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TECHNICAL SPECIFICATION

Digital cellular telecommunications system (Phase 2+) (GSM);
GSM/EDGE Radio subsystem synchronization
(3GPP TS 45.010 version 14.5.0 Release 14)

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Contents

Foreword

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1 Scope

The present document defines the requirements for synchronization on the radio sub-system of the digital cellular telecommunications systems GSM. However, it does not define the synchronization algorithms to be used in the Base Transceiver Station (BTS), CTS Fixed Part (CTS-FP) and Mobile Station (MS). These are up to the manufacturer to specify.

1.1 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. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: “Vocabulary for 3GPP Specifications”.

[2] 3GPP TS 25.123: “Requirements for support of radio resource management (TDD)”.

[3] 3GPP TS 25.133: “Requirements for support of radio resource management (FDD)”.

[4] 3GPP TR 43.030: “Radio network planning aspects”.

[5] 3GPP TS 43.052: “Lower layers of the Cordless Telephony System (CTS) Radio Interface; Stage 2”.

[6] 3GPP TS 43.059: “Functional stage 2 description of Location Services (LCS) in GERAN”.

[7] 3GPP TS 43.064: “Overall description of the GPRS radio interface; Stage 2”.

[8] 3GPP TS 44.018: “Mobile radio interface layer 3 specification, Radio Resource Control Protocol”.

[9] 3GPP TS 44.060: “General Packet Radio Service (GPRS); Mobile Station (MS) - Base Station System (BSS) interface; Radio Link Control/ Medium Access Control (RLC/MAC) protocol”.

[10] 3GPP TS 45.002: “Multiplexing and multiple access on the radio path”.

[11] 3GPP TS 45.005: “Radio transmission and reception”.

[12] 3GPP TS 45.008: “Radio subsystem link control”.

[13] 3GPP TS 45.050: “Background for RF Requirements”.

[14] 3GPP TS 45.056: “CTS-FP Radio Sub-system”.

[15] 3GPP TS 45.004: “Modulation”.

[16] 3GPP TS 36.133: “Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements for support of radio resource management”.

[17] 3GPP TS 36.211: “Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Channels and Modulation”.

[18] 3GPP TS 49.031: “Location Services (LCS); Base Station System Application Part, LCS Extension (BSSAP-LE)”.

1.2 Definitions and abbreviations

In addition to those below, abbreviations used in the present document are listed in 3GPP TR 21.905.

BTS: Base Transceiver Station.

BTTI: Basic TTI.

Coverage Class: see definition in 3GPP TS 43.064.

CTS-FP: CTS Fixed Part.

CTS-MS: MS operating in CTS mode.

Current Serving BTS: BTS on one of whose channels (TCH, DCCH, CCCH or PDCH) the MS is currently operating.

Current Serving CTS-FP: CTS-FP on one of whose channels (TCH or CTS control channels) the CTS-MS is currently operating.

EC: Extended Coverage, see definition in 3GPP TS 43.064.

EC operation: see definition in 3GPP TS 43.064.

EC-GSM-IoT: Extended Coverage GSM for Internet of Things.

FANR (Fast Ack/Nack Reporting): Fast Ack/Nack Reporting enables the use of a PAN field within an RLC/MAC block for EGPRS data transfer or for EGPRS2 data transfer. FANR enables the mobile station to transmit in the uplink direction a PAN field corresponding to a downlink TBF. Similarly FANR enables the network to transmit in the downlink direction a PAN field corresponding to an uplink TBF.

MS timing offset: delay of the received signal relative to the expected signal from an MS at zero distance under static channel conditions with zero timing advance. This is accurate to ± 1 symbol, and reported once per SACCH or after a RACH as. required (i.e. at the same rate as timing advance). For example, for an MS with a round trip propagation delay of P symbols, but with a timing advance of T symbols, the reported timing offset will be P-T quantized to the nearest symbol. For GPRS the MS timing offset is not reported.

Normal Symbol Period: duration of a symbol for bursts using a modulating symbol rate of 1625/6 ksymb/s (see 3GPP TS 45.004); it is equal to 48/13 µs. This symbol duration is used for transmission of GMSK, 8PSK, 16QAM and 32QAM modulated bursts on downlink and GMSK, 8PSK and 16QAM modulated bursts on uplink (see 3GPP TS 45.004).

Observed Frequency Offset (OFO): difference of frequency of signals received by a CTS-MS from a CTS-FP and a BTS. The Observed Frequency Offset is measured and reported by the CTS-MS on CTS-FP requirement. The Observed Frequency Offset is expressed in ppm with an accuracy of 1/64 ppm (i.e. about 0,016 ppm).

PAN: Piggy-backed Ack/Nack.

Quarter symbol number: timing of quarter symbol periods (12/13 µs or 10/13 µs depending on the actual symbol period used) within a timeslot. A symbol can represent 1 to 5 bits depending upon modulation.

Reduced Latency: refers to the use of FANR either in BTTI configuration or in RTTI configuration for EGPRS and EGPRS2.

Reduced Symbol Period: duration of a symbol for bursts using a modulating symbol rate of 325 ksymb/s (see 3GPP TS 45.004); it is equal to 40/13 µs. This symbol duration is used for transmission of QPSK, 16QAM and 32QAM modulated bursts on uplink and downlink (see 3GPP TS 45.004).

RTTI: Reduced TTI.

Symbol Period: symbol period is the duration of a symbol and shall refer to normal symbol period unless explicitly clarified to be the reduced symbol period.

TDMA frame number: count of TDMA frames relative to an arbitrary start point.

Timebase counters: set of counters which determine the timing state of signals transmitted by a BTS or MS.

Time group (TG): used for compact**,** time groups shall be numbered from 0 to 3 and a particular time group shall be referred to by its time group number (TG) (see 3GPP TS 45.002).

Timeslot number (TN): timing of timeslots within a TDMA frame.

Timing Advance: signal sent by the BTS to the MS which the MS uses to advance its timings of transmissions to the BTS so as to compensate for propagation delay.

Timing Advance Index: Timing Advance Index TAI used for GPRS, which determines the position of the subchannel on PTCCH (see 3GPP TS 45.002) used by the MS to send an access burst, from which the network can derive the timing advance.

TTI: Transmission Time Interval.

2 General description of synchronization system

This clause gives a general description of the synchronization system. Detailed requirements are given in clauses 3 to 7.

The BTS sends signals on the BCCH carrier or, for COMPACT on the CPBCCH carrier, to enable the MS to synchronize itself to the BTS and if necessary correct its frequency standard to be in line with that of the BTS. The signals sent by the BTS for these purposes are:

a) Frequency correction bursts;

b) Synchronization bursts.

