications".

NOTE: Part 10, sub-part 15 (Transfer of control), part 13 (SDL) and part 14 (PICS) of this multi-part deliverable are in status "historical" and are not maintained.

Introduction

Originally there were two different speech transportation format options defined for the TETRA InterSystem Interface (ISI) speech transmission one for circuit mode support and another for packet mode support.

The two options allow different techniques in designing and interconnecting TETRA Switching and Management Infrastructure (SwMIs). Those based on circuit mode transmission technology can use the complementary circuit mode based option, and those based on packet mode transmission technology can take advantage of the present document of the ISI.

The reason for having two options is found in the nature of existing TETRA SwMIs from various manufacturers. The existing SwMIs can generally be divided into two types: those that use packet switched technology and those that are using a circuit switched technology.

When connecting a circuit switched SwMI to a packet switched SwMI there must be a conversion performed from one technology to the other.

The present document defines a compromise solution in the speech transportation format so that no additional conversion is required. The present document should be applied in new designs instead of TS 100 392-3-6 [10] and TS 100 392-3-7 [11].

1 Scope

The present document specifies speech transmission format implementation independent of SwMI type.

The present document defines the format of user information that is transported between two SwMIs using the TETRA ISI.

The present document covers how TETRA air interface circuit mode traffic is encoded for transport over various media.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:
  - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;
  - for informative references.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

[1] ETSI EN 300 392-2: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 2: Air Interface (AI)".

[2] ETSI EN 300 392-3-1: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 3: Interworking at the Inter-System Interface (ISI); Sub-part 1: General Design".

[3] ETSI EN 300 395-2: "Terrestrial Trunked Radio (TETRA); Speech codec for full-rate traffic channel; Part 2: TETRA codec".

2.2 Informative references

[4] ITU-T Recommendation G.703: "Physical/electrical characteristics of hierarchical digital interfaces".

[5] ITU-T Recommendation G.704: "Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736 kbit/s hierarchical levels".

[6] ITU-T Recommendation Q.920: "ISDN user-network interface data link layer -General aspects".

[7] ITU-T Recommendation Q.920 Amendment 1: "ISDN user-network interface data link layer - General aspects".

[8] ITU-T Recommendation Q.921: "ISDN user-network interface - Data link layer specification".

[9] ITU-T Recommendation Q.921 Amendment 1: "ISDN user-network interface - Data link layer specification".

[10] ETSI TS 100 392-3-6: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 3: Interworking at the Inter-System Interface (ISI); Sub-part 6: Speech format implementation for circuit mode transmission".

[11] ETSI TS 100 392-3-7: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 3: Interworking at the Inter-System Interface (ISI); Sub-part 7: Speech Format Implementation for Packet Mode Transmission".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document the following terms and definition applies:

Frame rate: nominal time between start of two consecutive frames.

NOTE: There may be gaps in the flow of the frames so that a frame is missing in its normal time position.

3.2 Abbreviations

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

ACELP	Algebraic CELP
DLCI	Data Link Connection Identifier
DMO	Direct Mode Operation
E1	European format for digital transmission
FCS	Frame Check Sequence
HDLC	High level Data Link Control
ISDN	Integrated Services Digital Network
ISI	Inter System Interface
MS	Mobile Station
PDU	Protocol Data Unit
PVC	Permanent Virtual Circuit
SwMI	Switching and Management Infrastructure
TETRA	Terrestrial Trunked Radio
V+D	Voice plus Data

4 Overview

Independently of SwMI implementation, TETRA speech and circuit mode data traffic is carried in packets between two TETRA systems. The TETRA traffic is carried in PDUs that may be transported in various media.

In ISI phase 1 one TETRA ISI call may be carried per 64 kbit/s slot on the 2 Mbit/s E1 link. Other transport mechanisms and scenarios are outside the present document.

Since the transmission defined in the present document is "packet mode", packets may be subject to jitter. The maximum jitter is a SwMI specific characteristic. The value of the allowable maximum jitter value is outside the scope of the present document.

5 PDU format and procedures

5.1 General on traffic PDU contents

As TETRA is a radio system normally at least one end of the communication is using air interface. The structure of the TETRA air interface sets some requirements on the traffic ISI PDU contents and format on the ISI. The main structure of the air interface and speech encoding is retained and traffic ISI PDU supports:

- 30 ms and 60 ms speech frames;
- 170/3 ms (~56,67 ms) and 60 ms frame rates;
- ACELP speech coding and reservation for other codecs; and
- Call reference.

