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**Digital cellular telecommunications system (Phase 2+);
GSM Cordless Telephony System (CTS), Phase 1;
Lower Layers of the CTS Radio Interface;
Stage 2
(GSM 03.52 version 8.0.1 Release 1999)**

GLOBAL SYSTEM FOR
MOBILE COMMUNICATIONS

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Special Mobile Group (SMG).

The present document was submitted to One-step Approval with the ETSI number 301 404. For publication the number was changed to 302 404 because the number 301 404 is reserved and was allocated accidentally.

The present document gives an overall description of the lower layers of the radio interface for GSM based Cordless Telephony Systems.

The contents of the present document is subject to continuing work within SMG and may change following formal SMG approval. Should SMG modify the contents of the present document it will be re-released with an identifying change of release date and an increase in version number as follows:

Version 8.x.y

where:

- 8 indicates Release 1999 of GSM Phase 2+.
- x the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- y the third digit is incremented when editorial only changes have been incorporated in the specification.

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1 Scope

The present document gives an overall description of the lower layers of the radio interface for GSM based Cordless Telephony Systems (GSM-CTS).

The GSM-CTS system is intended to provide a cordless connection between the fixed network and GSM-based CTS Mobile Stations (CTS-MS) via a private CTS Fixed Part (CTS-FP).

Stage 1 is an overall description, from the service subscribers and user's standpoint, that view the network as a single entity which provides service to the user. GSM 02.56 contains the CTS Stage 1 service description.

GSM 03.56 is a Stage 2 document that describes the system architecture of the GSM Cordless Telephone Systems (GSM-CTS), i.e. the system elements, the system interfaces and the functional capabilities.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.
- For this Release 1999 document, references to GSM documents are for Release 1999 versions (version 8.x.y).

[1] GSM 01.04: "Digital cellular telecommunications system (Phase 2+); Abbreviations and Acronyms".

[2] GSM 02.56: "Digital cellular telecommunications system (Phase 2+); GSM Cordless Telephone System (CTS); Service Description; Stage 1".

[3] GSM 03.22: "Digital cellular telecommunications system (Phase 2+); Functions related to Mobile Station (MS) in idle mode and group receive mode".

[4] GSM 03.20: "Digital cellular telecommunications system (Phase 2+); GSM Cordless Telephone System (CTS); Security related network functions; Stage 2".

[5] GSM 03.56: "Digital cellular telecommunications system (Phase 2+); GSM Cordless Telephony System (CTS); CTS Architecture Description; Stage 2".

[6] GSM 04.08: "European digital cellular telecommunications system (Phase 2+); Mobile radio interface layer 3 specification".

[7] GSM 05.02 (V6.3): "Digital cellular telecommunications system (Phase 2+); Multiplexing and multiple access on the radio path".

[8] GSM 05.03 (V6.1): "Digital cellular telecommunications system (Phase 2+); Channel coding".

[9] GSM 05.04: "Digital cellular telecommunications system (Phase 2+); Modulation".

[10] GSM 05.05: "Digital cellular telecommunications system (Phase 2+); Radio transmission and reception".

[11] GSM 05.08: "Digital cellular telecommunications system (Phase 2+); Radio subsystem link control".

[12] GSM 05.10: "Digital cellular telecommunications system (Phase 2+); Radio subsystem synchronization".

3 Definitions and abbreviations

3.1 Definitions

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

CTS Mobile Station: GSM-MS supporting CTS.

CTS Fixed Part: CTS-FP is a device which acts as a link between the CTS-MS and the fixed network.

GSM-CTS: Cordless Telephony System based on GSM.

3.2 Abbreviations

The following list describes the abbreviations and acronyms used in the present document. The GSM abbreviations explained in GSM 01.04 [1] are not included below.

AFA	Adaptive Frequency Allocation
CTS	Cordless Telephony System
CTSAGCH	CTS Access Grant CHannel
CTSARCH	CTS Access Request CHannel
CTSBCH	CTS Beacon CHannel
CTS-FP	CTS Fixed Part
CTS-MS	CTS Mobile Station
CTSMSI	CTS Mobile Subscriber Identity
CTSPCH	CTS Paging CHannel
DPLMN	Donor Public Land Mobile Network
FPBI	Fixed Part Beacon Identity
GFL	Generic Frequency List
RX	Receive
TFH	Total Frequency Hopping
TX	Transmit

4 Main concepts of the CTS radio interface

The main assumption behind the CTS work item and in particular the CTS radio interface, is that a modified single timeslot state of the art GSM-MS chipset could be used for a home base station, i.e. as a CTS-FP.

The CTS radio interface has been designed to meet a requirement of low generated interference, either from the CTS to existing overlaying PLMNS, either from a CTS to another CTS. This requirement is achieved by the combined usage of the three concepts: beacon concept, AFA concept and TFH concept.

4.1 Beacon concept

A limited number of CTS-MS shall be served by one CTS-FP (see GSM 02.56). Therefore, a broadcast channel continuously transmitted such as the BCCH in GSM is not needed for CTS.

A channel called CTS beacon channel (CTSBCH) is proposed with the following main characteristics: it is transmitted by the CTS-FP every 26 frames in a 52-multiframe pattern, and allows the CTS-MS to synchronise with the CTS-FP. Minimum signalling is also supported by the CTSBCH, so that it is the only logical channel a CTS-FP shall periodically transmit on the CTS radio interface. Every other logical channel is only transmitted "on demand".

4.2 Adaptive Frequency Allocation (AFA) concept

A precise radio frequency planning can not be applied to the CTS-FP/MS pair, as the CTS is intended to be deployed by the end-user. Therefore, a list of frequencies (the GFL) on which it is allowed to operate is given to the CTS. With the AFA, interference measurements will be performed on the frequencies in the GFL to provide a ranking in the AFA table, in order to exclude unacceptably interfered frequencies from the usage in CTS.

4.3 Total Frequency Hopping (TFH) concept

The remaining frequencies are used by the Total Frequency Hopping algorithm in order to reduce the interference of the CTS with the overlaying PLMN and other CTS-FP/MS pairs. With TFH the interference caused by the CTS link is spread across multiple GSM links (interference averaging) and the co-channel interference is due to different users at different locations (interference diversity).

A new hopping algorithm which is especially tailored for use in CTS with improved performance compared to the GSM hopping algorithms shall be used.

5 Radio Transmission and Reception

The CTS-FP and CTS-MS shall in Phase 1 GSM-CTS conform to the transmission and reception specifications of at least one or more of the following cellular standards:

- P-GSM900;
- E-GSM900;
- DCS1800;
- PCS1900.

The final choice of characteristics and performance requirements depends on system scenario calculations.

5.1 Frequency Band and Channel Arrangement

The frequency band and channel arrangement for the GSM-CTS are as specified in GSM 05.05 clause 2.