The timings of timeslots, TDMA frames, TCH frames, control channel frames, and (for COMPACT) the rotation of time groups are all related to a common set of counters which run continuously whether the MS and BTS are transmitting or not. Thus, once the MS has determined the correct setting of these counters, all its processes are synchronized to the current serving BTS.

The MS times its transmissions to the BTS in line with those received from the BTS. The BTS sends to each MS a "timing advance" parameter (TA) according to the perceived round trip propagation delay BTS-MS-BTS. The MS advances its timing by this amount, with the result that signals from different MS's arriving at the BTS and compensated for propagation delay. This process is called "adaptive frame alignment".

Additionally, synchronization functions may be implemented in both the MS and the BTS to support the so-called pseudo synchronization scheme for circuit-switched handovers. The support of this scheme is optional except that MS shall measure and report the Observed Timing Difference (OTD), which is a mandatory requirement. The detailed specifications of the pseudo-synchronization scheme for circuit-switched handovers are included in annex A.

While in dual transfer mode an MS performs all the tasks of dedicated mode. In addition, upper layers can require the release of all the packet resources, which triggers the transition to dedicated mode, or the release of the RR resources, which triggers the transition either to idle mode and packet idle mode or, depending upon network and MS capabilities, to packet transfer mode.
When handed over to a new cell, the MS leaves the dual transfer mode, enters the dedicated mode where it switches to the new cell, may read the system information messages sent on the SACCH and may then enter dual transfer mode in the new cell (see 3GPP TS 44.060).

In CTS, the CTS-FP sends signals on the CTSBCH to enable the MS to synchronize itself to the CTS-FP and if necessary correct its frequency standard to be in line with that of the CTS-FP.

The signals sent by the CTS-FP for these purposes are:

a) Frequency correction bursts;

b) Synchronization bursts.

The timings of timeslots, TDMA frames, CTSBCH, CTSARCH, CTSAGCH and CTSPCH frames are all related to a first common set of counters which run continuously whether the CTS-MS and CTS-FP are transmitting or not. Thus, once the CTS-MS has determined the correct setting of these first counters, the CTS-MS is able to attach to the current serving CTS-FP. In addition, during CTS-MS attachment, the CTS-FP sends to the CTS-MS the remaining counters for SACCH and TCH frames. Then, all processes of the CTS-MS are synchronized to the current serving CTS-FP.

The CTS-MS times its transmissions to the CTS-FP in line with those received from the CTS-FP. The timing advance parameter is set to zero for CTS.

Additionally, the CTS-FP may be assisted by a CTS-MS to adjust its frequency source. When required by the CTS-FP, the CTS-MS estimates if possible and reports the Observed Frequency Offset of the CTS-FP with a specified BTS. The CTS-FP may then adjust its frequency source according to this value.

3 Timebase counters

3.1 Timing state of the signals

The timing state of the signals transmitted by a BTS (for normal symbol period), a MS (for normal symbol period), a CTS-FP, or an Compact BTS and MS is defined by the following counters:

- Quarter symbol number QN (0 - 624)
- Symbol number BN (0 - 156);
- Timeslot number TN (0 - 7);
- TDMA frame number FN (0 to (26 x 51 x 2048) - 1 = 2715647); or
- for a non attached CTS-MS, TDMA frame number modulo 52 T4 (0 - 51); or
- for Compact, TDMA frame number FN (0 to (52 x 51 x 1024) -1 = 2715647).

In CTS, the CTS-MS shall manage different sets of counters for CTS operation and GSM operation.

Alternatively, in case of transmission using reduced symbol period, for a BTS or an MS the following counters have the following ranges:

- Quarter symbol number QN (0-749)
- Symbol number BN (0-187)

3.2 Relationship between counters

The relationship between these counters is as follows:

- QN increments every 12/13 µs for normal symbol period and every 10/13µs for Reduced Symbol Period;
- BN = Integer part of QN/4;
- TN increments whenever QN changes from count 624 to 0 for normal symbol periodand whenever QN changes from count 749 to 0 for reduced symbol period;
- FN increments whenever TN changes from count 7 to 0; or
- for a CTS-MS, T4 increments whenever TN changes from count 7 to 0.

4 Timing of transmitted signals

The timing of signals transmitted by the MS, BTS and CTS-FP is defined in 3GPP TS 45.002.

i) The MS can use the timing of receipt of the synchronization burst to set up its timebase counters as follows:

QN is set by the timing of the training sequence;

TN = 0 when the synch burst is received;

FN = 51 ((T3-T2) mod (26)) + T3 + 51 x 26 x T1 when the synch burst is received, (where T3 = (10 x T3') + 1, T1, T2 and T3' being contained in information fields in synchronization burst).

ii) For Compact, the MS can use the timing of receipt of the synchronization burst to set up its timebase counters as follows:

QN is set by the timing of the training sequence;

FN = (R1 x 51 + R2) x 52 + 51 when the synch burst is received (where R1 and R2 are contained in information fields in synchronization burst);

TN is determined from TG as described in 3GPP TS 45.002, where TG is contained in information fields in synchronization burst.

iii) For CTS, the timebase counters are set as follows:

QN is set by the timing of the training sequence;

TN is set according to the CTSBCH-SB position (see Annex C);

T4 = 51 when the CTSBCH-SB is received (prior to attachment);

FN = (51 ((T3-T2) mod (26)) + T3 + 51 x 26 x T1) mod (2715648) when the CTS-MS receives the last CTSAGCH burst of the non-hopping access procedure, where T2 = T4 mod (26), and T1 and T3 being contained in this CTS immediate assignment message.

iv) For EC-GSM-IoT, the MS can use the timing of receipt of the synchronization burst on EC-SCH to set up its timebase counters as follows:

QN is set by the timing of the training sequence;

TN = 1 when the synch burst is received

FN = RFN_{QH} + 51 x 26 x 512 x QUARTER_HYPERFRAME_INDICATOR

where,

RFN_{QH} = FN within a quarter hyperframe = (51 x 52 x T1') + (4 x 51 x T2' + 51 x T2'') + T3 when the synch burst is received,

T1', T2' are contained in information fields in the synchronization burst, and,

T2'' is signalled through the cyclic shift pattern used on the EC-SCH, see 3GPP TS 45.003.

T3 is determined e.g. by the device through the identification of the mapping of the FCCH, or EC-SCH, onto the specific TDMA frames within the 51-multiframe.

QUARTER_HYPERFRAME_INDICATOR is obtained in the immediate assignment, see 3GPP TS 44.018.

NOTE: Depending on the coverage condition, the MS may optionally use the timing of receipt of the synchronization burst (SCH) to set up its timebase counters as described in i).

Thereafter, the timebase counters are incremented as in subclause 3.2.

