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SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Digital terminal equipments – Principal characteristics of transcoder and digital multiplication equipment

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Digital circuit multiplication equipment using 8 kbit/s CS-ACELP

ITU-T Recommendation G.768

(Formerly CCITT Recommendation)

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ITU-T Recommendation G.768

Digital circuit multiplication equipment using 8 kbit/s CS-ACELP

Summary

This Recommendation specifies the elements of DCME using 8 kbit/s CS-ACELP, Digital Speech Interpolation (DSI) and facsimile demodulation/remodulation in order to achieve interworking of such equipment. It specifies extensions and deviations for ITU-T G.763, ITU-T G.766 and ITU-T G.767 which specify a 32 kbit/s ADPCM DCME, and facsimile demodulation/remodulation and 16 kbit/s LD-CELP DCME respectively.

Source

ITU-T Recommendation G.768 was prepared by ITU-T Study Group 15 (2001-2004) and approved under the WTSA Resolution 1 procedure on 15 March 2001.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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Digital circuit multiplication equipment using 8 kbit/s CS-ACELP

1 Scope

This Recommendation specifies the elements of DCME using 8 kbit/s CS-ACELP, Digital Speech Interpolation (DSI) and facsimile demodulation/remodulation in order to achieve interworking of such equipment. It is an extension to ITU-T G.763 (Digital circuit multiplication equipment using 32 kbit/s ADPCM and digital speech interpolation) and ITU-T G.766 (Facsimile demodulation/remodulation for DCME), as it specifies the deviations of the 8 kbit/s DCME from ITU-T G.763.

2 Reference

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

– ITU-T G.726 (1990), *40, 32, 24, 16 kbit/s Adaptive Differential Pulse Code Modulation (ADPCM).*

– ITU-T G.728 Annex J (1999), *Variable bit-rate operation of LD-CELP mainly for voiceband-data applications in DCME*.

– ITU-T G.729 (1996), *Coding of speech at 8 kbit/s using conjugate-structure algebraic-code-excited linear prediction (CS-ACELP).*

– ITU-T G.729 Annex D (1998), *6.4 kbit/s CS-ACELP speech coding algorithm.*

– ITU-T G.763 (1998), *Digital circuit multiplication equipment using G.726 ADPCM and digital speech interpolation.*

– ITU-T G.766 (1996), *Facsimile demodulation/remodulation for digital circuit multiplication equipment.*

– ITU-T G.767 (1998), *Digital circuit multiplication equipment using 16 kbit/s LD-CELP, digital speech interpolation and facsimile demodulation/remodulation.*

3 Terms and definitions

In addition to the terms and definitions of ITU-T G.763 and ITU-T G.766, the following definitions are listed in this Recommendation:

3.1 Basic Control Channel (BCC): A DCME control channel used for a pool with IT numbers less than or equal to 240. It can accommodate four assignment messages/frame.

3.2 expanded control channel (ECC): A DCME control channel used for a pool with IT numbers more than 240. It can accommodate eight assignment messages/frame.

3.3 digital circuit multiplication equipment (DCME): A general class of equipment which permits concentration of a number of 64 kbit/s PCM encoded input trunk channels on a reduced number of transmission channels (see 3.6).

3.4 digital speech interpolation (DSI): A process which, when used in the transmit unit of a DCME, causes a trunk channel to be connected to a bearer channel only when activity is actually present on the trunk channel. This, by exploiting the probability of the speech activity factor of trunk channels being less than 1.0, enables the traffic from a number of trunk channels to be concentrated and carried by a lesser number of time-shared bearer channels. The signals carried by a bearer channel therefore represent interleaved bursts of speech signals derived from a number of different trunk channels.

NOTE – A process complementary to DSI is required in the receive unit of a DCME, i.e. assignment of the interleaved bursts to their appropriate trunk channels.

3.5 DCME frame: A time interval, the beginning of which is identified by a unique word in the control channel. The DCME frame need not coincide with the multi-frames defined in Recommendation G.704. The format specification of the DCME frame includes channel boundaries and bit position significance.

3.6 transmission channel: A 64 kbit/s time slot within a DCME frame.

3.7 bearer channel (BC): A bearer channel is a unidirectional, digital transmission path from the transmit unit of one DCME to the receive unit of a second associated DCME used to carry concentrated traffic between the two DCMEs.

NOTE 1 – A number of bearer channels in each direction of transmission form the both-way link required between two DCMEs. This link may be, for example, a 2048 kbit/s system.

NOTE 2 – A bearer channel may have any of the following instantaneous bit rates: either 64, 40, 16, 8, or 6.4 kbit/s.

3.8 intermediate trunk (IT): A channel mapping designation which ranges between 1 and 620 which relates each trunk channel to an internal numbering designation used within the DCME for conveying trunk channel to bearer channel connectivity via the control channel (see 3.10).

3.9 assignment message: The message specifying the interconnections required between trunk channels and bearer channels.

3.10 control channel (CC): A unidirectional transmission path from the transmit unit of one DCME to the receive unit of one or more associated DCMEs which is dedicated primarily to carrying channel assignment messages. In addition, the control channel transmits other messages such as idle noise levels, dynamic load control, alarm messages and, optionally, line signalling information.

NOTE – An alternative name for control channel is "assignment channel".

3.11 overload channels: The additional bearer channel capacity which is generated using VBR encoding to minimize or eliminate DSI competitive clipping.

3.12 freeze-out: The condition when a trunk channel becomes active and cannot immediately be assigned to a bearer channel, due to lack of available transmission capacity.

3.13 freeze-out fraction (FOF): The ratio of the total time that the individual channels experience the freeze-out condition to the total time of the active intervals and their corresponding hangover times and front end delays, for all trunks over a fixed interval of time.

3.14 clique: A set of bearer channels which are associated with a set of trunk channels which are independent in operation and control from other bearer channels. The set of trunk channels is directed to a single destination.

NOTE – An alternative term for clique is "bundle".

3.15 multi-clique mode: A DCME operational mode in which more than one clique is used when each clique is associated with a different destination.

3.16 multi-destination mode: A DCME operational mode where traffic is exchanged between more than two (2) corresponding DCMEs simultaneously and trunk channel traffic is interpolated over a pool of available bearer channels for all destinations having traffic in the pool. The transmit trunk channels are designated to receive trunk channels at corresponding locations.

3.17 facsimile demodulation/remodulation: Processing introduced in a DCME where facsimile traffic is discriminated from voiceband data; subsequently demodulated to recover the baseband digital signal; time-division multiplexed into 32 kbit/s DCME bearers; demultiplexed in the DCME receive unit; and remodulated using the same modulation scheme as used on the original signal received by the DCME transmit unit.

4 Abbreviations

This Recommendation uses the following abbreviations:

ADPCM	Adaptive Differential Pulse Code Modulation
AM	Assignment Message
BB	Bit Bank
BC	Bearer Channel
BCC	Basic Control Channel
BCH	Base-Chaudhuri-Hocquengheim
CC	Control Channel
CCT	Channel Check Test
CME	Circuit Multiplication Equipment
CS-ACELP	Conjugate Structure Algebraic-Code-Excited Linear-Prediction
DCME	Digital Circuit Multiplication Equipment
DLC	Dynamic Load Control
DSI	Digital Speech Interpolation
ECC	Expanded Control Channel
FB	Fax Bank
FEC	Forward Error Correction
FOF	Freeze-Out Fraction
HL	High Load
IT	Intermediate Trunk
LD-CELP	Low-Delay Code-Excited Linear Predaction
LL	Low Load
LRE	Low Rate Encoding
PCM	Pulse Code Modulation
QB	Quarter Byte
Rx	Receive
STI	Statistic Test Interval
TS	Time Slot

Tx	Transmit
UCA	Capacity for 64 kbit/s Unrestricted Available
UCNA	Capacity for 64 kbit/s Unrestricted Not Available
USM	User Signalling module
UW	Unique Word
VBD	Voice-Band Data

5 DCME frame structure

5.1 General

5.1.1 Supported services

The 8 kbit/s DCME frame structure accommodates the following services:

- 8 bit channels to support 64 kbit/s transparent of VBD calls;
- 1 bit channels to support voice calls at CS-ACELP 8 kbit/s and 6.4 kbit/s according to ITU-T G.729 and its Annex D;
- 2 bit channels to support SS No. 5 Tone Signals at 16 kbit/s according to ITU-T G.726;
- 5 bit channels to support VBD calls at 40 kbit/s according to ITU-T G.728 and its Annex J;
- 4 bit channels to support fax banks (FB) carrying demodulated fax calls in the same manner as in ITU-T G.763 and ITU-T G.766;
- 4 bit channels to support bit banks (BB) carrying the fifth bits of 40 kbit/s channels for non-demodulated fax calls and voiceband data calls;
- 8, 5 and 1 bit channels to support 64 kbit/s, 40 kbit/s, 8 kbit/s, and 6.4 kbits pre-assigned channels.