5.2 Receiver Characteristics

5.2.1 CTS-MS characteristics

It is the intention to keep the CTS-MS characteristics in line with the GSM-MS characteristics as specified in GSM 05.05 clause 5, but the final decision depends on system scenario calculations.

5.2.2 CTS-FP characteristics

It is the intention to keep the CTS-FP characteristics in line with the GSM-MS characteristics as specified in GSM 05.05 clause 5, but with reversed frequency bands. The final decision depends on system scenario calculations.

5.3 Transmitter Characteristics

5.3.1 CTS-MS characteristics

It is the intention to keep the CTS-MS characteristics as far as possible in line with the GSM-MS characteristics as specified in GSM 05.05 clause 4, but the final decision depends on system scenario calculations.

In addition, it is intended to lower the maximum nominal output power and the lowest nominal output power to values which shall be determined by system scenario calculations. Both values could be below the nominal output powers specified in GSM 05.05 subclause 4.1.1.

5.3.2 CTS-FP characteristics

It is the intention to keep the CTS-FP characteristics as far as possible in line with the GSM-MS characteristics as specified in GSM 05.05 subclause 4, but with reversed frequency bands. The final decision depends on system scenario calculations.

In addition, it is intended to lower the maximum nominal output power and the lowest nominal output power to values which shall be determined by system scenario calculations. Both values could be below the nominal output powers specified in GSM 05.05 subclause 4.1.1.

5.4 CTS transmitter / receiver performance

It is the intention to keep the CTS transmitter / receiver performance in line with the GSM transmitter / receiver performance as specified in GSM 05.05 clause 6.

The GSM requirement on receiver performance for frequency hopping where frequencies are interfered shall be fulfilled by both the CTS-MS and CTS-FP.

6 Modulation and Raw Data Rates

The modulation technique and raw data rates are as specified in GSM 05.04.

7 Channel Coding and Interleaving

The channel coding algorithm and interleaving schemes of existing GSM channels used in the GSM CTS radio interface are as specified in GSM 05.03.

Channel coding algorithms and interleaving schemes for new logical channels are defined in clause 10.

8 Time Slots and TDMA-Frames

The time slot organisation is as specified in GSM 05.02 subclause 4.3.1.

The TDMA frames are organised in multiframes, superframes, and hyperframes. The hyperframe is the longest recurrent time period and consists of 26 x 51 x 2048 TDMA frames. The TDMA frames are numbered modulo this hyperframe, which means that the frame number FN ranges from 0 to FN_MAX= (26 x 51 x 2^{11}) -1 = 2715647. The CTS-FP keeps track of the frame numbering once initialised.

Two types of multiframes exist in the GSM-CTS system:

- a 26-multiframe with a duration of 120 ms, comprising 26 TDMA frames. This multiframe is used to carry TCH, SACCH, and FACCH (see clause 10);

- a 52-multiframe with a duration of 240 ms, comprising 52 TDMA frames. This multiframe is used to carry CTSBCH, CTSARCH, CTSAGCH and CTSPCH (see clause 10), and is indicated as CTSBCH multiframe.

NOTE: GSM-CTS uses a scheme slightly different from the GSM-based frame structure in that instead of 51-multiframes, 52-multiframes are used. The reason for this choice is that the bursts of the CTSBCH have a frame distance that coincides with the idle frames of a TCH/F connection; it is therefore possible to support in the CTS-FP a speech connection and the CTSBCH transmission in parallel on the same timeslot, which allows the realisation of the CTS-FP hardware with a state of the art chipset for a GSM-MS supporting only a single timeslot.

9 Bursts

In the physical layer of the GSM-CTS system, three types of burst formats are used:

- Normal Burst (NB);
- Frequency Correction Burst (FB);
- Synchronisation Burst (SB).

They are as specified in GSM 05.02 subclause 5.2, with the difference that the synchronisation bursts used in GSM-CTS shall have a specific training sequence, in order to avoid misleading detection of a GSM-CTS synchronisation bursts by a GSM-MS.

10 Logical Channels

For the GSM-CTS system, eight logical channels have been specified. There is one traffic channel TCH/F, and there are six signalling channels CTSBCH, CTSARCH, CTSAGCH, CTSPCH, SACCH, and FACCH.

10.1 CTS Beacon Channel (CTSBCH)

The CTSBCH logical channel is used to provide frequency and synchronisation information in the downlink direction. From this information the CTS-MS is able to synchronise and to recognise the identity of the CTS-FP. It is made up of a pair of CTSBCH-SB and CTSBCH-FB transmitted in every 52-multiframe.

Signalling mechanisms have been defined in order to reduce emissions from both CTS-FP and CTS-MS.

In cases where the CTS-FP has no resources to handle accesses from a CTS-MS, the CTSBCH shall indicate that no CTS-MS shall attempt to access the CTS-FP.

In order to avoid continuous broadcasting of the CTSPCH, signalling is provided on the CTSBCH that indicates the presence of the CTSPCH.

10.1.1 CTSBCH format

- burst:
  - Frequency Correction Burst (FB) is used for the CTSBCH-FB;
  - Synchronisation Burst (SB) is used for the CTSBCH-SB.
- channel coding scheme: CTSBCH-SB uses the same channel coding scheme as the SCH, specified in GSM 05.03 subclause 4.7. No channel coding is required for CTSBCH-FB.

10.1.2 CTSBCH timing

The timing of the CTSBCH is as follows (see figure 1):

- frame position:
  - FN mod 52 =25 the CTSBCH-FB is transmitted;
  - FN mod 52 =51 the CTSBCH-SB is transmitted.
- timeslot position: a pair of CTSBCH-SB and CTSBCH-FB shall have the same timeslot position within one 52-multiframe but the position can change from one 52-multiframe to another according to the Beacon timeslot management procedure (see subclause 11.2).

10.1.3 CTSBCH radio frequency channel

The CTSBCH is transmitted on the CTSBCH frequency channel, according to the CTSBCH frequency selection, see subclause 12.2.2.

10.1.4 CTSBCH-SB information

The CTSBCH-SB carries 25 information bits. These 25 bits shall be divided into five fields as follows:

- a status field indicating whether the CTS-FP has any radio resource available;
- a flag indicating the presence of the CTSPCH in the next 52-multiframe;
- a flag indicating whether the CTS-FP is currently performing timeslot shifting (see subclause 11.2) on the CTSBCH;
- a field indicating the timeslot number of the CTSARCH, CTSAGCH and CTSPCH;
- the FPBI field indicating the identity of the CTS-FP, in such a way that invalid attachment attempts by CTS-MS which are not enrolled (see GSM 03.56) with this CTS-FP are minimised.