(When adjacent BTS's are being monitored for handover purposes, or for cell reselection purposes in group receive mode, the MS may choose to store the values of QN, TN and FN for all the BTS's whose synchronization bursts have been detected relative to QN, TN and FN for its current serving BTS).

5 BTS Requirements for Synchronization

5.0 General

The conditions under which the requirements of subclauses 5.4 and 5.6 must be met shall be 3 dB below the reference sensitivity level or input level for reference performance, whichever applicable, in 3GPP TS 45.005 and 3 dB less carrier to interference ratio than the reference interference ratios in 3GPP TS 45.005.

For EC-GSM-IoT, the conditions shall be met at the input level for reference performance of EC-RACH, and at the reference carrier to interference ratios of the EC-RACH, for the highest coverage class, as defined in TS 45.005 for the supported TS option(s) of EC-RACH.

5.1 Frequency source

The BTS shall use a single frequency source of absolute accuracy better than 0.05 ppm for both RF frequency generation and clocking the timebase. The same source shall be used for all carriers of the BTS.

For the pico-BTS and Local Area multicarrier BTS classes the absolute accuracy requirement is relaxed to 0.1ppm.

NOTE: BTS frequency source stability is one factor relating to E-OTD LCS performance and the reader is referred to Annex C for the relationship between BTS frequency source stability and E-OTD LCS performance characteristics.

5.2 Timebase counters

It is optional whether the timebase counters of different BTS's are synchronized together.

For COMPACT inter base station time synchronization is required such that timeslot number (TN) = i (i = 0 to 7) and frame number (FN) with FN mod 208 =0 shall occur at the same time in all cells. The timebase counters of different BTSs shall be synchronized together such that the timing difference between different BTSs shall be less than 1 symbol period, 48/13 µs (which can be 1 or 3 bits depending upon modulation) measured at the BTS antenna.

If a cell defines a COMPACT cell in its neighbour list, time synchronization is required such that timeslot number (TN) = i (i = 0 to 7) and frame number (FN) with FN mod 208 =0 shall occur at the same time in both cells.

When extended DRX (eDRX) is supported in a routing area (RA) time synchronization is required such that any given timeslot number (TN) and frame number (FN) shall occur at the same time in all cells within the RA subject to an allowed tolerance. The timebase counters of different BTSs shall be synchronized together such that the timing difference between different BTSs (allowed tolerance) shall be less than 4 seconds measured at the BTS antenna.

5.3 Internal BTS carrier timing

The channels of different carriers transmitted by a BTS shall be synchronized together, i.e. controlled by the same set of counters. The timing difference between the different carriers shall be less than ¼ normal symbol periods, measured at the BTS antenna.

For pico-BTS and Local Area multicarrier BTS, the timing difference between different carriers shall be less than 2 symbol periods, measured at the BTS antenna.

5.4 Timing advance estimation

5.4.1 Initial timing advance estimation

When the BTS detects an access burst transmission on RACH, PRACH, or one or a sequence of access burst(s) on EC-RACH, it shall measure the delay of this signal relative to the expected signal from an MS at zero distance under static channel conditions. This delay, called the timing advance, shall be rounded to the nearest normal symbol period and included in a response from the BTS when applicable.

For the pico-BTS and Local Area multicarrier BTS, there is no requirement to measure this timing advance. However, either this measured value or a programmable value of timing advance shall be included in the response from the BTS when a timing advance value needs to be sent.

5.4.2 BTS Timing Advance Estimation for Positioning

A higher level of accuracy of the timing advance estimation by the BTS (reported to the SMLC, see 3GPP TS 43.059 [6]) is desired when the following positioning procedures are used:

- Multilateration Timing Advance procedure for assessing the timing advance in the serving cell and in non-serving cells, and
- Multilateration Observed Time Difference procedure for assessing the timing advance in the serving cell,

The actual algorithms and methods for estimation of the timing advance value are implementation dependent.

Moreover, a BSC that reports a timing advance value based on transmissions from an MS (e.g. the EC Multilateration Request message or EGPRS Multilateration Request message, see 3GPP TS 44.018 [8] and 3GPP TS 44.060 [9]) using the RLC Data Block or the Extended Access Burst method, shall establish a reported timing advance value = $\overline{t_{A_{Reported}}}$. It does so by first using the BTS estimated TA value = $t_{A_{Estimated}}$ (based on the AB received on the RACH or on the EC-RACH (including blind physical layer transmissions for CC2, CC3 and CC4) identified when the MS starts the positioning procedure and using it as the assigned TA value = $t_{A_{Assigned}}$ (i.e. the TA value sent to the MS using an assignment message on the AGCH/EC-AGCH is the value of the $t_{A_{Estimated}}$ rounded off to the nearest symbol). It then adjusts the most recent estimated TA value as it receives subsequent updated timing advance estimation values from the BTS (i.e. the BTS provides an updated timing advance estimation for each subsequent burst it receives from the MS for the remainder of the positioning procedure wherein each burst sent by the MS uses the assigned TA).The final reported TA value ($\overline{t_{A_{Reported}}}$) is calculated by the BSC after it has received the last estimated TA value from the BTS based on the last transmission from the MS for the current positioning procedure and takes into account the MS Transmission Offset sent by the MS during the procedure (see 3GPP TS 44.018 [8] and 3GPP TS 44.060 [9] and 3GPP TS 43.059 [6]). This is shown in the formulas below.

$$\overline{t_{A_{Reported}}} = \frac{1}{N}\sum_{i=1}^{N} t_{A_i} \quad (1)$$

where

$$t_{A_1} = t_{A_{Estimated_1}} + t_{MS\,Transmisson\,Offset} \quad (2)$$

$$t_{A_{i=2...N}} = t_{A_{Estimated_i}} + t_{A_{Assigned}} + t_{MS\,Transmisson\,Offset} \quad (3)$$

where $t_{MS\,Transmisson\,Offset}$ corresponds to the time as reported by the MS in the “MS Transmission Offset IE” (see 3GPP TS 49.031 [18]).

For the Extended Access burst method the number of timing advance estimations is N= 2 wherein both the RACH burst and the Extended Access burst are used for timing advance estimation. Similarly, for the RLC Data Block method the number of timing advance estimations correspond to N=5 (for the case of no HARQ retransmissions needed on the (EC-)PDTCH) wherein the AB received on RACH or EC-RACH and the 4 normal bursts used to receive the RLC data block are used for timing advance estimation.