The call reference is used to link the traffic and call instance together especially in scenarios where no virtual connection is applied.

Optionally a fully stolen or otherwise not available frame may be indicated to help an easier re-use of that timeslot for other signalling purposes at the terminating system.

5.2 TETRA ISI payload

5.2.1 TETRA ISI payload encoding

The protocol has been designed to support TETRA speech codec frames (single/dual), circuit mode data and U-plane services. However, the present document only describes in detail the PDU formats for TETRA speech codec frames (single and dual) and U-plane services. Nevertheless, this principle applies equally to the other U-plane services. Generic payload structure is presented in figure 5.1.

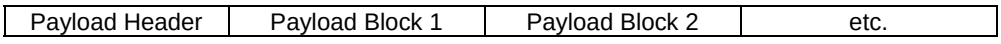

Figure 5.1: TETRA payload structure

NOTE: More than two payload blocks may be used in future versions of the present document.

5.2.2 Traffic PDU

The traffic PDU is comprised of the following information elements, see table 5.1:

- Call reference: this information element links the traffic PDU and call instance together;
- Traffic type: this information element shall identify the type of circuit mode speech/data service;
- Framing rate: this information element shall identify whether the circuit mode speech/data is continuous flow or contains jumps due to the 18^{th} frame of the air interface;
- Frame Number: this information element shall indicate the sequence of packets (and may indicate where frame 18 occurs); and
- Contents control and payload: this information element shall define contents of the payload and the payload blocks.

Table 5.1: Traffic PDU

Information element	Length	Type	C/O/M	Remarks
Framing rate	1	1	M	
Frame number	5	1	M	
Information element control	2	1	M	Shall be set to a value with "Additional information information element is not present"
Additional information	8		C	See notes 1 and 2
Call reference	24		C	See note 2
Traffic type	4	1	M	
Contents control and payload	Variable	1	M	
NOTE 1: The Additional information information element allows future expansion of the PDU. NOTE 2: This information element shall be present as defined in the Information element control information element.				

5.3 Traffic PDU information elements

5.3.1 Framing rate

The Framing rate information element shall be encoded as defined in table 5.2.

The Framing rate allows the destination SwMI to determine the characteristics of the circuit mode speech/data packet stream. Different buffering schemes may then be applied to optimize audio delay for ISI calls.

NOTE: Any other jitter in addition to the gap due to the 18th frame in the air interface is outside the scope of the present document.

Table 5.2: Contents of the framing rate information element

Information element	Length	Value	Remarks
Framing rate	1	0	170/3 ms i.e. there is a gap at the 18th frame position
		1	60 ms i.e. regular frame rate without a gap for the 18th frame

5.3.2 Frame number

The Frame number information element shall be encoded as defined in table 5.3.

Frames are numbered 1 to 17 for transmission purposes for 170/3 ms and 60 ms rate.

The Frame number information element can be used by the destination SwMI to monitor the sequence of packets and, when used in conjunction with the Framing rate information element, identify when the frame 18 gap will occur in the packet stream.

NOTE 1: The frame numbering can be used to optimize buffering on 170/3 ms frame rate.

When the payload message originates from an MS i.e. uses Framing rate 170/3 ms, the frame number in the payload header shall represent the frame number associated with the packet when base station received it over the air interface.

When the payload message originates from the SwMI i.e. uses Framing rate 60 ms, the Frame number in the payload header shall be used as a sequence counter only.

NOTE 2: For the Framing rate 60 ms each speech item may start with a Frame number 1.

Table 5.3: Contents of the Frame number information element

Information element	Length	Value	Remarks
Frame number	5	0	Reserved
		1	Frame 1
		2	Frame 2
		etc.	etc.
		17	Frame 17
		18	Reserved
		19	Frame number not available, see note
		20	Reserved
		etc.	etc.
		31	Reserved
NOTE: This unnumbered frame option may be used, if the Frame rate is 60 ms. It is provided for internal usage and should not be used over ISI.			

5.3.3 Information element control

The Information element control present information element shall be encoded as defined in table 5.4.