10.2 CTS Access Request Channel (CTSARCH)

The CTSARCH is transmitted in the uplink by the CTS-MS to request dedicated radio resources from the CTS-FP; it is also used during the Alive check procedure (see clause 12).

10.2.1 CTSARCH format

- Burst: Synchronisation Bursts (SB) are used for the CTSARCH.

NOTE: due to the short distance between the CTS-FP and the CTS-MS, there is no need to use a burst of reduced length like the Access Burst (as specified in GSM 05.02 subclause 5.2).

- Channel coding scheme: same as for the SCH, specified in GSM 05.03 subclause 4.7.

10.2.2 CTSARCH timing

The timing of the CTSARCH is as follows (see figure 1):

- frame position:
  - FN mod 52 = 2 to 9 for CTSARCH used for the non-hopping access procedure, see subclause 12.3.3.2;
  - FN mod 52 = 10 to 15 for CTSARCH used for the hopping access procedure (see subclause 12.3.3.2) and the alive check procedure (see subclause 12.3.2 and subclause 12.3.5).
- timeslot position: the CTSARCH is transmitted on a timeslot number which shall be indicated in the CTSBCH-SB information bits (see subclause 10.1.4).

10.2.3 CTSARCH radio frequency channel

The CTSARCH radio frequency channel is:

- the CTS beacon frequency for the CTSARCH used for the non-hopping access procedure, see subclause 12.3.3.2;
- mapped on a predefined set of frequencies by the Total Frequency Hopping for the CTSARCH used for the hopping access procedure (see subclause 12.3.3.2) and the alive check procedure (see subclause 12.3.2).

Refer to subclause 10.8.2 for background on the choice of the radio frequency channel.

10.2.4 CTSARCH information

The CTSARCH carries 25 information bits forming an access request message. These 25 bits shall be divided into two fields as follows:

- a field indicating the cause of the type of the access request;
- a field carrying the CTS Mobile Subscriber Identity (CTSMSI) allocated to the CTS-MS.

10.3 CTS Access Grant Channel (CTSAGCH)

The CTSAGCH is used in the downlink by the CTS-FP to grant a dedicated RR connection to a CTS-MS that has requested radio resources by the use of the CTSARCH.

10.3.1 CTSAGCH format

- Burst: Normal Bursts (NB) are used for the CTSAGCH.
- Training sequence: it is determined by the three LSBs of the FPBI. These three bits form the 3-bit training sequence code (TSC) which selects one of the eight training sequences specified in GSM 05.02 subclause 5.2.3.
- Channel coding and interleaving schemes: same as for the SACCH, as specified in GSM 05.03 subclause 4.1, over 4 consecutive bursts.

10.3.2 CTSAGCH timing

The timing of the CTSAGCH is as follows (see figure 1):

- frame position:
  - FN mod 52 = 16 to 19 for the CTSAGCH used for the non-hopping access procedure, see subclause 12.3.3.2;
  - FN mod 52 = 20 to 23 for the CTSAGCH used for the hopping access procedure, see subclause 12.3.3.2.
- timeslot position: the CTSAGCH is transmitted on a timeslot number which shall be indicated in the CTSBCH-SB information bits (see subclause 10.1.4).

10.3.3 CTSAGCH radio frequency channel

The CTSAGCH radio frequency channel is:

- the CTS beacon frequency for the CTSAGCH used for the non-hopping access procedure, see subclause 12.3.3.2;
- mapped on a predefined set of frequencies by the Total Frequency Hopping for the CTSAGCH used for the hopping access procedure, see subclause 12.3.3.2.

Refer to subclause 10.8.2 for background on the choice of the radio frequency channel.

10.3.4 CTSAGCH information

The CTSAGCH carries 23 octets of information, forming a message which directs the CTS-MS to a channel on which the RR connection can be continued. This message provides the CTS-MS with channel and timing information.

10.4 CTS Paging Channel (CTSPCH)

The CTSPCH is used in the downlink by the CTS-FP to broadcast information for paging (see subclause 12.3.3.3) and alive check (see subclause 12.3.2) procedures. The presence of the CTSPCH on the physical channel is indicated by a signalling information in the CTSBCH (see subclause 10.1.4).

10.4.1 CTSPCH format

- Burst: Normal Bursts (NB) are used for the CTSPCH.
- Training sequence: it is determined by the three LSBs of the FPBI. These three bits form the 3-bit training sequence code (TSC) which selects one of the eight training sequences specified in GSM 05.02 subclause 5.2.3.
- Channel coding and interleaving schemes: same as for the SACCH, as specified in GSM 05.03 subclause 4.1, over 4 consecutive bursts.

10.4.2 CTSPCH timing

The timing of the CTSPCH is as follows (see figure 1):

- frame position: FN mod 52 = 2 to 5;
- timeslot position: the CTSPCH is transmitted on a timeslot number which shall be indicated in the CTSBCH-SB information bits (see subclause 10.1.4).

10.4.3 CTSPCH radio frequency channel

The CTSPCH radio frequency channel is mapped on a predefined set of frequencies by the Total Frequency Hopping algorithm.

Refer to subclause 10.8.2 for background on the choice of the radio frequency channel.

10.4.4 CTSPCH information

The CTSPCH contains 23 octets of information, forming the following possible messages:

- a message used for the paging procedure, see subclause 12.3.3.3;
- a message used for alive check procedure, see subclause 12.3.2.

10.5 SACCH

In GSM-CTS, the TDMA frames where the CTSBCH is transmitted (FN mod 26 = 25) are not available for any SACCH transmission, in contrary to GSM. This results in the requirement that the SACCH multiframe shall span 104 TDMA frames (480 ms) as for GSM, however the interleaving scheme of the 4 SACCH bursts shall be so that no SACCH burst is sent in the TDMA frames: FN mod 104 = 25, 51, 77 or 103.

Therefore, the mapping in time of the 4 SACCH/CTS frames onto the physical channel shall be as follows:

- TN = 0 and 1 FN mod 104 = 12, 38, 64, 90;
- TN = 2 and 3 FN mod 104 = 38, 64, 90, 12;
- TN = 4 and 5 FN mod 104 = 64, 90, 12, 38;

- TN = 6 and 7 FN mod 104 = 90, 12, 38, 64.

The timing of the SACCH on the 26-multiframe is shown on figure 2.

The SACCH radio frequency channel is mapped on a predefined set of frequencies by the Total Frequency Hopping algorithm, as defined in subclause 10.8.2, except in the case of the non-hopping access procedure (for the attachment or enrolment of a CTS-MS), where the SACCH is mapped on the CTS beacon frequency.

SACCH is a point-to-point dedicated control channel used to transmit signalling messages for the layered GSM-CTS protocol.

10.6 FACCH

The standard GSM FACCH as defined in GSM 05.02 is used in GSM-CTS. Full rate FACCH/F is supported.