Moreover, a BTS estimating the timing advance value for an MS using the RLC Data Block or the Extended Access Burst methods will be subject to an accuracy limitation inherent to its implementation and the radio conditions applicable when receiving transmissions from the MS performing the Multilateration Timing Advance procedure. This accuracy limitation is expressed as an assessment error of the reported TA value $\overline{t_{A_{Reported}}}$ and shall be reported (to the SMLC via the BSS) as the BTS Reception Accuracy Level (see 3GPP TS 43.059 [6] and 3GPP TS 49.031 [18]) wherein the assessment error corresponds to the variance of the reported timing advance value of multiple timing advance estimations according to the equations below where N denotes the number of timing advance estimations and t_{Ai}, i=1...N denotes the estimated timing advance in estimation 'i'.

The variance $var\left(\overline{t_{A_{Reported}}}\right)$of the estimated timing advance value shall be evaluated using the formula:

$$var(\overline{t_{A\_Reported}}) = \frac{s^2}{N} \quad (4)$$

s^2 is the unbiased sample variance

$$s^2 = \frac{1}{N-1}\sum_{i=1}^{N}\left(t_{A_i} - \overline{t_{A_{Reported}}}\right)^2 \quad (5)$$

where $\overline{t_{A_{Reported}}}$ and t_{A_i} are calculated per the equations (1), (2) and (3) above.

For the Access Burst method the reported timing advance value corresponds to the estimated timing advance value derived from receiving the AB containing the EC Multilateration Request message or EGPRS Multilateration Request message.

When reporting the timing advance value to the SMLC the $\overline{t_{A_{Reported}}}$ is rounded off to the nearest 1/64 of a normal symbol period (see 3GPP TS 49.031 [18]).

Similarly, for the SMLC to be able to accurately estimate the number of required BTSs to be used during the Multilateration Timing Advance procedure (in order to meet a targeted positioning accuracy) each individual BTS shall provide the BSC with BTS Reception Accuracy Capability information (see 3GPP TS 49.031 [18]) as follows:

- with a guaranteed timing advance assessment error, it shall always be capable of supporting at radio conditions down to the reference sensitivity level for RACH, if the BTS is capable of PEO operation, for all MTA radio access methods supported by the BTS. The BTS Reception Accuracy Capability shall be evaluated at the reference sensitivity level for PRACH/11 bits as specified in TS 45.005 [11].
- with a guaranteed timing advance assessment error, it shall always be capable of supporting at radio conditions down to the input signal level for reference performance for EC-RACH (CC1), if the BTS is capable of EC operation, for all MTA radio access methods supported by the BTS. The BTS Reception Accuracy Capability shall be evaluated at the input signal level for reference performance for EC-RACH (CC1) as specified in TS 45.005 [11].

The BSC, in turn, reports this guaranteed timing advance assessment error value as the applicable BTS Reception Accuracy Capability in the Assistance Information Response message sent to the SMLC in response to an Assistance Information Request message (see 3GPP TS 43.059 [6]).

The BTS shall comply with the indicated BTS reception Accuracy Capability in 90 % of the timing advance estimations.

5.5 Maximum timing advance value

The maximum timing advance value TA_{max} shall be 63. If the BTS measures a value larger than this, it shall set the timing advance to 63. In the case of GSM 400 the extended timing advance information element is supported and the maximum timing advance value TA_{max} shall be 219. If the BTS measures a value larger than this, it shall set the timing advance to 219. (3GPP TR 43.030 defines how the PLMN deals with MS's where the delay exceeds timing advance value 63).

NOTE: The timing advance is always calculated in terms of number of symbols with normal symbol period irrespective of the actual symbol period used on the uplink.

5.6 Delay tracking

5.6.1 For circuit switched channels

For an MS in dedicated mode, the BTS shall thereafter continuously monitor the delay of the normal bursts sent by from the MS. If the delay changes by more than one symbol period, the timing advance shall be advanced or retarded 1 and the new value signalled to the MS.

Restricting the change in timing advance to 1 symbol period at a time gives the simplest implementation of the BTS. However the BTS may use a larger change than this but great care must then be used in the BTS design.

5.6.2 For packet switched channels

The BTS shall perform the continuous timing advance procedure for all MS working in packet transfer mode or in broadcast/multicast receive mode for which an PTCCH subchannel is assigned, except for an MS in dual transfer mode. Therefore the BTS shall monitor the delay of the access bursts sent by the MS on PTCCH and respond with timing advance values for all MS performing the procedure on that PDCH. These timing advance values shall be sent via a downlink signalling message on PTCCH. PTCCH shall not be assigned in case of an EC-GSM-IoT capable MS in EC operation.

The BTS shall update the timing advance values in the next downlink signalling message following the access burst.

The BTS may also monitor the delay of the normal bursts and access bursts sent by the MS on PDTCH and PACCH. Whenever an updating of TA is needed, the BTS may send the new TA value in a power control/timing advance message (see 3GPP TS 44.060).

For an MS in dual transfer mode the BTS shall follow the procedure described in subclause 5.6.1.

5.6.3 Delay assessment error

For circuit and packed switched channels, the delay shall be assessed in such a way that the assessment error (due to noise and interference) is less than ½ normal symbol periods for stationary MS. For MS moving at a speed up to 500 km/h the additional error shall be less than ¼ normal symbol period. For EC-GSM-IoT MS assigned CC2, CC3 or CC4 (see 3GPP TS 45.002) on the UL, the assessment error shall be less than ¾ normal symbol period for MS moving at a speed up to 50 km/h.

The control loop for the timing advance shall be implemented in such a way that it will cope with MSs moving at a speed up to 500 km/h, except for EC-GSM-IoT MS when it enters EC operation, where 50 km/h applies.

5.6.4 Pico-BTS and Local Area multicarrier BTS delay tracking

The pico-BTS and the Local Area multicarrier BTS have no requirement to track timing advance for any class of channels. However, it shall include either the measured timing advance as specified above or a programmable timing advance value in the response from the BTS when a timing advance value needs to be sent.

5.7 Timeslot length

5.7.0 Implementation options

Optionally, the BTS may use a timeslot length of 157 normal symbol periods on timeslots with TN = 0 and 4, and 156 normal symbol periods on timeslots with TN = 1, 2, 3, 5, 6, 7, rather than 156,25 normal symbol periods on all timeslots. This implementation option is illustrated in figure 5.7.4. When reduced symbol period is implemented, this option is further elaborated in subclause 5.7.2.

A BTS shall follow the implementation option of timeslot length with integer symbol periods for normal symbol periods, see subclause 5.7.2, on all transceivers in case EC-channels (EC-SCH, EC-BCCH, EC-CCCH, EC-PDTCH, or EC-PACCH) are mapped onto one or more transceiver resources.