Table 5.4: Contents of the information element control information element

Information element	Length	Value	Remarks
Information element control	2	0	Additional information information element is not present and Call reference information element is not present, see note
		1	Additional information information element is not present and Call reference information element is present, see note
		2	Additional information information element is present and Call reference information element is not present, see note
		3	Additional information information element is present and Call reference information element is present, see note
NOTE: For the present document only the value "Additional information information element is not present" is applicable.			

5.3.4 Additional information

The Additional information information element shall be encoded as defined in table 5.5.

Table 5.5: Contents of the Additional information information element

Information element	Length	Value	Remarks
Additional information	8	0	Reserved for additional information
		etc.	etc.
		255	Reserved for additional information

5.3.5 Call reference

The optional Call reference information element shall identify the call (CC instance) to which the traffic PDU belongs to. Refer to EN 300 392-3-1 [2].

NOTE: Depending on the scenario the Call reference information may be redundant, if an individual explicit or implicit (virtual) circuit is used to carry traffic PDUs.

5.3.6 Traffic type

The Traffic type information element shall be encoded as defined in table 5.6.

NOTE: Circuit mode data is outside the scope of the present document.

Table 5.6: Contents of the Traffic type information element

Information element	Length	Value	Remarks
Traffic type	4	0	ACELP, refer to EN 300 395-2 [3]
		1	Reserved for codec 2
		2	Reserved for codec 3
		3	Proprietary codec
		Other	Reserved

5.3.7 Contents control

The contents control information element shall be encoded as defined in table 5.7.

NOTE: Traffic 1 and U-plane 1 identify contents of sub-slot 1, and traffic 2 and U-plane 2 identify contents of sub-slot 2 in the air interface timeslot.

Table 5.7: Contents of the Contents control information element

Information element	Length	Value	Remarks
Contents control	4	0	Traffic 1 + Traffic 2
		1	U-plane 1 + Traffic 2
		2	U-plane 1 + U-plane 2
		3	Traffic 1 single 30 ms, first half-slot, see note 1
		4	Traffic 2 single 30 ms, second half-slot, see notes 1 and 2
		5	Null i.e. traffic is not available, may be used to indicate a fully stolen 60 ms speech frame
		6	U-plane 1, the second half-slot is not available, see note 3
		7	U-plane 2, the first half-slot is not available, see note 3
		8	Reserved
		etc.	etc.
		15	Reserved
NOTE 1: In the unnumbered case the Traffic 1 may be used also for transmitting Traffic 2, in which case Traffic 2 should not be used. NOTE 2: In numbered frames normally used to inform that the Traffic 1 is not available. NOTE 3: Typically the unavailable half-slot has been stolen for a C-plane message.			

5.3.8 Contents control and payload

The Contents control and payload information element shall be encoded as defined in tables 5.8 to 5.15.

Table 5.8: Contents of the Contents control and payload information element for traffic 1 and traffic 2

Information element	Length	Value	Remarks
Contents control	4	0	Traffic 1 and traffic 2
Speech payload 1	138		Padding bits shall be set to "0"
Padding bits in speech payload	6		
Speech payload 2	138		Padding bits shall be set to "0"
Padding bits in speech payload	6		

Table 5.9: Contents of the Contents control and payload information element for U-plane 1 and traffic 2

Information element	Length	Value	Remarks
Contents control	4	1	U-plane 1 and traffic 2
U-stealing payload 1	124		Padding bits shall be set to "0"
Padding bits in U-plane payload	4		
Speech payload 2	138		Padding bits shall be set to "0"
Padding bits in speech payload	6		

Table 5.10: Contents of the Contents control and payload information element for U-plane 1 and U-plane 2

Information element	Length	Value	Remarks
Contents control	4	2	U-plane 1 and U-plane 2
U-stealing payload 1	124		Padding bits shall be set to "0"
Padding bits in U-plane payload	4		
U-stealing payload 2	124		Padding bits shall be set to "0"
Padding bits in U-plane payload	4		

Table 5.11: Contents of the Contents control and payload information element for Traffic 1

Information element	Length	Value	Remarks
Contents control	4	3	Traffic 1
Speech payload 1	138		Padding bits shall be set to "0"
Padding bits in speech payload	6		

Table 5.12: Contents of the Contents control and payload information element for U-plane 2