The timing of the FACCH on the 26-multiframe is shown on figure 2.

The FACCH radio frequency channel is mapped on a predefined set of frequencies by the Total Frequency Hopping algorithm, as defined in subclause 10.8.2, except in the case of the non-hopping access procedure (for the attachment or enrolment of a CTS-MS), where the FACCH is mapped on the CTS beacon frequency.

FACCH is a point-to-point dedicated control channel used to transmit signalling messages for the GSM-CTS layered protocol.

10.7 TCH

The traffic channel TCH used in GSM-CTS is the standard GSM traffic channel TCH as defined in GSM 05.02.

The supported channel types shall be:

- TCH/F.

The supported channel modes shall be in the Phase 1 of the GSM-CTS:

- speech v1: full rate speech coder;
- speech v2: enhanced full rate speech coder;
- signalling only.

Discontinuous transmission (DTX) shall be supported on the speech TCH.

The timing of the TCH on the 26-multiframe is shown on figure 2.

The TCH radio frequency channel is mapped on a predefined set of frequencies by the Total Frequency Hopping algorithm, as defined in subclause 10.8.2, except in the case of the non-hopping access procedure (for the attachment or enrolment of a CTS-MS), where the TCH is mapped on the CTS beacon frequency.

10.8 Mapping of the Logical Channels onto Physical Channels

10.8.1 Mapping in time of the logical channels onto the physical channels

The following figures give the mapping in time of the logical channels onto the physical channels.

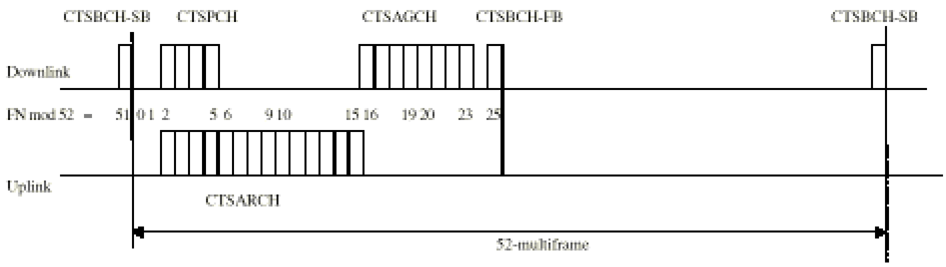

Figure 1: 52-multiframe structure

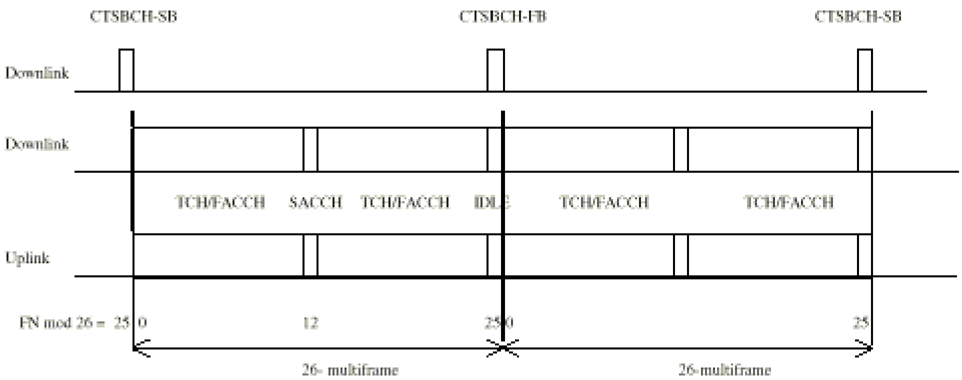

Figure 2: 26-multiframe structure

10.8.2 Mapping in frequency of the logical channels onto the physical channels

Prior to its attachment with a CTS-FP, the CTS-MS can not perform hopping as it is not aware of:

- the list of frequencies on which it shall hop: the TFH list (see subclause 12.2.2);
- the hopping sequence to use with the CTS-FP: this is computed from a set of parameters of the TFH algorithm (see below).

Therefore, the CTSBCH and the channels used in the attachment of a CTS-MS to access the CTS-FP (see non-hopping access procedure: subclause 12.3.3.2.1) are transmitted on the CTS beacon frequency.

After attachment, the CTS-MS has obtained the required information i.e. the TFH list and the parameters for the TFH algorithm, therefore hopping can be performed. All logical channels (except the CTSBCH) are mapped by the TFH algorithm on the TFH list.

The TFH algorithm shall be the Lempel-Greenberger algorithm concatenated with a non-repeating code (LG/NR). The hopping sequence is computed from a codeword which is continuously changing according to the LG/NR algorithm.

10.8.3 Permitted Channel Combinations

Due to the change of CTSBCH timeslot position from one 52-multiframe to another (see subclause 11.2), the following channel combinations are allowed on a physical channel:

(i) CTSBCH + CTSPCH + CTSARCH + CTSAGCH;

(ii) CTSPCH + CTSARCH + CTSAGCH;

(iii) CTSBCH;

(iv) CTSBCH + TCH/F + FACCH/F + SACCH/CTS;

(v) TCH/F + FACCH/F + SACCH/CTS.

Channel combinations (i), (iii) and (iv) shall be mutually exclusive in one 52-multiframe, because the CTSBCH is transmitted only once per 52-multiframe.

Channel combinations (i) and (ii) shall be also mutually exclusive.

11 Lower Layer Procedures

11.1 CTSBCH transmission

The CTS-FP shall transmit the CTSBCH on the selected CTSBCH frequency (indicated by the Frequency Management procedure in the RR upper layer, see subclause 12.2.2) at the maximum permitted output power.

11.2 CTSBCH timeslot management

In order to further reduce the interference between two CTS-FP and to ease the detection of the CTSBCH of neighbour CTS-FP (for GSM-CTS Phase 2), the timeslot position of the CTSBCH within the TDMA frame where the CTSBCH is transmitted shall not be fixed from one 52-multiframe to another.

A mechanism of CTSBCH timeslot shifting shall be performed on the CTSBCH while the CTS-FP is in RR Idle state (see subclause 12.1). This mechanism shall fulfil the following requirements:

- the shifting sequences of CTSBCH timeslot positions shall be predictable;
- a high number of shifting sequences shall be generated from a minimum number of parameters.

The mechanism of CTSBCH timeslot shifting is optional while the CTS-FP is in RR Active state (see subclause 12.1), i.e. has established a dedicated RR connection to a CTS-MS. A flag shall indicate in the CTSBCH-SB information bits whether the CTSBCH timeslot shifting is currently performed or not (see subclause 10.1.4).