Figure 5.7.1: void

5.7.1 Regular implementation with timeslot lengths of non-integral symbol periods

If the timeslot length for normal symbol period burst is 156.25 normal symbol periods for all bursts, then, a timeslot of length 187.5 reduced symbol periods shall be used for all bursts using reduced symbol period. This case is shown in Figure 5.7.2 and Table 5.7.1. In this case if there is a pair of different symbol period bursts on adjacent timeslots, then the guard period between the two bursts shall be 8.5 normal symbol periods which equals 10.2 reduced symbol periods.

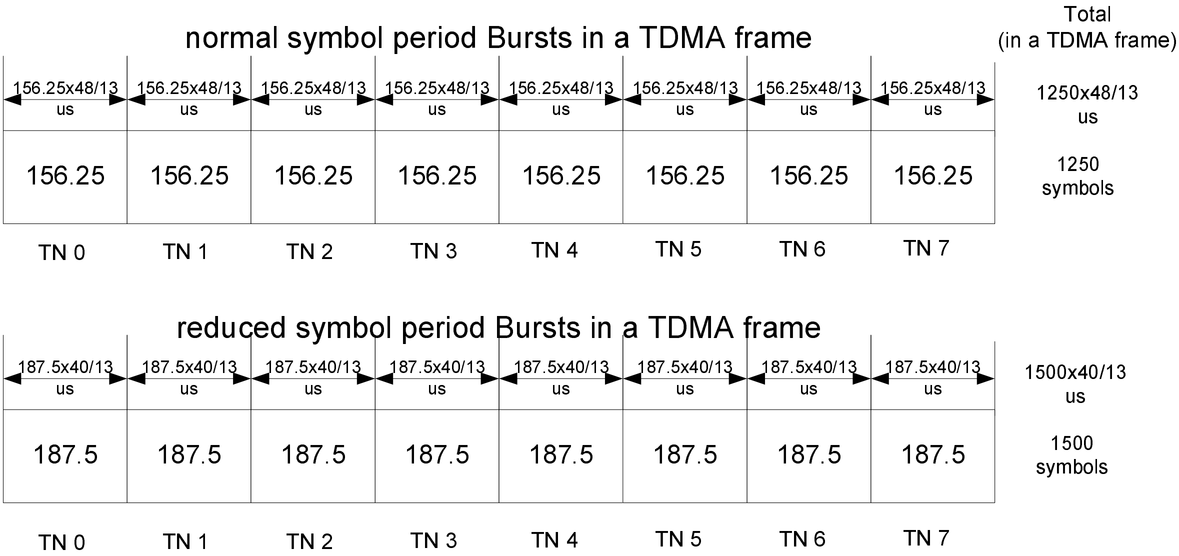

Figure 5.7.2: Implementation using non integral number of symbol periods in both Normal Symbol Period burst and Reduced Symbol Period bursts.

Irrespective of the symbol duration used, the centre of the training sequence shall occur at the same point in time. This is illustrated in Figure 5.7.3 below. This means that the active part of a reduced symbol period burst shall start 12/13 µs (which is a quarter of a normal symbol period) later in time and ends 12/13 µs earlier.

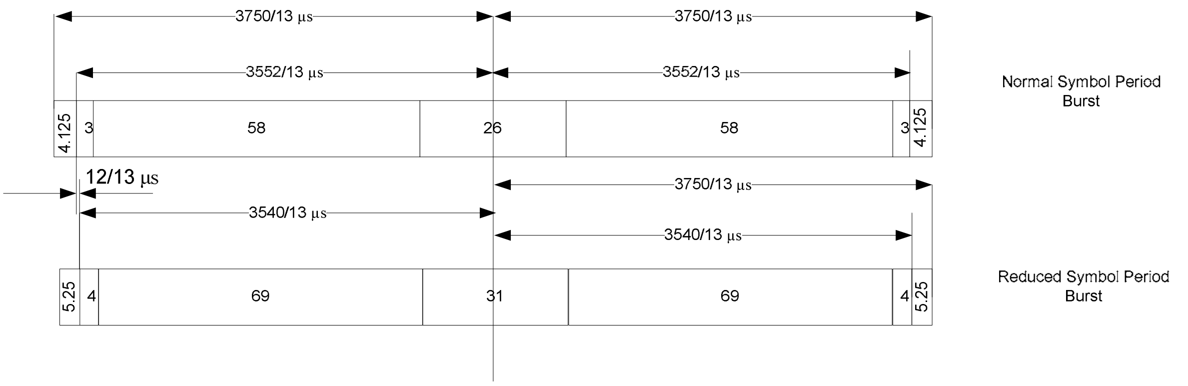

Figure 5.7.3: Timing alignment between normal symbol period and reduced symbol period bursts

The duration of various components of the timeslot are illustrated in Table 5.7.1.

Table 5.7.1: Duration of various components of the time slot

	reduced symbol period Bursts		normal symbol period Bursts	
	Symbols	**Duration (µs)**	**Symbols**	**Duration (µs)**
Tail (left)	4	$\frac{160}{13}$	3	$\frac{144}{13}$
Encrypted symbols (left)	69	$\frac{2760}{13}$	58	$\frac{2784}{13}$

Training sequence	31	$\frac{1240}{13}$	26	$\frac{1248}{13}$
Encrypted symbols (right)	69	$\frac{2760}{13}$	58	$\frac{2784}{13}$
Tail (right)	4	$\frac{160}{13}$	3	$\frac{144}{13}$
Guard period	10.5	$\frac{420}{13}$	8.25	$\frac{396}{13}$
Total	187.5	$\frac{7500}{13}$	156.25	$\frac{7500}{13}$

5.7.2 Implementation option for reduced symbol period bursts when integral symbol period option is used for normal symbol period bursts

In this implementation option, the length of timeslots for the burst with reduced symbol period shall be 188.4 reduced symbol periods for TN = 0, 4 and 187.2 reduced symbol periods for TN = 1, 2, 3, 5, 6, 7. This implementation is shown in Figure 5.7.4.