Information element	Length	Value	Remarks
Contents control	4	4	Traffic 2
Speech payload 2	138		Padding bits shall be set to "0"
Padding bits in speech payload	6		

Table 5.13: Contents of the Contents control and payload information element for Null

Information element	Length	Value	Remarks
Contents control	4	5	Null

Table 5.14: Contents of the Contents control and payload information element for U-plane 1

Information element	Length	Value	Remarks
Contents control	4	6	U-plane 1
U-stealing payload 1	124		Padding bits shall be set to "0"
Padding bits in U-plane payload	4		

Table 5.15: Contents of the Contents control and payload information element for U-plane 2

Information element	Length	Value	Remarks
Contents control	4	7	U-plane 2
U-stealing payload 2	124		Padding bits shall be set to "0"
Padding bits in U-plane payload	4		

Annex A (informative): TETRA ISI channel mapping

A.1 TETRA ISI channel mapping for E1 B-channels in phase 1

Scenario agreement defines TETRA ISI channel mapping to the transmission media. In phase 1 the TETRA ISI channels are statically configured and each TETRA ISI channel will use a specific E1 B-channel.

TETRA ISI channels are assigned PVC DLCIs and E1 B-channels according to table A.1.

NOTE 1: As the channels are assign so that there is only a single packet data channel per 64 kbit/s channel, then the HDLC DLCI values are redundant.

NOTE 2: As the TETRA ISI channels are permanently mapped on the EI slots the Call reference information element is also redundant and may not be used, refer to clause 5.3.4.

Table A.1: TETRA ISI channel addressing

TETRA ISI Channel	HDLC DLCI (Decimal)	E1 Slot B-Channel
1	21	1
2	22	2
3	23	3
4	24	4
5	25	5
6	26	6
7	27	7
8	28	8
9	29	9
10	30	10
11	31	11
12	32	12
13	33	13
14	34	14
15	35	15
CC	36	Q-SIG
16	37	17
17	38	18
18	39	19
19	40	20
20	41	21
21	42	22
22	43	23
23	44	24
24	45	25
25	46	26
26	47	27
27	48	28
28	49	29
29	50	30
30	51	31

NOTE 3: In later phases more TETRA channel capacity can be achieved in several ways:

- Multiple TETRA ISI channels can be carried over each B-Channel in separate PVCs.
- All TETRA ISI channels can be carried over common bandwidth in separate PVCs.

Annex B (informative): HDLC transport

B.1 General

HDLC framing may be used as a transport mechanism for ISI traffic.

B.2 HDLC framing format

HDLC framing is used to encapsulate the address, payload and checksum content with $7E_H$ flags as presented in table B.1.

The bit number 8 is the most significant bit. The bit number 1 is the least significant bit and shall be sent first (standard for HDLC protocol).

NOTE: The bits of an octet are numbered from 1 to 8 in the present document.

Table B.1: HDLC Frame

	8	7	6	5	4	3	2	1
Start Flag	$7E_H$							
Address 1	Upper DLCI						C/R	EA0
Address 2	Lower DLCI				FECN	BECN	DE	EA1
Payload	TETRA Payload							
FCS 1	FCS							
FCS 2	FCS							
Stop flag	$7E_H$							

Information elements in the table B.1:

Start Flag: $7E_H$;

DLCI: Defined by scenario agreement;

C/R (Command Response) = 1 = Command;

EA0 = 0 = One more address byte follows;

EA1 = 1 = Last address byte;

FECN and BECN = 0 (default values);

DE = 0 (default value);

TETRA Payload: see clause 5.2;

FCS: Frame Check Sequence;

FCS1: most significant 8 bits of FCS;

FCS2: least significant 8 bits of FCS;

Stop Flag: $7E_H$.

Cyclic redundancy check

Cyclic redundancy check shall be calculated with generation polynomial: $X^{16} + X^{12} + X^5 + 1$. The cyclic redundancy check calculation covers all bytes between and including address 1 and TETRA payload.