11.3 CTSBCH-FB detection

When triggered by the upper layers, the CTS-MS shall attempt to detect the CTSBCH-FB on the CTSBCH frequency given by the upper layers. When the CTSBCH-FB is detected, it is used by the CTS-MS to update its frequency synchronisation to the CTS-FP.

11.4 CTSBCH-SB decoding

When triggered by the upper layers, the CTS-MS shall attempt to decode the CTSBCH-SB on the CTSBCH frequency given by the upper layers. The decoding of the CTSBCH-SB allows the CTS-MS to update its time synchronisation to the CTS-FP.

The CTSBCH-SB information bits shall be sent to the RR upper layer of the CTS-MS: see subclause 12.2.3.

11.5 Discontinuous transmission (DTX)

DTX shall be used by the CTS-FP and the CTS-MS. The DTX procedure specified in the relevant GSM 06 series specifications and in GSM 05.08 subclause 8.3 shall be employed.

11.6 Interference measurements

A procedure shall be implemented in the CTS-FP by which it estimates the interference level on the uplink frequencies of the Generic Frequency List (GFL).

In the same manner, the CTS-MS shall estimate the interference level on the downlink frequencies of the GFL.

Such interference measurements are periodically triggered by the RR upper layer, i.e. the AFA algorithm: the list of frequencies of the GFL which are to be measured, the required number of samples per frequency and the allowed measurement period, shall be specified.

11.7 MS timing offset measurements

When triggered by the upper RR layer, the CTS-FP shall measure the MS timing offset (as specified in GSM 05.10) of the bursts received on the CTS radio interface, i.e. Synchronisation Bursts (SB) and Normal Bursts (NB). The measurements shall be reported to the RR upper layer.

The requirements on the measurement precision are intended to allow the control of the CTS-FP service range, as defined in subclause 12.2.4.

12 Radio Resource Management Procedures

12.1 Radio Resources management states

RR Idle state: for the CTS-FP, the state where it has been initialised (see GSM 03.56); for the CTS-MS, the state where it is attached to a CTS-FP (see GSM 03.56).

RR Active state: the state where the CTS-MS and the CTS-FP have successfully established a dedicated RR connection.

12.2 General procedures

12.2.1 Initial synchronization of a CTS-MS and CTS-FP

Some procedures, e.g. the enrolment of a CTS-MS, shall require the synchronization of a CTS-FP and CTS-MS, whereas no parameters have yet been exchanged between the CTS-FP and CTS-MS, such as the used CTSBCH frequency. A special procedure shall be implemented in the CTS-FP by which the CTS-MS synchronization, i.e. decoding of the CTSBCH, is eased. This procedure shall include ways for the CTS-MS to detect the CTS beacon frequency more rapidly.

At the end of this procedure, the CTS-FP and CTS-MS are synchronised and can establish a dedicated RR connection if requested by the upper layers.

12.2.2 Frequency management

The following figure 3 gives an overview of the frequency management in the CTS-FP and CTS-MS.

The purpose of the frequency management is to avoid that a CTS-FP and a CTS-MS use the same frequencies as the surrounding PLMN and cause a too high interference level to it, to other CTS-FP and to the corresponding MS (GSM or CTS).

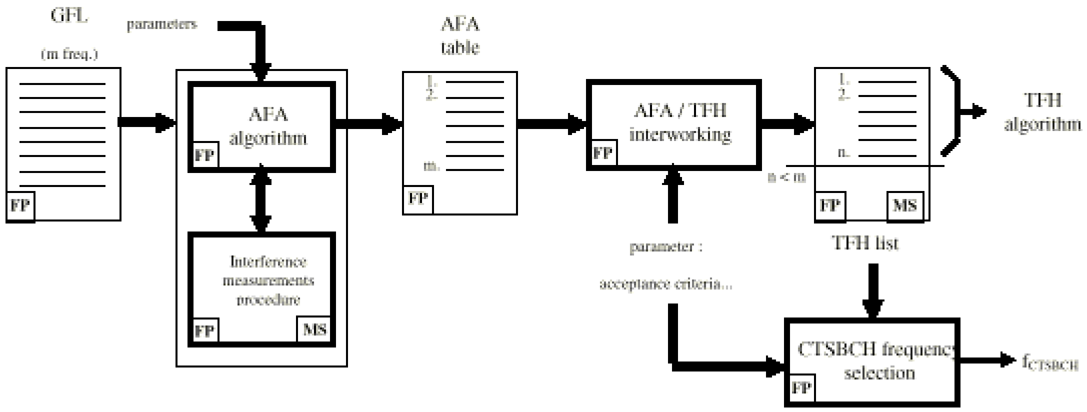

Figure 3: frequency management overview

- The GFL is allocated to a certain CTS-FP.
- The AFA table contains the frequencies of the GFL ranked and ordered by the AFA algorithm (see subclause 12.2.2.2); it is managed by the CTS-FP only.
- The TFH list is a reduced AFA table: the AFA / TFH interworking procedure (see subclause 12.2.2.3) has excluded some of the frequencies of the AFA table depending on an acceptance threshold and other parameters; the TFH list shall be known by both CTS-FP and CTS-MS, as it is the list of frequencies on which hopping is performed.

The whole management of the frequencies in the CTS system can be sub-divided into the following procedures.

12.2.2.1 Interference measurements exchange

The AFA algorithm shall periodically specify which interference measurements are to be performed on the Lower Layer in both CTS-FP and CTS-MS, then the interference measurements shall be reported from the Lower Layer of the CTS-FP and CTS-MS to the AFA algorithm.

The protocol to request and report the interference measurements shall use a dedicated RR connection (see subclause 12.3.3).

12.2.2.2 Adaptive Frequency Allocation (AFA) algorithm

The AFA algorithm shall perform a ranking with regard to interference measurements (see subclause 11.6), among the frequencies of the GFL, taking into account system parameters.

The reaction time of the AFA algorithm shall decrease in case high interference is measured on the used frequencies, e.g. to adapt to strong changes in the interference environment caused by frequency replanning on the cellular network. It shall, however, be resistant against interference fluctuations caused by short time traffic variations, e.g. day and night traffic.

12.2.2.3 AFA / TFH interworking

A set of frequencies from the AFA table shall be selected by the CTS-FP to be used by the Total Frequency Hopping (TFH) algorithm: this subset is the TFH list. The selection mechanisms shall use parameters, such as an acceptance criteria. All frequencies fulfilling the acceptance criteria shall be part of the TFH list.

12.2.2.4 CTSBCH frequency selection

Any frequency from the TFH list shall be selected as the CTSBCH frequency, i.e. the frequency on which the CTSBCH is transmitted. The CTSBCH frequency can be either the frequency showing the lowest interference level with respect to reported interference measurements, either a random frequency chosen in the TFH list.