5.1.2 PCM frame

As in ITU-T G.763, the bearer structure of the 8 kbit/s DCME retains compatibility with ITU-T G.704, so it contains 24 or 32 consecutively numbered 8 bit time slots, from 1 to 24, for a 1544 kbit/s facility, or from 0 to 31, for a 2048 kbit/s facility.

5.1.3 DCME frame and subframe

The low rate encoding algorithm used for speech signals in the 8 kbit/s DCME is CS-ACELP speech encoding algorithm conforming to ITU-T G.729 and its Annex D. The CS-ACELP algorithm has 10 ms of coding frame period, and consequently, the frame period of 8 kbit/s DCME is 10 ms.

5.1.4 DCME multiframe

The IT related circuit supervision/alarm condition field of the asynchronous word supports up to 620 ITs, carried over up to 20 primary rate interfaces. The G.768 DCME multiframe of 18 DCME frames is used to accommodate that.

5.1.5 Relationship between the frames

A DCME frame is composed of four DCME subframes having a subframe period of 2.5 ms, and each DCME subframe is composed of 20 PCM frames. A DCME multiframe is composed of 18 DCME frames. Figure 1 shows the relationship between DCME multiframe, DCME frame, DCME subframe and PCM frame.

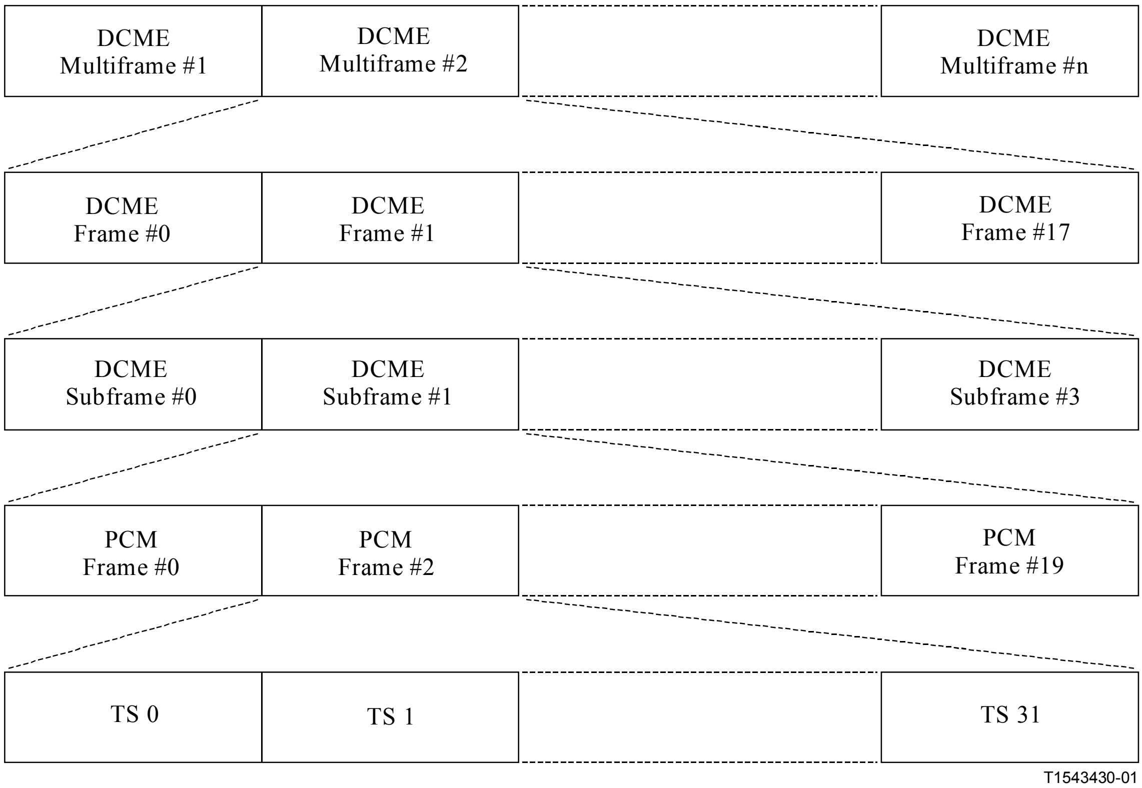

Figure 1/G.768 – Relationship between associated frames and multiframes

6 Trunk interface structure

6.1 Type of trunk interface

Trunk interface shall be either E1 or T1 PRI.

6.2 Number of trunk interfaces, trunk channels

Up to 20 E1 or T1 interfaces shall be supported by DCME. The maximum number of ITs shall be 620.

6.3 Type of trunk channels

The type of trunk channels shall be 64 kbit/s A-law or μ-law.

7 Bearer interface structure

7.1 Cliques, destinations and bearers

7.1.1 Number of cliques

The total number of cliques (pools) available over the 2 bearers shall be 4. Each pool starts and ends on TS boundaries (and therefore occupies an integral number of time slots); any single clique shall not be split into different physical interfaces and, consequently, shall not exceed the maximum bearer capacity of 31 time slots.

7.1.2 Number of destinations

The maximum number of destinations is 4 including cases of mixed operation between multiclique and multidestination modes.

7.1.3 Multiple outgoing bearers

Optionally the equipment can support a maximum of 2 outgoing bearer facilities. A single bearer facility may be able to carry up to 4 cliques, so if a single bearer carries the maximum of 4 cliques, there is no option for a second bearer. The purpose of supporting two outgoing bearer facilities is to utilize the outgoing bearer facilities more efficiently. The DCME is supporting the multidestination operation with up to 4 destinations and consequently four incoming bearer facilities become necessary, whereas one outgoing facility is enough to send out signals resulting in three outgoing bearer facilities which are not in use in typical hardware implementation.

The basic philosophy to support two outgoing bearers is to make more efficient use of hardware resources, with the potential sacrifice of compression gain.

One possibility is to dismiss the necessity of external cross-connect facility at the bearer side. The outgoing bearer channel pools can be assigned to different outgoing facilities.

Another possibility is to make use of more bearer channels to accommodate the traffic including voiceband data signals. Using two outgoing bearer facilities can enable the full use of ITs even in the case where a high compression gain cannot be expected because of the existence of VBD calls.

In this context, using two outgoing bearer facilities does not imply the duplication of DCME capacity. The fundamental design of 8 kbit/s DCME shall be based on the usage of a single outgoing bearer.

7.2 Assignment message

Following is the list of assignment messages to be processed in G.768 DCME. The number implies their priorities to be processed at the transmission unit.

1) Dummy message.
2) Signalling message via USM.
3) On-demand 64 kbit/s channel disconnection message.
4) Fax-bank disconnection message.
5) Overload BC disconnection message.
6) On-demand 64 kbit/s channel connection message.
7) Fax-bank release message.
8) Data connection message.
9) Speech connection message.
10) Channel check test disconnection message.
11) Refreshment message.