Zero Bit Insertion

Since $7E_H$ is used as a packet delimiter it is vital that this pattern does not appear within the packet itself causing the receiver of the packet to falsely detect an end of packet condition. Zero bit insertion is therefore used by the sending device so that after every 5 consecutive "1"s an additional "0" is inserted into the bit stream, i.e.:

0 1 1 1 1 1 1 1 1 1 1 0 1 1 1 1 1 0

becomes after zero insertion:

0 1 1 1 1 1 0 1 1 1 1 1 0 0 1 1 1 1 1 0 0

Annex C (informative): Physical layer and mapping

C.1 Physical layer

The physical media may be a copper cable carrying 2 Mbit/s signal according to ITU-T Recommendation G.703 [4] and having 64 kbit/s framing according to ITU-T Recommendation G.704 [5].

C.2 Mapping structure

For TETRA ISI Phase 1 the figure C.1 illustrates the mapping structure between the TETRA ISI traffic frames and the TETRA ISI E1 media between two SwMIs.

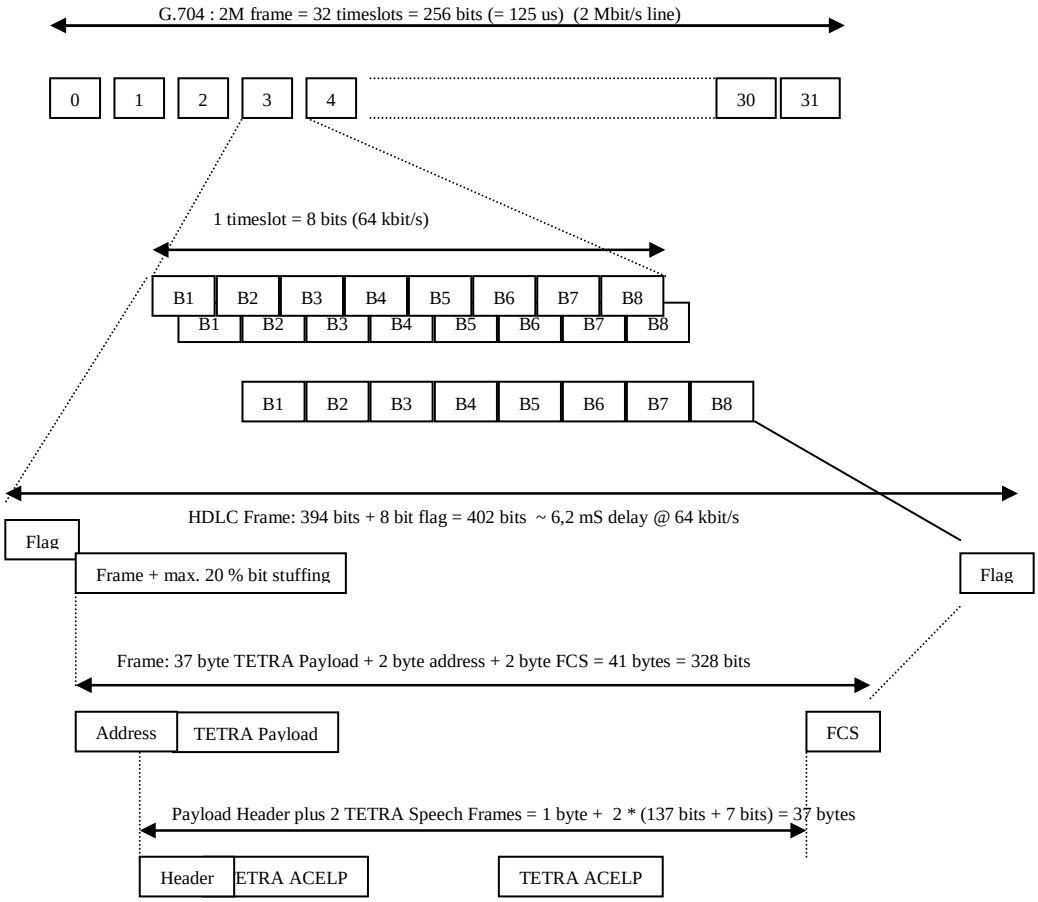

Figure C.1: Mapping Structure

The figure above indicates how a typical TETRA voice call will be carried over TETRA ISI using industry standards:

- the ITU-T Recommendations G.703 [4] and G.704 [5] framing are ITU-T standards for the physical layer;
- the ITU-T Recommendations Q.921 [8] and ITU-T Recommendations Q.921 Amendment 1 [9] define the HDLC structure.

History

Document history		
V1.1.1	April 2008	Publication