12.2.3 CTSBCH-SB information

The CTSBCH-SB shall be periodically transmitted by the CTS-FP on the CTS radio interface (see subclause 11.1). The information described in subclause 10.1.4, shall be sent by the CTS-FP at every CTSBCH-SB transmission.

12.2.4 Control of CTS-FP service range

The control of the CTS-FP service range can be performed using MS timing offset measurements (as defined in subclause 11.7). Considering the present MS requirements for synchronisation (see GSM 05.10 clause 6), the CTS-FP service range can be only controlled with an accuracy of ±750 m.

Methods for increasing this accuracy are needed in order to see if the CTS-FP service range can be restricted to 375 m. They are specified in GSM 05.10.

12.2.5 CTS-FP selection

When attempting to attach to a CTS-FP (see GSM 03.56), the CTS-MS shall periodically attempt to detect the CTSBCH-FB (see subclause 11.3) on the CTSBCH frequency. The CTSBCH frequency shall be stored in the CTS-MS for each CTS-FP it is enrolled with.

12.3 RR Idle state procedures

12.3.1 CTSBCH monitoring

In the RR Idle state, the CTS-MS RR layer shall periodically request the CTS-MS Lower Layer to decode the CTSBCH-SB (see subclause 11.4).

The periodicity of the CTSBCH monitoring shall ensure that synchronisation to the CTS-FP can be maintained and that the response time to information given in the CTSPCH is acceptable.

12.3.2 Alive check

The CTS-FP shall periodically verify the presence of its attached CTS-MS. This shall be performed in four steps:

- the CTSPCH indicator flag of the CTSBCH shall indicate the need to decode the next following CTSPCH;
- the CTS-FP shall transmit on the CTSPCH an alive check message: this message shall contain a CTSMSI, which is used by the CTS-FP to address one particular CTS-MS;
- the addressed CTS-MS shall transmit an access request message on one of the six CTSARCH which are mapped onto the physical channel as specified in subclause 10.2.2. The choice of the CTSARCH to be used shall be randomly performed;
- the alive check message shall be maintained on the CTSPCH until the access request message is received from the CTS-MS; however if after a timer has expired, no message is received from the CTS-MS, an alive check failure message shall be sent to the MM upper layer.

12.3.3 Establishment of a dedicated RR connection

12.3.3.1 Timeslot assignment for dedicated connection

The timeslot assignment for a dedicated channel shall be based on interference measurements performed by the CTS-FP in the uplink direction on any timeslot of the frequencies of the TFH list. The least interfered timeslot shall be used to establish a dedicated connection.

12.3.3.2 CTS-MS initiated RR connection establishment

When the CTS-MS is willing to establish a dedicated RR connection with a CTS-FP, it shall access the CTS-FP using one of the two following procedures. The choice is dependent on the type of request for dedicated RR connection as triggered by the upper layers: e.g. attachment, CTS-MS initiated call set-up, etc.

12.3.3.2.1 Non-hopping access procedure

An access request message shall be sent by the CTS-MS on the CTSARCH. The CTS-MS shall send two bursts on the CTSARCH: these two bursts shall be sent on two successive frames and shall contain the same access request message. The first sent burst can be used by the CTS-FP to assess the path loss between the CTS-MS and itself, in order to effectively decode the second burst. The choice of the two CTSARCH to be used among the eight CTSARCH which are mapped onto the physical channel as stated in subclause 10.2.2, shall be randomly performed, with the requirement of the first burst being sent in a TDMA frame with even FN.

On receipt of the access request message, the CTS-FP shall transmit a message on the CTSAGCH which is mapped onto the physical channel as stated in subclause 10.3.2.

This message shall contain the dedicated channel description.

Upon receipt of this message, the CTS-MS shall switch to the assigned channel, set the channel mode to "Signalling only", activate the assigned channel in non-hopping mode and establish the main signalling link. The dedicated RR connection is then considered as established: the CTS-FP shall transmit to the CTS-MS the required information to perform hopping, i.e. the hopping parameters to be used by the Total Frequency Hopping algorithm (see subclause 10.8.2) and the TFH list. Upper layers shall then be informed, in order to perform the required procedure.

12.3.3.2.2 Hopping access procedure

An access request message shall be sent by the CTS-MS on the CTSARCH. The CTS-MS shall send two bursts on the CTSARCH: these two bursts shall be sent on two successive frames and shall contain the same access request message. The first sent burst can be used by the CTS-FP to assess the path loss between the CTS-MS and itself, in order to effectively decode the second burst The choice of the two CTSARCH to be used among the six CTSARCH which are mapped onto the physical channel as stated in subclause 10.2.2, shall be randomly performed, with the requirement of the first burst being sent in a TDMA frame with even FN.

On receipt of the access request message, the CTS-FP shall transmit a message on the CTSAGCH which is mapped onto the physical channel as stated in subclause 10.3.2. This message shall contain the dedicated channel description.

Upon receipt of this message, the CTS-MS shall switch to the assigned channel, set the channel mode to "Signalling only", activate the assigned channel in hopping mode and establish the main signalling link. The dedicated RR connection is then considered as established: upper layers shall be informed, in order to perform the required procedure.

12.3.3.3 CTS-FP initiated RR connection establishment

When the CTS-FP is willing to establish a dedicated RR connection with a CTS-MS, it shall perform the paging procedure.

The CTSPCH indicator flag of the CTSBCH shall indicate the need for the CTS-MS to decode the next following CTSPCH. Then the CTS-FP shall transmit on the CTSPCH a paging message: this message shall contain a CTSMSI, which is used by the CTS-FP to address one particular CTS-MS.

On receipt of this paging message, the CTS-MS shall perform the hopping access procedure, similar to subclause 12.3.3.2.2.

The paging message shall be maintained on the CTSPCH until the access request message is received from the CTS-MS; however if after a timer has expired, no message is received from the CTS-MS, an paging failure message shall be sent to the MM upper layer.

The dedicated RR connection is then considered as established: upper layers shall be informed, in order to perform the required procedure.

12.3.4 CTSBCH failure detection

If the CTSBCH-SB can not be decoded by the CTS-MS performing CTSBCH monitoring, the CTS-MS shall attempts to monitor the CTSBCH again on the next 52-multiframe. If it cannot monitor the CTSBCH for a defined number of consecutive attempts, a CTSBCH failure message shall be sent to the upper layers.

12.4 RR Active state procedures

In the RR Active state, a dedicated RR connection has been successfully established between a CTS-MS and a CTS-FP.

12.4.1 Radio link failure detection

The radio link failure detection in the CTS-FP and the CTS-MS shall ensure that dedicated RR connection with unacceptable quality, which cannot be improved either by RF power control (see subclause 12.4.2) or intracell handover (see subclause 12.4.3) shall be released by the CTS-FP or the CTS-MS. A radio link failure message shall be sent to the upper layers.