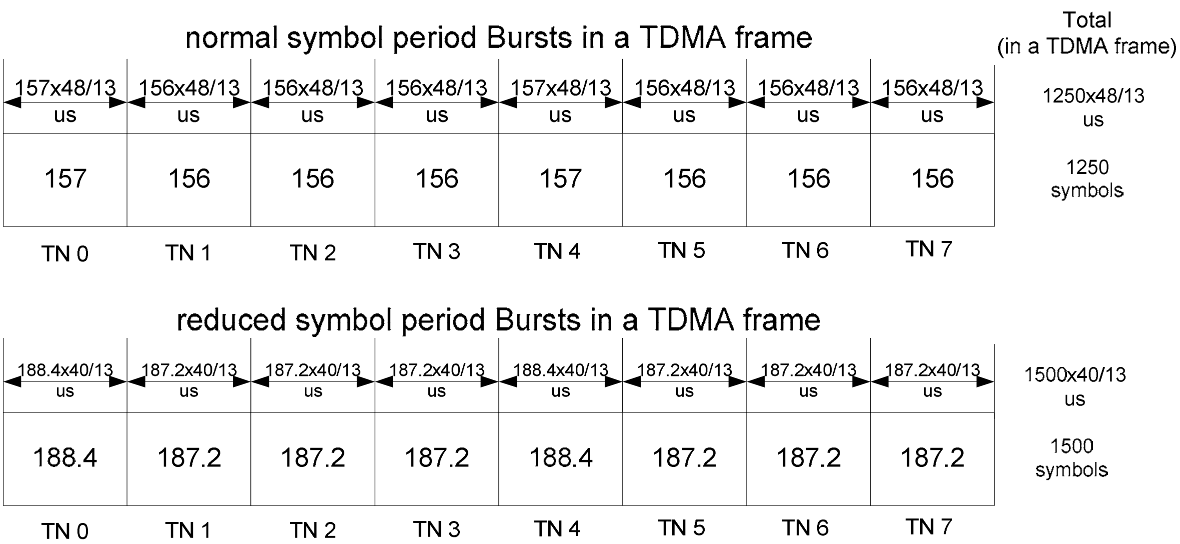

Figure 5.7.4: Implementation allowing integral number of symbol periods for normal symbol period bursts

The different burst lengths shall be obtained by changing the guard period lengths to values other than what is described in Table 5.7.1. The guard period lengths on adjacent timeslots shall be as described in Table 5.7.2.

Table 5.7.2: Guard period lengths between different timeslots

Burst Transition	Guard Period Between Timeslots (In terms of normal symbol periods)	Guard Period Between Timeslots (In terms of reduced symbol periods)

	TN0 and TN1 or TN4 and TN5	Any other timeslot pair	TN0 and TN1 or TN4 and TN5	Any other timeslot pair
normal symbol period to normal symbol period	9	8	10.8	9.6
normal symbol period to reduced symbol period	9.25	8.25	11.1	9.9
reduced symbol period to normal symbol period	9.25	8.25	11.1	9.9
reduced symbol period to reduced symbol period	9.5	8.5	11.4	10.2

5.8 Range of Timing advance

The timing advance shall be in the range 0 to TA_{max} (see subclause 5.5). The value 0 corresponds to no timing advance, i.e. the MS transmissions to the BTS are 468,75 symbol periods behind (see subclause 6.4). The value TA_{max} corresponds to maximum timing advance, i.e. the MS transmissions are 468,75 - TA_{max} symbol periods behind.

6 MS Requirements for Synchronization

6.0 General

The MS shall only start to transmit to the BTS if the requirements of subclauses 6.1 to 6.4 are met.

The conditions under which the requirements of subclauses 6.1 to 6.4 must be met shall be 3 dB below the reference sensitivity level or input level for reference performance, whichever applicable, in 3GPP TS 45.005 and 3 dB less carrier to interference ratio than the reference interference ratios or the interference ratios for reference performance, whichever applicable, in 3GPP TS 45.005. For EC-GSM-IoT, the conditions shall be met at the input signal level and at the interference ratios of EC-SCH at reference performance, as defined in 3GPP TS 45.005.

In discontinuous reception (DRX), the MS should meet the requirements of subclauses 6.1 to 6.3 during the times when the receiver is required to be active.

For CTS, the CTS-MS shall fulfil all the requirements of subclauses 6.1 to 6.4, 6.7, 6.8, 6.10 and 6.11 where «BTS» designates the CTS-FP. The CTS-MS shall always use a TA value of zero. The CTS-MS shall only start to transmit to the CTS-FP if the requirements of subclauses 6.1 to 6.4 are met. The conditions under which the requirements of subclauses 6.1 to 6.4 must be met shall be 3 dB below the reference sensitivity level or input level for reference performance, whichever applicable, in 3GPP TS 45.005 and 3 dB less carrier to interference ratio than the reference interference ratios in 3GPP TS 45.005. In discontinuous reception (DRX), the CTS-MS should meet the requirements of subclauses 6.1 to 6.3 during the times when the receiver is required to be active.

6.1 MS carrier frequency

The MS carrier frequency shall be accurate to within 0.1 ppm, or accurate to within 0.1 ppm compared to signals received from the BTS, except for GSM 400 where 0.2 ppm shall apply in both case (these signals will have an apparent frequency error due to BTS frequency error and Doppler shift). In the latter case, the signals from the BTS must be averaged over sufficient time that errors due to noise or interference are allowed for within the above 0.1 ppm and 0.2 ppm figure. The MS shall use the same frequency source for both RF frequency generation and clocking the timebase.

6.2 Internal timebase

The MS shall keep its internal timebase in line with that of signals received from the BTS. If the MS determines that the timing difference exceeds 2 µ seconds, it shall adjust its timebase in steps of ¼ normal symbol period. This adjustment shall be performed at intervals of not less than 1 second and not greater than 2 seconds until the timing difference is less than ½ normal symbol periods.

6.3 Assessment of BTS timing

6.3.1 General

In determining the timing of signals from the BTS, the timings shall be assessed in such a way that the timing assessment error is less than ½ normal symbol periods. The assessment algorithm must be such that the requirements of 6.2 can be met.

6.3.2 MS Assessment of BTS timing for Positioning

A higher level of accuracy of the assessment of the BTS timing by the MS (reported to the SMLC, see 3GPP TS 43.059 [6]) is desired when the following positioning procedures are used:

- Multilateration Timing Advance procedure for assessing the TA in the serving cell and in non-serving cells, and
- Multilateration Observed Time Difference procedure for assessing the TA in the serving cell,The Initial LLC-PDU received from the MS;

During the positioning procedure the minimum requirement on the error assessment of the BTS timing by the MS at and above the reference sensitivity level of the SCH or, in the case of EC operation, at and above the input signal level of the EC-SCH at reference performance, shall be ± ¼ normal symbol period unless the MS Sync Accuracy the MS can realize when performing the positioning procedure in a given cell meets a tighter requirement for the assessment of the BTS timing than the default value (indicated in the MSRAC IE - see 3GPP TS 24.008). In this case the value of the MS Sync Accuracy sent by the MS indicates the tighter requirement. Furthermore, to meet the targeted positioning accuracy for a targeted number of BTSs the SMLC determines a target assessment of BTS timing required of the MS and includes this as the Requested MS Sync Accuracy in the triggering RRLP message when indicating to the MS to use the RLC Data block or Extended Access burst method (see 3GPP TS 43.059 [6] and 3GPP TS 49.031[18]).