Compared with conventional G.763 DCME and G.767 DCME, a tenth message for channel check test disconnection is added. The reason for adding this new message is to avoid the CCT sequence staying on the same BC in case the channel activity is rather low.

Details of the procedure for generating the channel check test disconnection message is as follows:

When a CCT signal connected to a BC becomes inactive, the connection shall be disconnected. The transmit unit shall execute the disconnection procedure and send out an assignment message being composed of the corresponding BC number and the synchronous data word of "0000". On receiving this message, the receive unit shall disconnect corresponding BC and the special test port. The associated BC encoder and decoder shall become free.

7.3 Bearer Channels (BC)

8 kbit/s CS-ACELP encoded voice calls nominally use 1 bit every PCM frame. Therefore the 8 kbit/s DCME bearer channels occupy 1 bit each. These basic Bearer Channels (BCs) shall occupy 80 bits every DCME frame.

7.4 Control Channel (CC)

The Basic Control Channel (BCC) of the 8 kbit/s DCME occupies 4 bits every PCM frame, i.e. 2 QBs. BCC holds the synchronization word, four assignment messages (IT and BC numbers and synchronous data word), the asynchronous data word and some error correction bits in every DCME frame. BCC shall be applied to the pool with ITs less than or equal to 240 channels.

If the number of ITs exceeds 240 channels on a specific pool, an Expanded Control Channel (ECC) shall be used for the pool. ECC occupies 6 bits every PCM frame, i.e. 3 QBs, and holds the synchronization word, eight assignment message (IT and BC numbers and synchronous data word), the asynchronous data words and some error correction bits in every DCME frame.

7.5 BC numbering and the use of the bearer frame

Each time slot is subdivided into 1 bit slots. The leftmost two or three QBs (four or six 1 bit slots) of each pool carries the control channel (BCC or ECC, respectively). The remaining 1 bit slots of the pool are the Bearer Channels (BCs) and are used to carry traffic.

The normal range BCs are consecutively numbered. When BCC is used, the BC that follows the control channel is BC number one. In the case of ECC, the numbering starts with 3, i.e. BC number 1 and 2 are skipped. In the case of a single pool, the maximum number of normal BCs is 244 for BCC case and 242 for ECC case. The numbering scheme is shown in Figure 2.

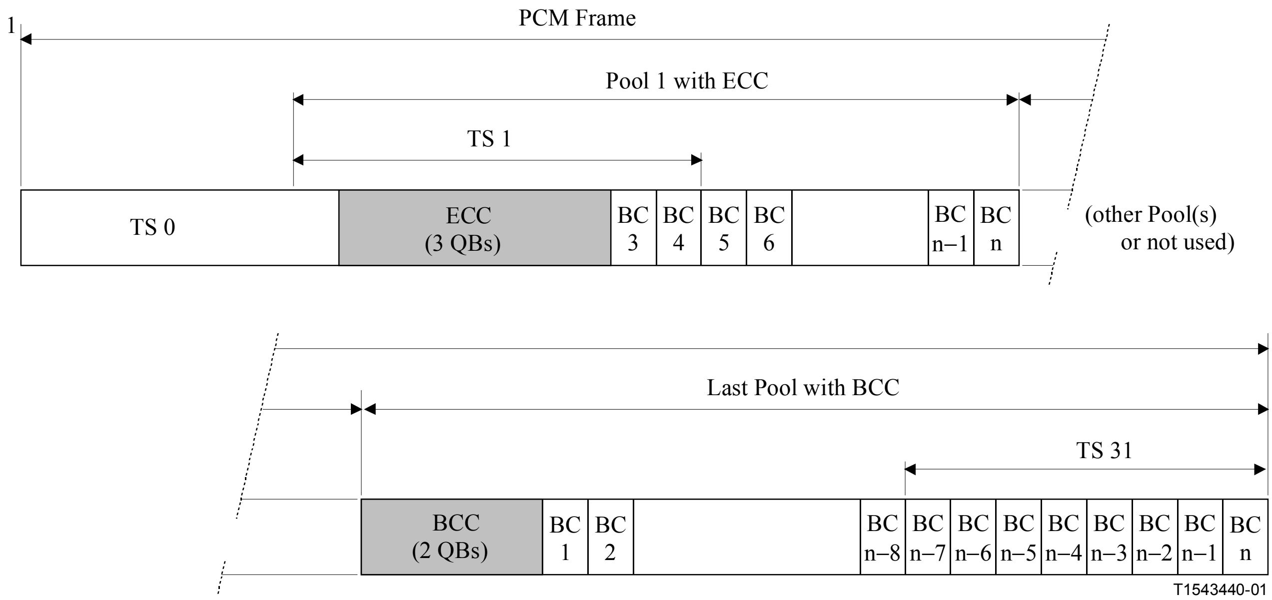

Figure 2/G.768 – Example of DCME frame structure

7.5.1 8 bit (64 kbit/s transparent calls) BCs

The BC number in the assignment message indicates the BC which carries the first bit of the 8 bit sample (MSB). The rest of the bits are carried by the next seven higher BCs. The same restrictions of G.763 are maintained, so unrestricted 64 kbit/s ITs will occupy one G.704 time slot. 8 kbit/s DCME shall maintain frame integrity of consecutive trunk time slots which are allocated for N × 64 kbit/s calls.

7.5.2 5 bit (VBD optimized 40 kbit/s LD-CELP) BCs

The BC number in the assignment message indicates the BC which carries the first bit (MSB) of the 5 bit sample. The next higher BC carries the next bit (MSB – 1) and so on. The fifth bit (LSB) is obtained from a different 4 bit bearer channel which is independently assigned as a bit bank. Similarly to ITU-T G.763, all 4 bit BCs (data, FB or BB) occupy either the four MSBs or the four LSBs of a G.704 time slot. This implies that the BC number in the assignment message, for such BCs, can be expressed as:

$$4 \times n + 1 \ (\mathrm{n} = 0, 1, 2, 3, \ldots)$$

7.5.3 4 bit BCs (bit bank, fax bank)

8 kbit/s DCME fax banks and bit banks are used in the same manner as they are used in ITU-T G.763 and ITU-T G.766. The BC number in the assignment message indicates the BC which carries the first bit of the 4 bit sample. The next higher BC carries the second LSB and so on.

7.5.4 2 bit (16 kbit/s ADPCM for SS No. 5 tone) BCs

The BC number in the assignment message indicates the BC which carries the first bit (MBS) of the 2 bit samples. The 2 bit BC shall occupy QB and the BC number in the assignment message shall be the odd BC number.

7.5.5 Normal range 1 bit BCs (CS-ACELP voice)

The BC number in the assignment message indicates the BC which carries the CS-ACELP encoded IT bits. If high load conditions exist, overload channels will be created.

7.5.6 Overload BCs

The BC number in the assignment message indicates an overload bearer channel which carries the IT bits.

7.5.7 Pre-assigned BCs

8 kbit/s DCME pre-assigned ITs are assigned in the same manner as they are in ITU-T G.763 DCME. 64, 40, 16, 8, and 6.4 kbit/s ITs can be pre-assigned.

8 Control channel

8.1 General

The 8 kbit/s DCME control channel operates with four or eight assignment messages in the 10 ms time-frame. The control channel contains a total of 320 or 480 bits of data in each 10 ms DCME frame, depending on whether four or eight assignment messages (AMs) are used. These bits are transmitted at a rate of 4 or 6 bits every 125 μs PCM frame. The control channel, thus, occupies 2 Quarter Bytes (QBs) in the case of BCC and 3 QBs in the case of ECC.

Apart from assignment messages, the control channel also conveys the asynchronous data words.

8.2 Number of assignment messages

The use of either four messages in a DCME frame period, or eight messages in the DCME frame period, is determined for each clique according to the following rules:

8.2.1 BCC/ECC criterion

When the number of ITs belonging to the pool is equal or less than 240, that clique's control channel shall be BCC. When the number of ITs belonging to the pool exceeds 240, that clique's control channel shall be ECC.