12.4.2 RF power control

In the RR Active state, RF power control shall be employed to minimise the transmit power required by the CTS-MS or the CTS-FP whilst maintaining the quality of the radio link. Both the CTS-MS and CTS-FP shall apply power control in the uplink and downlink.

The output power control level to be used by the CTS-MS shall be determined in the CTS-FP and shall be communicated to the CTS-MS on the SACCH.

The requirements for the power control algorithm are specified in GSM 05.08.

12.4.3 Intracell handover

Intracell handover (change of active timeslot) shall be carried out in the case of unacceptable connection quality when in RR Active state. The handover shall be triggered by the CTS-FP.

If an intracell handover is triggered, the CTS-FP shall re-assign another randomly chosen timeslot for the dedicated connection.

12.4.4 Channel release

When triggered by the upper layers or if a radio link failure is detected (see subclause 12.4.1), the dedicated RR connection shall be released by the CTS-MS and CTS-FP.

Annex A (informative): GSM backwards compatibility issues

This annex is intended to study the impacts on a GSM-MS behaviour in a PLMN due to the deployment of CTS-FPs in the PLMN coverage area.

This study is split in 3 scenarios:

- Scenario 1: CTS is not operated by PLMN operator, or CTS and GSM are operated in separate bands. It means that PLMN and CTS-GFL have no common frequency in the whole overlapping coverage area;
- Scenario 2: CTS and GSM are operated in shared band with optimal GFL definition in the considered area. It means that at every given location PLMN and CTS-GFL have no common frequency;
- Scenario 3: CTS and GSM are operated in shared band with sub-optimal GFL definition for some considered area. It means that at some given locations PLMN and CTS-GFL (then possibly FPs) have common frequencies.

NOTE: PLMN refers either to the home PLMN when the GSM-MS is under its coverage, or the roaming PLMN otherwise.

A.1 Reasons for possible impact of a CTS-FP on a GSM-MS in the PLMN

A.1.1 Power measurement of BCCH carrier

CTS and GSM potentially share same frequency band. Thus signals emitted by a CTS-FP may impact the power measurement performed by the MS on GSM frequencies.

Signals emitted by a CTS-FP are:

- on the beacon frequency, maximum 6 bursts on 52 frames:
  - the CTSBCH, permanently, 2 bursts every 52 frames;
  - part of the CTSAGCH (non hopping), on demand, 4 bursts every 52 frames.
- on a defined set of frequencies, using Total Frequency Hopping procedure :
  - the CTSPCH, on demand, 4 bursts every 52 frames;
  - part of the CTSAGCH (hopping), on demand, 4 bursts every 52 frames;
  - SACCH, FACCH, TCH/F, for each dedicated connection, total of 50 bursts every 52 frames.

The BCCH carrier power measured by the GSM-MS is according to GSM 05.08 and GSM 03.22 the average on 5 measurements, evenly spread in 5 s.

A.1.1.1 Power on CTS-FP beacon frequency seen by the GSM-MS in cell selection

Considering the logical channels mapping for a CTS-FP, the GSM-MS has a maximum probability of $(6/416)^n$ to see (n/5) bursts of the CTS-FP beacon in the 5 measurements, i.e. probability 0.014 to see 1/5 of the beacon power, 0.00020 to see 2/5 of the beacon power, ...

A.1.1.2 Power on CTS-FP hopping frequencies seen by the GSM-MS in cell selection

On any other frequency, the CTS-FP has to perform Total Frequency Hopping. The power seen by the GSM-MS will depend on the number of frequencies used and the state of the FP (signalling, dedicated connection, ...).

If there is one dedicated connection, one timeslot will be used, spread over the hopped frequencies. For example, when hopping on 8 frequencies, the impact on power is as low as for the beacon frequency.

A.1.2 Synchronisation of a GSM-MS

CTS and GSM share same burst format for frequency burst (FCH and CTSBCH-FB). Therefore a GSM-MS could perform misleading FCH detection. But the Synchronisation Bursts (SCH and CTSBCH-SB) have different training sequences. A GSM-MS will not be able to decode a CTSBCH-SB. In addition, multiframe scheme is different between BCCH and CTS beacon.

A.2 Scenario 1: PLMN and CTS-GFL have no common frequency in whole coverage area

In this section, we consider that any GFL in the considered PLMN coverage and any BA list in this PLMN never have any common frequency.

This section corresponds mainly to the following cases:

- donor PLMN and CTS are operated in separate bands;
- the considered PLMN is not a CTS Donor PLMN.

A.2.1 Cell Selection

A.2.1.1 GSM-MS has no BA list stored on the SIM

In this case, the GSM-MS shall scan all frequencies allowed by its type (GSM 900Mhz, 1800Mhz, multi-band, ...), the number of such frequencies being possibly reduced by network parameter such as BA RANGE.

The GSM-MS may see a CTS-FP frequency as the next most powerful frequency and try to find a FCH. If it is not a CTS beacon frequency, frequency burst detection will fail. If it is a CTS beacon frequency, the frequency burst may be detected, but the MS will fail to decode an SCH.

The impact on GSM-MS is an **additional delay of maximum 0,5 s per CTS frequency on which synchronisation is attempted**, i.e. CTS frequency seen with higher power than the BCCH on which the MS is finally camping (see GSM 05.08 subclause 6.2 for maximum delay allowed for synchronisation to a BCCH carrier).

A.2.1.2 GSM-MS has a stored BA list on the SIM (optional)

The GSM-MS attempts first to camp on a cell with frequency in that BA list.

If the GSM-MS achieves to camp on a cell with frequency from the BA list, no frequency used by any CTS-FP has been scanned. CTS deployment has **no impact on GSM-MS behaviour**.

If the GSM-MS fails to camp on any cell with frequency from the stored list, the GSM-MS behaviour is like in subclause 2.1.1. The impact on GSM-MS is an **additional delay of maximum 0,5 s per CTS frequency on which synchronisation is attempted**.

A.2.2 Cell reselection

When camped on a cell, the GSM-MS shall monitor frequencies from the BA list provided on the BCCH.

Since the BA list and GFL have no common frequency, the GSM-MS never monitors CTS-FP frequency. CTS deployment has **no impact on GSM-MS behaviour**.

A.2.3 Handover

When in connected mode, the GSM-MS shall monitor frequencies from the BA list provided on the SACCH.

Since the BA list and GFL have no common frequency, the GSM-MS never monitors CTS-FP frequency. CTS deployment has **no impact on GSM-MS behaviour**.

A.3 Scenario 2: PLMN and CTS-GFL have locally no common frequency

In this section we consider the locations where the BA list of any covering cell and the GFL of any covering CTS-FP have no common frequency.