The MS shall attempt to achieve the Requested MS Sync Accuracy using a minimum of 2 or a maximum of 10 repeated synchronizations to the same BTS and report the achieved error in the assessment of the sync accuracy (i.e. assessment of BTS timing on the downlink) in the uplink RLC data block or the Extended Access Burst as the MS Sync Accuracy. The error of the sync accuracy corresponds to the variance of the estimated timing of multiple repeated synchronizations according to the equations below where N denotes the number of independent synchronization attempts and t_i, i=1...N denotes the estimated timing in synchronization 'i'.

The variance $var(\bar{t})$ of the estimated timing shall be evaluated using the formula:

$$var(\bar{t}) = \frac{s^2}{N}$$

s^2 is the unbiased sample variance

$$s^2 = \frac{1}{N-1}\sum_{i=1}^{N}(t_i - \bar{t})^2$$

and $\bar{t}$ is the mean of t_i, i.e.

$$\bar{t} = \frac{1}{N}\sum_{i=1}^{N} t_i$$

Similarly, to support accurate positioning using the Multilateration Observed Time Difference (OTD) procedure, a higher level of accuracy of the assessment of BTS timing is required in order to determine the difference in arrival time between (EC-)SCH synchronization sequences of two base station transmissions which is reported to the network in the

RRLP Multilateration OTD Response message. At and above the reference senstivity level of the SCH or, in the case of EC operation, at and above the input signal level of the EC-SCH at reference performance (see 3GPP TS 45.005 [11]), the absolute value of a Multilateration OTD report's error shall be ≤ ¼ normal symbol period. An MS applying the Multilateration OTD procedure shall report in the OTD Measurement Information IE the achieved assessment error of the BTS timing, according to the formulas above in this clause, as the MS Sync Accuracy for the respective neighbour cell.

6.4 Timing of transmission

The MS shall time its transmissions to the BTS according to signals received from the BTS. The MS transmissions to the BTS, measured at the MS antenna, shall be 468,75-TA normal symbol periods (i.e. 3 timeslots-TA) behind the transmissions received from the BTS, where TA is the last timing advance received from the current serving BTS. The tolerance on these timings shall be ± 1 normal symbol period. For CTS, the tolerance on these timings shall be ± ½ normal symbol period.

For an MS that transmits to a BTS in response to a RRLP Multilateration Timing Advance Request or RRLP Multilateration Observed Time Difference message (see 3GPP TS 43.059 [6]) the requirement on tolerance on the timings of its transmissions, when operating at and above the reference sensitivity level of the SCH or, in the case of EC operation, at and above the input signal level of the EC-SCH at reference performance (see 3GPP TS 45.005 [11]), shall be ±1/8 normal symbol period or better. In addition, immediately prior to transmitting to a BTS while performing Multilateration Timing Advance procedure using the RLC Data Block method or the Extended Access Burst Method (see 3GPP TS 44.018 [8] and 3GPP TS 43.059 [6]), the MS shall also calculate the offset between the nominal transmission opportunity, as determined in relation to the estimated timing of the BTS, and the selected transmission opportunity, as dictated by the internal timebase. The offset shall be reported as the MS Transmission Offset in the uplink RLC data block or in the Extended Access Burst [6]. If the selected uplink transmission opportunity occurs earlier than the nominal transmission opportunity, the MS transmission Offset shall be reported as a positive value. Similarly, if the selected uplink transmission opportunity occurs later than the nominal transmission opportunity, the MS transmission Offset shall be reported as a negative value. Note that upon receiving an assigned TA value the resulting new transmission opportunity (selected according to the nearest available timebase specific transmission opportunity identified after applying the indicated TA value) needs to be in the same direction as before, i.e., if before receiving an assigned TA value the selected uplink transmission opportunity (selected using the nearest available timebase specific transmission opportunity) occurred earlier than the nominal transmission opportunity then the MS shall establish a new nominal transmission opportunity using the indicated TA value and then select an uplink transmission opportunity (selected using the nearest available timebase specific transmission opportunity) that occurs earlier than the new nominal transmission opportunity (and similarly for the case where the selected uplink transmission opportunity occurred later than the nominal transmission opportunity).

In case of a multislot configuration, the MS shall use a common timebase for transmission of all channels. In this case, if the MS, not in EC operation, does not support transmission of reduced symbol period bursts, it may optionally use a timeslot length of 157 normal symbol periods on timeslots TN = 0 and 4, and 156 normal symbol periods on timeslots with TN = 1, 2, 3, 5, 6 and 7, rather than 156,25 normal symbol periods on all timeslots. An EC-GSM-IoT MS, when in EC operation, shall use the timeslot length with integer symbol periods, see subclause 5.7.2.

If the MS supports reduced symbol period transmissions, it shall use a timeslot length of 187.5 reduced symbol periods or a timeslot of length 156.25 normal symbol periods. When there is a pair of different symbol period bursts on adjacent timeslots, then the guard period between the two bursts shall be 8.5 normal symbol periods which equals 10.2 reduced symbol periods. The active part of a reduced symbol period burst shall start a quarter of a normal symbol period later compared to a normal symbol period burst as shown in Figure 5.7.3.

In case of a circuit switched multislot configuration, the common timebase shall be derived from the main channel and the TA values received on other channels shall be neglected. In case of a packet switched multislot configuration the common timebase shall be derived from all timeslots monitored by the MS. In this case, the MS may assume that the BTS uses a timeslot length of 156,25 normal symbol periods on all timeslots using normal symbol period and a timeslot length of 187,5 reduced symbol periods on all timeslots using reduced symbol period. In the case of a combination of circuit and packet switched channel configuration the MS may derive the common timebase from the circuit switched channel only.

6.5 Application of Timing Advance

6.5.1 For circuit switched channels

When the MS receives a new value of TA from the BTS on the SACCH, it shall implement the new value of TA at the first TDMA frame belonging to the next reporting period (as defined in 3GPP TS 45.008), after the SACCH frame containing the new TA value. On channels used for a voice group call, the TA value sent by the BTS applies only to an MS currently allocated the uplink.

The MS shall signal the used TA to the BTS on the SACCH.

6.5.2 For packet switched channels

The following requirements apply for all MS in packet transfer mode or in broadcast/multicast receive mode:

The MS shall transmit access bursts (AB, see 3GPP TS 45.002) with TA value=0.

Within the packet resource assignments (see 3GPP TS 44.018 and 3GPP TS 44.060) for uplink or downlink messages the MS gets the Timing Advance Index (TAI). If a PTCCH subchannel is assigned to the MS, the MS shall send access bursts on the subchannel defined by the TAI on the PTCCH. These access bursts received on PTCCH are used by the BTS to derive the timing advance.

When the MS receives the updated value of TA from the BTS on the downlink PTCCH, it shall always use the last received TA value for the uplink transmission of normal bursts.