8.2.2 Total number of assignment messages

The total number of assignment messages per Tx unit is 20.

8.3 Control channel content

The contents of the control channel are a synchronization pattern, four or eight assignment messages, an asynchronous data word and error correction code.

8.3.1 CC synchronization

The frame synchronization pattern is a unique word of 20 bits, one bit every PCM frame of the DCME frame. The 20 bit unique word also provides a means of identifying the beginning of a 180 ms DCME multiframe (18 DCME frames) for use by the asynchronous data word.

8.3.1.1 Unique word pattern

Four unique words, UW_0, UW_1, UW_2 and UW_3, shall be used for DCME synchronization. UW_0, used in the first DCME subframe of the DCME frame will take the following bit sequence except for the first DCME subframe of the DCME multiframe.

$$UW_0 : \ 0\,0\,0\,1\,0\,0\,0\,1\,1\,1\,1\,1\,0\,0\,1\,0\,1\,1\,0\,1$$

In the first DCME subframe of a DCME multiframe (once in 180 ms), the unique word sequence shall be the one which is complementary to normal UW_0 mentioned above:

$$\overline{UW_0} \ : \ 1\,1\,1\,0\,1\,1\,1\,0\,0\,0\,0\,0\,1\,1\,0\,1\,0\,0\,1\,0$$

UW_1, UW_2 and UW_3, used in the DCME subframes 1, 2 and 3 respectively, shall take the following bit sequence which is equal to UW_0.

$$UW_1 = UW_2 = UW_3 \ (= \overline{UW_0}\,) : \quad 1\,1\,1\,0\,1\,1\,1\,0\,0\,0\,0\,0\,1\,1\,0\,1\,0\,0\,1\,0$$

All the information carried by asynchronous data word can maintain the same information interval as they have in G.767 DCME over 620 ITs.

8.3.1.2 Unique word detection

The unique word detection is based on the detection of a correlation match between the accumulated contents of the first bit of the CC and a locally stored unique word pattern on a DCME subframe basis. The resulting correlation matches is used to attain, maintain and regain the synchronization of the CC message.

In the steady state, the erroneous detection threshold of three is used to maintain synchronization, and a 3 bit window centred 20 bits after the previous detection of the correlation match is used to locate the start of the DCME subframe for the proper decoding of the CC message. If the correlation match is not achieved in either DCME subframe of the DCME frame, the CC message bits shall be discarded and a search procedure is initiated over a 20 bit window.

8.3.2 Assignment messages

Each assignment message consists of 25 bits that include:

- 10 bits IT identification word;
- 10 bits BC identification word (1 bit BC type + 9 bits BC number);
- 5 bits synchronous data word.

8.3.2.1 IT Identification word

The 10 bits of the IT identification word is used to identify the ITs. IT numbering is given in Table 1.

Table 1/G.768 – IT identification words

IT number	IT identification
0	Explicit disconnection of BC or used during system start-up and map change.
1 through 620	IT used for traffic.
621 through 624	Voice order wire to destination number 1 to 4 respectively.
625 through 628	CCT to pool 1 to 4 respectively.
629 through 632	Local IT number to receive channel check from destination number 1 to 4 respectively.
637	BC used as a bit bank.
638	BC used as a fax bank.
1023	Ineffective CC message when all traffic is pre-assigned.
	– IT field of CC message will be used to carry IT numbers when optional USM is used (see details in CC message structure).

8.3.2.2 BC identification word

The first (MSB) bit of the 10 bit BC identification word is used to indicate the BC type. For data, this bit will be 1 and for all other BC types it will be 0.

The 9 LSBs in binary code identify the BC number in accordance with the agreed numbering scheme. The normal BC numbering range is 1 through 244. The overload BC numbering range is 256 through 316.

For 4 bit services, the BC number identifies the first 1 bit BC of four consecutive 1 bit BCs, used to create a 4 bit BC and is expressed as follows;

$$4 \times n + 1 \quad (n = 0, 1, 2, 3, \ldots)$$

For a 64 kbit/s transparent channel, the BC number identifies the first 1 bit BC of a group of 8 consecutive BCs that occupy exactly one G.704 time slot of the bearer.

BC number 0 in binary code is used for CC messages transmitted during system start-up or during a DCME transmit unit map change.

BC number 1023 in binary code is used to indicate an ineffective CC message if all traffic is pre-assigned.

Table 2 summarizes the BC identification words.

Table 2/G.768 – BC identification words

BC Number	BC identification
0	Used during system start-up and map change.
1 through 244	Normal BC.
256 through 316	Overload BC.
1023	Ineffective CC message when all traffic is pre-assigned.
	– BC 1 and 2 will not be used for double AM operation. The normal BC will start from BC3. – BC field of CC message will be used to carry IT numbers when optional USM is used (see details in CC message structure).

8.3.2.3 Synchronous data word

The 5 bits synchronous data word supports the following messages:

- Background noise level (16 levels).
- Indication of 16 kbit/s ADPCM channel assignment.
- Channel check test procedure.
- Transparent request.
- Signalling information when optional USM is used.
- The ineffective code (transmitted when the IT number indicates a fax bank or a bit bank and when a disconnect message or an ineffective message is sent).

Table 3 shows the synchronous data word encoding. The same criteria shall be applied as that of ITU-T G.767.

Table 3/G.768 – Synchronous data word encoding

Code	Transmit side action: measure noise level	Receive side action: store noise level	Code	Transmit side action: measure noise level	Receive side action: store noise level
00000	Ineffective		10000	n/u	
00001	μ-law: $n < –72.0$ A-law: not applicable	μ-law: no noise	10001	$–54.0 \le n < –51.0$	–52
00010	μ-law: $–72.0 \le n < –67.0$ A-law: $n < –67.0$	μ-law: –68 A-law: no noise	10010	$–51.0 \le n < –49.0$	–50
00011	$–67.0 \le n < –65.5$	–66.5	10011	$–49.0 \le n < –47.0$	–48
00100	$–65.5 \le n < –64.0$	–65	10100	$–47.0 \le n < –45.0$	–46
00101	$–64.0 \le n < –61.0$	–62.5	10101	$–45.0 \le n < –44.0$	–44.5
00110	$–61.0 \le n < –59.0$	–60	10110	$–44.0 \le n < –42.8$	–43
00111	$–59.0 \le n < –56.0$	–57.5	10111	$–42.8 \le n < –42.0$	–42.5
01000	$–56.0 \le n < –54.0$	–55	11000	$–42.0 \le n$	–42
01001	n/u		11001	n/u	
01010	n/u		11010	n/u	
01011	n/u		11011	n/u	

Table 3/G.768 – Synchronous data word encoding *(concluded)*

<table>
<tr><th>Code</th><th>Transmit side action: measure noise level</th><th>Receive side action: store noise level</th><th>Code</th><th>Transmit side action: measure noise level</th><th>Receive side action: store noise level</th></tr>
<tr><td>01100</td><td colspan="2">n/u</td><td>11100</td><td colspan="2">16 kbit/s ADPCM channel creation</td></tr>
<tr><td>01101</td><td colspan="2">n/u</td><td>11101</td><td colspan="2">Transparent</td></tr>
<tr><td>01110</td><td colspan="2">n/u</td><td>11110</td><td colspan="2">n/u</td></tr>
<tr><td>01111</td><td colspan="2">n/u</td><td>11111</td><td colspan="2">BC is under channel check procedure</td></tr>
<tr><td colspan="6">NOTE 1 – Noise levels in dBm0.
NOTE 2 – The transmit unit noise measurement should be broadband.
NOTE 3 – "n/u" means this code is not used – reserved for future use.
NOTE 4 – It is suggested that because the noise inserted at the receive unit is broadband, the transmit unit noise measurement should also be broadband.
NOTE 5 – The DCME transmit unit noise intervals are implementation specific, a tolerance of ±2 dB is suggested.
NOTE 6 – When the background noise level is high (–46 dBm0 or greater), some Administrations have indicated there may be a subjective benefit in inserting lower values of noise at the receive unit than those measured at the transmit unit. The contrast is most apparent when the noise spectral density at the DCME transmit unit is substantially different from the noise inserted at the receive unit. Since the noise inserted at the receive unit does not affect DCME interoperability, the selection of the noise level is left as an option (–50 dBm0 is being considered).</td></tr>
</table>

8.3.3 Asynchronous data word

The asynchronous data word consists of 10 bits for each DCME subframe transmitted in a multiframe structure of 18 DCME frames (72 DCME subframes: 180 ms). This results in 720 bits per DCME multiframe for the asynchronous data message. The asynchronous data message holds a net number of 620 bits, including:

- 620 bits IT related circuit supervision/alarm indication.
- 4 bits DCME bearer backward alarm.
- 4 bits DLC support message.
- 5 bits report channel check results.
- 8 bits report BC related channel check results.
- 9 bits number of decoder under test.