This section corresponds to the typical operation of GSM and CTS in shared band with appropriate GFL depending on CTS-FP location.

A.3.1 Cell Selection

A.3.1.1 GSM-MS has no BA list stored on the SIM

The GSM-MS behaviour is same as in scenario 1 (see subclause 2.1.1). The impact on GSM-MS is **an additional delay of maximum 0,5 sec per CTS frequency on which synchronisation is attempted**.

A.3.1.2 GSM-MS has a stored BA list on the SIM (optional)

The GSM-MS attempts first to camp on a cell with frequency in that BA list.

Either no CTS-FP transmits on any frequency in the stored BA list, and impacts are similar to scenario 1 (see subclause 2.1.2). This is typically the case when the GSM-MS did not move since BA list was stored.

Or one or more CTS-FPs transmit on frequency in the stored BA list at the MS current location. Then the GSM-MS will perform power measurements on CTS frequencies and possibly attempt to synchronise to them. The impact on GSM-MS is **an additional delay of maximum 0,5 sec per CTS frequency on which synchronisation is attempted**.

A.3.2 Cell reselection

A.3.2.1 GSM-MS camping on its home PLMN

When camped on a cell, the GSM-MS shall monitor frequencies from the BA list provided on the BCCH.

Since the BA list and GFL have locally no common frequency, the GSM-MS never monitors CTS-FP frequency. CTS deployment has **no impact on GSM-MS behaviour**.

A.3.2.2 GSM-MS camping on a visited PLMN in home country

When on a VPLMN in home country, the GSM-MS has in addition to search its HPLMN with a period T, T from 6 minutes to 8 hours (this parameter is normally on the SIM, otherwise default value is 30 minutes). So every T minutes the GSM attempts to access its HPLMN. In this case, impact on GSM-MS is, as in subclause 2.1.1., **an additional delay of max 0,5 sec per CTS frequency on which synchronisation is attempted**.

A.3.3 Handover

When in connected mode, the GSM-MS shall monitor frequencies from the BA list provided on the SACCH.

Since the BA list and GFL have locally no common frequency, the GSM-MS never monitors any CTS-FP frequency. CTS deployment has **no impact on GSM-MS behaviour**.

A.4 Scenario 3: PLMN and CTS-GFL have locally some common frequencies

In this section we consider the locations where the BA list of a covering cell and the GFL of a covering CTS-FP have at least one common frequency.

This clause typically corresponds to GSM and CTS operated in shared band where GFL is sub-optimal for that location. It could happen for example where almost all frequencies are used for BCCH, or at the border between GFL areas.

One AFA requirement is to avoid that BCCH frequencies are used by a CTS-FP. Then scenario 3 is equivalent to scenario 2.

However, if this is not achieved (just after a new frequency planning for example), impacts are described hereafter. Note that impacts are similar to those on a GSM-MS in a PLMN where two cells with same BCCH frequency overlap.

A.4.1 Cell selection

Due to the presence of the CTS-FP, the power measured by the GSM-MS on a BCCH may be higher than its actual value. The ranking of the BCCH power may be modified.

In addition, if the GSM-MS tries to synchronise to such a "double" frequency it may find the CTSBCH-FB before the FCH (probability is 1/5 due to frequency burst repetition schemes). In thus case, it will fail to find the SCH at the expected frame, then discard that BCCH.

The impact is that the GSM-MS could camp on a cell which is not the most powerful. This is as for a GSM-MS in a PLMN at a location where 2 different BCCH are transmitted on same frequency.

A.4.2 Cell reselection

Due to the presence of the CTS-FP, the power measured by the GSM-MS on a BCCH from the BA list may be higher than its actual value. The ranking of the 6 strongest BCCH carriers may be modified.

In addition, the first time the GSM-MS tries to decode the BSIC of such a "double" frequency it may find the CTSBCH-FB before the FCH (probability is 1/5 due to FCH and CTSBCH-FB repetition schemes). It will fail to find the SCH at the expected frame, then discard that BCCH candidate. The MS shall attempt a new BSIC decoding every 30 s if the BCCH is still in the 6 strongest surrounding cells, with same probability of failure. Note that if the BSIC is decoded once, the GSM-MS keeps track of the synchronisation and BSIC decoding will not fail anymore.

The impact is that the GSM-MS ranking of the 6 strongest surrounding cells may be modified, the GSM-MS may camp on a valid but not best cell, and a valid BCCH may be temporarily discarded from the 6 strongest surrounding cells. This could also happen for a GSM-MS in a PLMN at a location where 2 different BCCH are transmitted on same frequency.

A.4.3 Handover

Due to the presence of the CTS-FP, the power measured by the GSM-MS on a BCCH from the BA list may be higher than its actual value. The ranking of the 6 strongest BCCH carriers may be modified. It has an impact only if it affects the ranking of a candidate cell for handover.

In addition, the first time the GSM-MS tries to decode the BSIC of such a "double" frequency it may find the CTSBCH-FB before the FCH (probability is 1/5 due to FCH and CTSBCH-FB repetition schemes). It will fail to find the SCH at the expected frame, then discard that BCCH candidate. The MS shall attempt a new BSIC decoding every 10 s if the BCCH stays in the 6 strongest surrounding cells, with same probability of failure. Note that if the BSIC is decoded once, the GSM-MS keep track of the synchronisation and BSIC decoding will not fail anymore.

The impact is that the GSM-MS ranking of the 6 strongest surrounding cells may be modified, the GSM-MS may handover on a valid but not best cell, and a valid BCCH may be temporarily discarded from the 6 strongest surrounding cells. This could also happen for a GSM-MS in a PLMN at a location where 2 different BCCH are transmitted on same frequency.

A.5 Conclusion

If GSM and CTS are operated in separated bands (scenario 1), there is no impact on a GSM-MS except a small possible delay for cell selection in some specific cases.

Where GSM and CTS are operated in shared band with proper GFL definition (scenario 2), impacts are same as for scenario 1.

Where GSM and CTS are operated in shared band with sub-optimal GFL definition (scenario 3), AFA aims at having a configuration similar to scenario 2. If this is not achieved, possibly after new frequency planning, the impacts on the GSM-MS are similar to those of a PLMN where two cells overlap with same BCCH frequency.

Annex B (informative): Document change history

SPEC	SMG#	CR	PHASE	VERS	NEW_VERS	SUBJECT
03.52	s29	A005	R97	7.0.1	7.1.0	Modification of access request operation
03.52	s31			7.1.0	8.0.0	Version for Release 1999
03.52				8.0.0	8.0.1	Version update to 8.0.1 for Publication

History

Document history		
V8.0.0	April 2000	One-step Approval Procedure OAP 20000825: 2000-04-26 to 2000-08-25 (as EN 301 404)
V8.0.1	September 2000	Publication