These bits are transmitted in the asynchronous data word according to Table 4 where bit 0 is transmitted first and bit 9 is transmitted last.

Table 4 shows the encoded messages to be transported by the asynchronous data word.

Table 4/G.768 – Asynchronous data word bit allocation

DCME Frame No.	DCME Sub frame No.	Bit number (awi)										Remarks
		0	1	2	3	4	5	6	7	8	9	
0	0	1	2	3	4	5	6	7	8	9	10	**Type**: IT-related circuit supervision/alarm condition. **Designation**: The number represents IT number. **Content**: 0 = normal condition. 1 = alarm condition. (Total 620 ITs).
	1	11	12	13	14	15	16	17	18	19	20	
	2	21	22	23	24	25	26	27	28	29	30	
	3	31	32	33	34	35	36	37	38	39	40	
	.	.	.	.	.	.	.	.	.	.	.	
	.	.	.	.	.	.	.	.	.	.	.	
14	56	561	562	563	564	565	566	567	568	569	570	
	57	571	572	573	574	575	576	577	578	579	580	
	58	581	582	583	584	585	586	587	588	589	590	
	59	591	592	593	594	595	596	597	598	599	600	
15	60	601	602	603	604	605	606	607	608	609	610	
	61	611	612	613	614	615	616	617	618	619	620	
	62	x	x	x	x	x	x	x	x	x	x	
	63	x	x	x	x	x	x	x	x	x	x	
16	64	A1	A2	A3	A4	x	x	x	x	x	x	**Type**: DCME bearer backward alarm. **Designation**: The data word bit number represents Rx bearer number.
	65	p	q	r	s	x	x	x	x	x	x	**Type**: DLC support message. **Designation**: P: voice/voice-band data. q : unrestricted 64 kbit/s. **Content**: 0 = LL or UCA. 1 = HL or UCNA. r, s = 2 bit binary code to identify each receive destination.

Table 4/G.768 – Asynchronous data word bit allocation *(concluded)*

<table>
<tr><th rowspan="2">DCME Frame No.</th><th rowspan="2">DCME Sub frame No.</th><th colspan="10">Bit number (awi)</th><th rowspan="2">Remarks</th></tr>
<tr><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th></tr>
<tr><td rowspan="2"></td><td>66</td><td>b1</td><td>b2</td><td>R</td><td>Y</td><td>T</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>Type: Identification of Rx bearer to which channel check results apply, if channel check is progressing normally.
Designation and content:
B1, b2: Rx bearer number.
R:
1 = channel check disregarded (high BER).
0 = progressing normally.
Y:
0 = normal (pass).
1 = alarm (fail).
T: Transmit channel check inhibit.
0 = channel check normal.
1 = channel check interrupted.</td></tr>
<tr><td>67</td><td>x</td><td>BC (MSB)</td><td>BC</td><td>BC</td><td>BC</td><td>BC</td><td>BC</td><td>BC</td><td>BC</td><td>BC (LSB)</td><td>Type: BC related channel check results, transmitted one BC per DCME multiframe.
BC: 9 bit code represents the number of the BC for which the results apply.</td></tr>
<tr><td rowspan="4">17</td><td>68</td><td>D (MSB)</td><td>D</td><td>D</td><td>D</td><td>D</td><td>D</td><td>D</td><td>D</td><td>D</td><td>D (LSB)</td><td>D: 10 bit code represents the number of the decoder for which the results apply.</td></tr>
<tr><td>69</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td rowspan="3"></td></tr>
<tr><td>70</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td></tr>
<tr><td>71</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td></tr>
<tr><td colspan="13">NOTE – x means unused, set to zero, reserved for future use.</td></tr>
</table>

8.3.4 Error correction

8.3.4.1 Bit count

Each assignment message contains 25 bits (10 bit BC, 10 bit IT and 5 bit synchronous data word). The 10 bit asynchronous data word appears once (regardless of the size of CC) in the control channel. A spare of 4 bits is reserved for each DCME subframe. It is therefore required to protect 39 bits in the BCC (25 + 10 + 4) and 64 bits (25 + 25 + 10 + 4) in the ECC.

8.3.4.2 Error correction code

The control channel error correction code to be used is BCH (63,45) which uses the polynomial division remainder of:

$$g(X) = X^{18} + X^{17} + X^{16} + X^{15} + X^{9} + X^{7} + X^{6} + X^{3} + X^{2} + X^{1} + 1$$

This is a triple error correcting code of minimum distance 7. The code is capable of protecting up to 45 bits by adding 18 check bits.

Since the code is capable of protecting 45 bits by adding 18 check bits, and here it is required to protect only 39 data bits in BCC and additional 25 data bits in ECC, it is assumed that the 6 unused most significant bits of data in BCC and 20 unused most significant bits of data in ECC are all zero at both Tx and Rx side, as shown in Figures 3 and 4 respectively.

The information to be protected for BCC is as follows:

Assignment message	25 bits
Asynchronous data word	10 bits
Spare bit	4 bits
	39 bits

The information to be protected additionally in ECC case is as follows:

Additional assignment message 25 bits

- Each BCH coding sequence shall be applied for each DCME subframe.
- FEC sequences shown in Figure 3 shall be repeated 4 times in a DCME frame, corresponding to 4 DCME subframes, in BCC case.
- A pair of FEC sequences shown in Figures 3 and 4 shall be repeated 4 times in a DCME frame, corresponding to 4 DCME subframes, in ECC case.
- 3 MSBs of check bits for additional message in ECC case will be conveyed in the bit positions next to UW (2nd bit of ECC) in PCM 17, 18 and 19 of each DCME subframe.

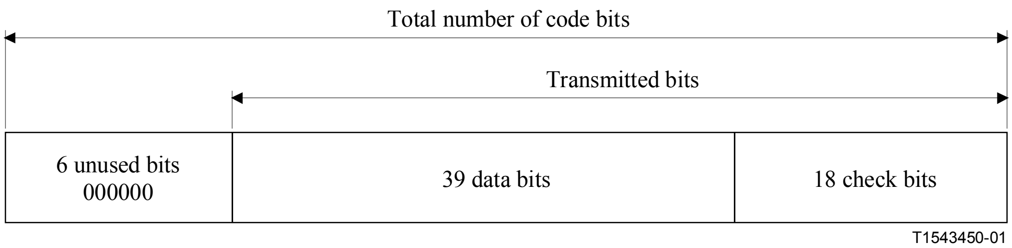

Figure 3/G.768 – Structure of BCH (63,45) code for first AM channel

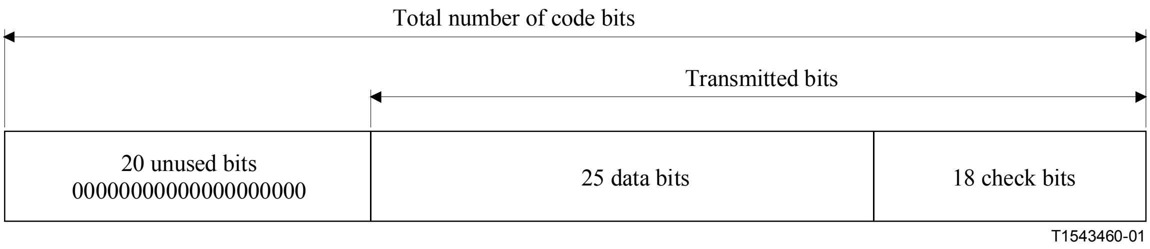

Figure 4/G.768 – Structure of BCH (63,45) code for second AM channel in double AM

8.4 CC message transmission scheme

8.4.1 Control channel structure

8.4.1.1 Basic Control Channel (BCC) for one subframe

- assignment message: 25 bits
- asynchronous data word: 10 bits
- spare: 4 bits
- error correction: 18 bits
- dummy: 3 bit
- synchronization pattern: <u>20 bits</u>
- *Total* 80 bits

8.4.1.2 Expanded Control Channel (ECC) for one subframe

- assignment messages: 50 bits (25 × 2)
- asynchronous data word: 10 bits
- spare: 4 bits
- error correction: 36 bits (18 × 2)
- synchronization pattern: <u>20 bits</u>
- *Total* 120 bits

8.4.2 CC bit mapping

Following are the control channel message transmission schemes for BCC and ECC and for USM. The schemes are given in Tables 5 through 10. Each row in the tables lists the bits to be transmitted in one PCM frame within the DCME frame. The left most bit of each row is transmitted first. For each field of the message (BC identification, IT identification, etc.) bit number 0 (e.g. it0, bc0) is the MSB, bit number 1 is MSB – 1 and so on.

Table 5/G.768 – CC message transmission scheme of a BCC

DCME Subframe No.	PCM Frame No.	Control channel bits			
		UW	Assignment message		
0	PCM frame #0	$UW_0$0	aw0	bc1,0	bc1,1
	PCM frame #1	$UW_0$1	aw1	bc1,2	bc1,3
	PCM frame #2	$UW_0$2	aw2	bc1,4	bc1,5
	PCM frame #3	$UW_0$3	aw3	bc1,6	bc1,7
	PCM frame #4	$UW_0$4	aw4	bc1,8	bc1,9
	PCM frame #5	$UW_0$5	aw5	it1,0	it1,1
	PCM frame #6	$UW_0$6	aw6	it1,2	it1,3
	PCM frame #7	$UW_0$7	aw7	it1,4	it1,5
	PCM frame #8	$UW_0$8	aw8	it1,6	it1,7
	PCM frame #9	$UW_0$9	aw9	it1,8	it1,9
	PCM frame #10	$UW_0$10	s0	sw1,0	sw1,1
	PCM frame #11	$UW_0$11	s1	sw1,2	sw1,3
	PCM frame #12	$UW_0$12	s2	sw1,4	c1,0
	PCM frame #13	$UW_0$13	s3	c1,1	c1,2
	PCM frame #14	$UW_0$14	c1,15	c1,3	c1,4
	PCM frame #15	$UW_0$15	c1,16	c1,5	c1,6
	PCM frame #16	$UW_0$16	c1,17	c1,7	c1,8
	PCM frame #17	$UW_0$17	dummy	c1,9	c1,10
	PCM frame #18	$UW_0$18	dummy	c1,11	c1,12
	PCM frame #19	$UW_0$19	dummy	c1,13	c1,14
1	(20 PCM frames)	(UW_1)	(2nd message)		
2	(20 PCM frames)	(UW_2)	(3rd message)		
3	(20 PCM frames)	(UW_3)	(4th message)		

Table 6/G.768 – CC message transmission scheme of ECC

DCME Subframe No.	PCM Frame No.	Control channel bits						
		UW	Assignment message			Assignment message	
0	PCM frame #0	$UW_0$0	aw0	bc1,0	bc1,1	bc2,0	bc2,1
	PCM frame #1	$UW_0$1	aw1	bc1,2	bc1,3	bc2,2	bc2,3
	PCM frame #2	$UW_0$2	aw2	bc1,4	bc1,5	bc2,4	bc2,5
	PCM frame #3	$UW_0$3	aw3	bc1,6	bc1,7	bc2,6	bc2,7
	PCM frame #4	$UW_0$4	aw4	bc1,8	bc1,9	bc2,8	bc2,9
	PCM frame #5	$UW_0$5	aw5	it1,0	it1,1	it2,0	it2,1
	PCM frame #6	$UW_0$6	aw6	it1,2	it1,3	it2,2	it2,3
	PCM frame #7	$UW_0$7	aw7	it1,4	it1,5	it2,4	it2,5
	PCM frame #8	$UW_0$8	aw8	it1,6	it1,7	it2,6	it2,7
	PCM frame #9	$UW_0$9	aw9	it1,8	it1,9	it2,8	it2,9
	PCM frame #10	$UW_0$10	s0	sw1,0	sw1,1	sw2,0	sw2,1
	PCM frame #11	$UW_0$11	s1	sw1,2	sw1,3	sw2,2	sw2,3
	PCM frame #12	$UW_0$12	s2	sw1,4	c1,0	sw2,4	c2,0
	PCM frame #13	$UW_0$13	s3	c1,1	c1,2	c2,1	c2,2
	PCM frame #14	$UW_0$14	C1,15	c1,3	c1,4	c2,3	c2,4
	PCM frame #15	$UW_0$15	C1,16	c1,5	c1,6	c2,5	c2,6
	PCM frame #16	$UW_0$16	C1,17	c1,7	c1,8	c2,7	c2,8
	PCM frame #17	$UW_0$17	C2,15	c1,9	c1,10	c2,9	c2,10
	PCM frame #18	$UW_0$18	C2,16	c1,11	c1,12	c2,11	c2,12
	PCM frame #19	$UW_0$19	C2,17	c1,13	c1,14	c2,13	c2,14
1	(20 PCM frames)	(UW_1)	(3rd message)			(4th message)	
2	(20 PCM frames)	(UW_2)	(5th message)			(6th message)	
3	(20 PCM frames)	(UW_3)	(7th message)			(8th message)	

Table 7/G.768 – Notes for Tables 5 and 6

UW_n (n = 0 to 3)	DCME Unique Words for DCME subframes 0, 1, 2 and 3 respectively (UWi0= MSB).
Itn,0-itn,9 (n = 1 to 8)	T number for messages 1 to 8 respectively (itn0 = MSB).
Bcn,0 (n = 1 to 8)	BC type for messages 1 to 8 respectively.
Bcn,1-bcn,9 (n = 1 to 8)	BC number for messages 1 to 8 respectively (bcn1 = MSB).
swn,0-swn,4 (n = 1 to 8)	Synchronous data word for messages 1 to 8 respectively (swn,0 = MSB).
aw0-aw9	Asynchronous data word (aw0 = MSB).
s0-s3	Spare (set to 0 if not used).
Dummy	Dummy bits set to 0.
Cn,0-cn,17 (n = 1 to 8)	Check bits for messages 1 to 8 respectively (cn,0 = MSB).

Table 8/G.768 – CC USM message transmission scheme of BCC

DCME Subframe No.	PCM Frame No.	Control channel bits			
		UW	Assignment bits		
0	PCM frame #0	$UW_0$0	aw0	it1,0	it1,1
	PCM frame #1	$UW_0$1	aw1	it1,2	it1,3
	PCM frame #2	$UW_0$2	aw2	it1,4	it1,5
	PCM frame #3	$UW_0$3	aw3	it1,6	it1,7
	PCM frame #4	$UW_0$4	aw4	it1,8	it1,9
	PCM frame #5	$UW_0$5	aw5	it2,0	it2,1
	PCM frame #6	$UW_0$6	aw6	it2,2	it2,3
	PCM frame #7	$UW_0$7	aw7	it2,4	it2,5
	PCM frame #8	$UW_0$8	aw8	it2,6	it2,7
	PCM frame #9	$UW_0$9	aw9	it2,8	it2,9
	PCM frame #10	$UW_0$10	s0	a1	b1
	PCM frame #11	$UW_0$11	s1	a2	b2
	PCM frame #12	$UW_0$12	s2	dummy	c1,0
	PCM frame #13	$UW_0$13	s3	c1,1	c1,2
	PCM frame #14	$UW_0$14	c1,15	c1,3	c1,4
	PCM frame #15	$UW_0$15	c1,16	c1,5	c1,6
	PCM frame #16	$UW_0$16	c1,17	c1,7	c1,8
	PCM frame #17	$UW_0$17	dummy	c1,9	c1,10
	PCM frame #18	$UW_0$18	dummy	c1,11	c1,12
	PCM frame #19	$UW_0$19	dummy	c1,13	c1,14
1	(20 PCM frames)	(UW_1)	(2nd message block for IT3 and IT4)		
2	(20 PCM frames)	(UW_2)	(3rd message block for IT5 and IT6)		
3	(20 PCM frames)	(UW_3)	(4th message block for IT7 and IT8)		

Table 9/G.768 – CC USM message transmission scheme of ECC

DCME Subframe No.	PCM Frame No.	Control channel bits					
		UW	Assignment bits			Assignment bits	
0	PCM frame #0	$UW_0$0	aw0	it1,0	it1,1	it3,0	it3,1
	PCM frame #1	$UW_0$1	aw1	it1,2	it1,3	it3,2	it3,3
	PCM frame #2	$UW_0$2	aw2	it1,4	it1,5	it3,4	it3,5
	PCM frame #3	$UW_0$3	aw3	it1,6	it1,7	it3,6	it3,7
	PCM frame #4	$UW_0$4	aw4	it1,8	it1,9	it3,8	it3,9
	PCM frame #5	$UW_0$5	aw5	it2,0	it2,1	it4,0	it4,1
	PCM frame #6	$UW_0$6	aw6	it2,2	it2,3	it4,2	it4,3
	PCM frame #7	$UW_0$7	aw7	it2,4	it2,5	it4,4	it4,5
	PCM frame #8	$UW_0$8	aw8	it2,6	it2,7	it4,6	it4,7
	PCM frame #9	$UW_0$9	aw9	it2,8	it2,9	it4,8	it4,9
	PCM frame #10	$UW_0$10	s0	a1	b1	a3	b3
	PCM frame #11	$UW_0$11	s1	a2	b2	a4	b4
	PCM frame #12	$UW_0$12	s2	dummy	c1,0	dummy	c2,0
	PCM frame #13	$UW_0$13	s3	c1,1	c1,2	c2,1	c2,2
	PCM frame #14	$UW_0$14	c1,15	c1,3	c1,4	c2,3	c2,4
	PCM frame #15	$UW_0$15	c1,16	c1,5	c1,6	c2,5	c2,6
	PCM frame #16	$UW_0$16	c1,17	c1,7	c1,8	c2,7	c2,8
	PCM frame #17	$UW_0$17	c2,15	c1,9	c1,10	c2,9	c2,10
	PCM frame #18	$UW_0$18	c2,16	c1,11	c1,12	c2,11	c2,12
	PCM frame #19	$UW_0$19	c2,17	c1,13	c1,14	c2,13	c2,14
1	(20 PCM frames)	(UW_1)	(2nd message block for IT5 and IT6)			(2nd message block for IT7 and IT8)	
2	(20 PCM frames)	(UW_2)	(2nd message block for IT9 and IT10)			(2nd message block for IT11 and IT12)	
3	(20 PCM frames)	(UW_3)	(2nd message block for IT13 and IT14)			(2nd message block for IT15 and IT16)	

Table 10/G.768 – Notes for Tables 8 and 9

UW_n (n = 0 to 3)	DCME Unique Words for DCME subframes 0, 1, 2 and 3 respectively (UWi0 = MSB).
Itn,0-itn,9 (n = 1 to 16)	IT number for messages 1 to 8 respectively (itn0 = MSB).
An, bn (n = 1 to 16)	Signalling information associated with itn.
aw0-aw9	Asynchronous data word (aw0 = MSB).
s0-s3	Spare (set to 0 if not used).
Dummy	Dummy bits set to 0.
Cn,0-cn,17 (n = 1 to 8)	Check bits for messages 1 to 8 respectively (cn,0 = MSB).

8.4.2.1 Single IT USM

Optionally, USM will be used to carry signalling information of a single IT and its associated *abcd* bits. In this case, the a2 and b2 fields in Tables 8 and 9 will be used to carry the *c* and *d* bits (respectively) associated with it1, the a3 and b3 fields will carry the *c* and *d* bits of it3, and the it2 and it4 fields will not be used.

9 Low bit-rate codecs

9.1 Variable bit rate and overload channel creation

9.1.1 Principles

The CS-ACELP algorithm produces an 80 bit code word every 80 PCM frames (10 ms) when operating in 8 kbit/s, a 64 bit code word in the same time-frame when operating in 6.4 kbit/s.

The change of rate can be done at the boundary of coding frame (10 ms). The above-mentioned rates are achieved using two basic packaging schemes:

9.1.1.1 Creation of 8 kbit/s channels

To create an 8 kbit/s channel, a 1 bit slot is used to carry one channel.

9.1.1.2 Creation of 6.4 kbit/s channels

For one scheme to create a 6.4 kbit/s channel , four 1 bit slots are used to carry five 6.4 kbit/s-channels. From each 1 bit slot 1 bit is "stolen" every 5 PCM frames therefore leaving 64 bits in each 1 bit slot to carry one normal range 6.4 kbit/s channel. The total amount of "stolen" bits within the algorithmic frame is 64 (16 × 4) bits serving one additional 6.4 kbit/s overload channel.

For another scheme to create a 6.4 kbit/s channel, five 1 bit slots are used to carry five 6.4 kbit/s channels and one 8 kbit/s channel. From each 1 bit slot 1 bit is "stolen" every 5 PCM frames therefore leaving 64 bits in each 1 bit slot to carry one normal range 6.4 kbit/s channel. The total amount of "stolen" bits within the algorithmic frame is 80 (16 × 5) bits serving one additional 8 kbit/s overload channel.

9.1.2 Overload channel creation

9.1.2.1 General

The overload channel creation scheme shall basically be the same as that used in ITU-T G.763.

The descriptions in the following subclauses shall supersede corresponding descriptions for overload channel creation and bit bank handling in ITU-T G.763.

The normal BCs range from BC numbers 1 to 244 and the overload BCs can range from BC numbers 256 to 316.

9.1.2.2 Creation of five 6.4 kbit/s channels from four 8 kbit/s channels

Table 11 shows the bearer channel bit-mapping for creating five 6.4 kbit/s channels from four normal range 8 kbit/s channels.

Table 11/G.768 – Bearer channel bit-mapping for five 6.4 kbit/s channel

		Channel Bit Position			
		M	**m+i**	**m+j**	**m+k**
DCME Frame (10 ms: 125 µs × 80 PCM FR)	FR0	ch(m)-0	ch(m+i)-0	ch(m+j)-0	ch(m+k)-0
	FR1	ch(m)-1	ch(m+i)-1	ch(m+j)-1	ch(m+k)-1
	FR2	ch(m)-2	ch(m+i)-2	ch(m+j)-2	ch(m+k)-2
	FR3	ch(m)-3	ch(m+i)-3	ch(m+j)-3	ch(m+k)-3
	FR4	ovl(n)-0	ovl(n)-1	ovl(n)-2	ovl(n)-3
	FR75	ch(m)-60	ch(m+i)-60	ch(m+j)-60	ch(m+k)-60
	FR76	ch(m)-61	ch(m+i)-61	ch(m+j)-61	ch(m+k)-61
	FR77	ch(m)-62	ch(m+i)-62	ch(m+j)-62	ch(m+k)-62
	FR78	ch(m)-63	ch(m+i)-63	ch(m+j)-63	ch(m+k)-63
	FR79	ovl(n)-60	ovl(n)-61	ovl(n)-62	ovl(n)-63
NOTE – Shaded portions indicate overload channel bits.					

9.1.2.3 Creation of five 6.4 kbit/s channels and one 8 kbit/s channel from five 8 kbit/s channels

Table 12 shows the bearer channel bit-mapping for creating five 6.4 kbit/s channels and one 8 kbit/s overload channel from five normal range 8 kbit/s channels.

Table 12/G.768 – Bearer channel bit-mapping for five 6.4 kbit/s channels and one 8 kbit/s channel

		Channel Bit Position				
		m	m+i	m+j	m+k	m+l
DCME Frame (10 ms: 125 μs × 80 PCM FR)	FR0	ch(m)-0	ch(m+i)-0	ch(m+j)-0	ch(m+k)-0	ch(m+l)-0
	FR1	ch(m)-1	ch(m+i)-1	ch(m+j)-1	ch(m+k)-1	ch(m+l)-1
	FR2	ch(m)-2	ch(m+i)-2	ch(m+j)-2	ch(m+k)-2	ch(m+l)-2
	FR3	ch(m)-3	ch(m+i)-3	ch(m+j)-3	ch(m+k)-3	ch(m+l)-3
	FR4	ovl(n)-0	ovl(n)-1	ovl(n)-2	ovl(n)-3	ovl(n)-4
	FR75	ch(m)-60	ch(m+i)-60	ch(m+j)-60	ch(m+k)-60	ch(m+l)-60
	FR76	ch(m)-61	ch(m+i)-61	ch(m+j)-61	ch(m+k)-61	ch(m+l)-61
	FR77	ch(m)-62	ch(m+i)-62	ch(m+j)-62	ch(m+k)-62	ch(m+l)-62
	FR78	ch(m)-63	ch(m+i)-63	ch(m+j)-63	ch(m+k)-63	ch(m+l)-63
	FR79	ovl(n)-75	ovl(n)-76	ovl(n)-77	ovl(n)-78	ovl(n)-79
NOTE – Shaded portions indicate overload channel bits.						

9.1.2.4 Condition for creating overload channels

The conditions for creating overload channels are as follows:

$Nov > 0$ and $Nv/4 \geq Nov$

where:

Nov (overload list): The number of overload channels (*ov*)

Nv (voice list): The number of BCs which are in normal range available for bit-steal

The number of 8 kbit/s channels in the overload range (N_{o8k}) can be calculated as follows:

$$N_{o8k} = Nov \qquad if\ \frac{Nv-(Nov\times 4)}{Nov} \geq 1$$

$$N_{o8k} = \left(Nv-(Nov\times 4)\right) \text{ modulo } Nov \qquad if\ \frac{Nv-(Nov\times 4)}{Nov} < 1$$

when *Nov* is greater than 0, the integer variables *Pv* and *Pov* shall be computed as follows:

Pv = (IT modulo *Nv*)

Pov = (IT modulo *Nov*)

where:

IT is the IT number contained in the assignment message in 2nd subframe of DCME frame.

Pv and *Pov* represent voice and overload list positions.

NOTE – Using the assignment message in the first subframe of DCME frame is considered to be inadequate if R1/R2 is used for signalling.

9.2 Codec to support SS No. 5 tone signals

To carry SS No. 5 tone signals, 16 kbit/s ADPCM codec conforming to ITU-T G.726 shall be used. For the creation of 16 kbit/s ADPCM channel, the synchronous word of "11100" shall be used in the relevant assignment message.

9.3 Frame alignment between the different types of codecs

G.729 CS-ACELP codec, G.728 LD-CELP codec and G.726 ADPCM codec have different coding frame intervals, i.e. 10 ms, 2.5 ms and 125 µsec. In 8 kbit/s DCME operation, LD-CELP coding frame boundary and ADPCM coding frame boundary shall be aligned with that of CS-ACELP, composing DCME frame. Any LD-CELP coding frame or ADPCM coding frame shall not be split into two adjacent CS-ACELP frames (i.e. DCME frames).

9.4 Processing delay compensation between the different types of codecs

The theoretical processing delay of these three types of codecs are as follows:

– in encoders:

8/6.4 kbit/s CS-ACELP	15 ms	(5 ms look-ahead delay + 10 ms coding frame).
40 kbit/s LD-CELP	0.625 ms	(0.625 ms coding subframe).
16 kbit/s ADPCM	125 µs	(125 µs coding frame).

Processing delay in decoders will depend on the hardware and/or software design.

When switchover of the codec types should occur, due to the signal classification from voice to data for example, during the active part of input signal, the switchover from 8/6.4 kbit/s CS-ACELP codec to 40 kbit/s LD-CELP should follow. Without absorbing the difference of processing delays, not only the click noise but the duplication (or cut-off) of signal should occur. It should also be noted that such a switchover may occur, although not desired, and not often, in the case where a miss-clarification of input signal takes place.

It is important to avoid generating such unnecessary noises. To ensure the interoperability between the CME of different manufacturers, the absorption of delay difference shall be independently executed within transmit unit and receive unit. The real implementation of delay difference absorption will depend on the design, and the details are left to the manufacturers.

The equipment design is requested to take notice on the existence of processing delay difference between the different types of speech codecs used in a single equipment, and to absorb the difference of processing delay independently within the transmit unit and receive unit.

9.5 Synchronous reset between encoder and corresponding decoder

To obtain better speech quality using low bit-rate codecs, synchronous reset between the encoder and corresponding decoder, to synchronize the internal variables and realize the quicker convergence of the codecs as employed in ITU-T G.763 DCME, shall take place.

The synchronous reset is required for CS-ACELP codecs, LD-CELP codecs and ADPCM codecs. When the codec pair gets the new assignment after the silence period, the synchronous reset shall be performed. The synchronous reset shall also be taken place when the input signal is classified as different as before and gets different type of codec pair to be used.

10 Channel check procedure

A means of verifying end-to-end continuity and correct assignment of channels similar to the procedure described in ITU-T G.763 shall be provided.

The use of the control channel for conveying channel check messages as specified in 8.3.3 is the same as specified in ITU-T G.763.

Details of the test procedure are for further study.

11 Facsimile demodulation/remodulation

Fax demodulation in the 8 kbit/s DCME shall perform in the same manner as those specified in ITU-T G.767. In each DCME subframe of 2.5 ms, the same procedure as specified in ITU-T G.767 shall be taken.

12 System statistics measurement

System statistics measurements in the 8 kbit/s DCME shall basically be performed in the same manner as defined in 15.2.3/G.763 (1998), with the modification that the Statistic Test Interval (STI) is in the range of 10 to 60 minutes (in 5 minute steps).

Additionally, the measurement of a new statistic parameter which directly indicates the dynamic usage of the bearer shall be introduced. The definition of new statistic, bearer occupancy, is as follows:

The new statistic parameter, bearer occupancy, indicates dynamically how many percent of the bearer bits are assigned to active traffics. The definition of the parameter is as follows:

$$\text{Bearer occupancy (\%)} = \frac{\sum_{N} \frac{Nnonv + Nvact}{Nnonv + (DSIpool - Nnonv) \times 1.25}}{N} \times 100$$

where:

Nnonv	number of DSI bearer bits used for non-voice traffics.
Nvact	number of connected active voice trunks.
DSI pool	size of corresponding DSI pool (in bits, CC not included).
N	number of DCME frames in a single STI.
Nonv + *Nvact*	total of bearer bits assigned for (1) Non-voice traffic and (2) Active voice traffic.
DSIpool – *Nnonv*	number of bearer bits which can be assigned to voice traffic.
(*DSIpool* – *Nnonv*) × 1.25	number of maximum voice channels which can be connected.

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