If an MS is allocated different TAI values for simultaneous uplink and downlink packet transfer, the MS may choose to use any one or both PTCCH subchannels. If two subchannels are used, the MS shall always use the received TA value corresponding to the last transmitted PTCCH uplink burst. If the MS has been assigned TAIs for both UL and DL and if either the last UL or the last DL TBF is released, the MS shall use the TAI assigned for the remaining direction of data transfer.

If the MS receives a packet resource assignment or power control/timing advance message (see 3GPP TS 44.018 and 3GPP TS 44.060) without a TAI for the corresponding UL or DL TBFs, the MS shall not use the old assigned TAI for the continuous timing advance procedure for that direction of data transfer. If no more TAIs are valid the MS shall not perform the continuous timing advance procedure at all.

Upon initiation of the continuous timing advance procedure the MS shall disregard the TA values on PTCCH until it has sent its first access burst on PTCCH.

The network may request the MS to send 4 access bursts to calculate a new TA value. For this purpose, the network sets the system information element CONTROL_ACK_TYPE to indicate that the MS is to respond with a PACKET_CONTROL_ACKNOWLEDGEMENT consisting of 4 access bursts (see 3GPP TS 44.060), and sends a PACKET_POLLING_REQUEST to the MS. In this case, the MS shall transmit 4 consecutive access bursts on the assigned resources.

If the MS receives a packet resource assignment or power control/timing advance message (see 3GPP TS 44.018 and 3GPP TS 44.060), the MS shall use the included TA value for normal burst transmissions until it receives a new value on PTCCH. If the message does not contain a TA value, the MS shall not change its TA value.

When entering packet transfer mode or broadcast/multicast receive mode, the MS is not allowed to transmit normal bursts until it has received a valid TA value by any of the methods described above.

An MS in dual transfer mode shall follow the procedures described in subclause 6.5.1. If the CS connection is released and the MS leaves dual transfer mode to enter packet transfer mode, the MS shall follow the procedures described in the present subclause. The MS shall perform the continuous timing advance procedure if a TAI is contained in the packet CS release indication message (see 3GPP TS 44.060). The mobile station shall use the last value of the timing advance received whilst in dual transfer mode until a new value of the timing advance is determined from the continuous timing advance procedure or is received from the network.

6.6 Access to a new BTS

When the MS accesses a new BTS or the serving BTS is changed, or the MS initiates a packet transfer, or the MS performs a multilateration access attempt using the Access burst method or Extended Access Burst method (see 3GPP TS 43.059), the MS shall change the TA as follows:

Random access and Packet random access:

- the MS shall use a TA value of 0 for the Random Access burst (AB), Extended Synchronisation Access Burst (ESAB) and Extended Dual Slot Access Burst (EDAB), see 3GPP TS 45.002. When a TA is received from the BTS that TA shall be used.

- the MS shall use the assigned TA value received within a corresponding Acknowledgement on the (EC-)AGCH for the Extended Access Burst (Extended AB), see 3GPP TS 45.002.

Synchronized or Pseudo Synchronized circuit-switched handover:

- after the HANDOVER ACCESS bursts which shall be sent with a TA value of 0 the MS shall use a TA calculated as specified in annex A. When a TA is received from the new BTS that TA shall be used. The transmission of the HANDOVER ACCESS bursts is optional if so indicated by the BTS.

Synchronized packet-switched handover:

- after the PS HANDOVER ACCESS bursts which shall be sent with a TA value of 0 the MS shall use a TA calculated as specified in annex A. When a TA is received from the new BTS that TA shall be used. The transmission of the PS HANDOVER ACCESS bursts is optional if so indicated by the BTS.

In those cells that support extended TA values if TA value in new cell is greater than 63 and the HANDOVER COMMAND message indicates that the transmission of four HANDOVER ACCESS messages is optional the MS shall not transmit these four messages.

Non-synchronized circuit-switched handover:

- the MS shall use a TA value of 0 for the HANDOVER ACCESS bursts sent. When a TA is received in a PHYSICAL INFORMATION message that TA shall be used. Before a TA is received from the new BTS no valid "used TA" shall be signalled to the new BTS.

Non-synchronized packet-switched handover:

- the MS shall use a TA value of 0 for the PS HANDOVER ACCESS bursts sent. When a TA is received in a PACKET PHYSICAL INFORMATION message that TA shall be used. Before a TA is received from the new BTS no valid "used TA" shall be signalled to the new BTS.

Pre-synchronized circuit-switched handover:

- after the HANDOVER ACCESS bursts which shall be sent with a TA value of 0 the MS shall use a TA as specified in the HANDOVER COMMAND message by the old BTS, or a default value of 1, if the old BTS did not provide a TA value. The transmission of the HANDOVER ACCESS bursts is optional if so indicated by the BTS.

Pre-synchronized packet-switched handover:

- after the PS HANDOVER ACCESS bursts which shall be sent with a TA value of 0 the MS shall use a TA as specified in the PS HANDOVER COMMAND message by the old BTS, or a default value of 1, if the old BTS did not provide a TA value. The transmission of the PS HANDOVER ACCESS bursts is optional if so indicated by the BTS.

In those cells that support extended TA values if TA value in new cell is greater than 63 and the HANDOVER COMMAND message (respectively PS HANDOVER COMMAND message) indicates that the transmission of four HANDOVER ACCESS messages (respectively PS HANDOVER ACCESS messages) is optional the MS shall not transmit these four messages.

6.7 Temporary loss of signal

During a temporary total loss of signal, of up to 64 SACCH block periods, the MS shall update its timebase with a clock which is accurate to within 0,2 ppm, or to within 0,2 ppm of the signals previously received from the BTS.

6.8 Timing of channel change

When the MS receives an intracell channel change command or a circuit-switched handover command (see 3GPP TS 44.018) or a packet-switched handover command (see 3GPP TS 44.060), it shall be ready to transmit on the new channel within T_GSM_Delay of the last timeslot of the message block containing the command, unless the access is delayed to an indicated starting time, in which case it shall be ready to transmit on the new channel at the designated starting time, or within T_GSM_Delay, whichever is the later. The time between the end of the last complete speech or data frame or message block sent on the old channel and the time the MS is ready to transmit on the new channel shall be less than T_GSM_Interrupt.

T_GSM_Delay and T_GSM_Interrupt are defined in table 6.8.1.

Table 6.8.1: Channel change delay and interruption times.

Target cell	T_GSM_Delay (ms) (Note 1)	T_GSM_Interrupt (ms)
Synchronized GSM cell	120 ms	20 ms
Not Synchronized GSM cell Under good radio conditions	220 ms	120 ms
NOTE 1: In case of packet-switched handover, if the MS is required to transmit a PACKET CONTROL ACKNOWLEDGMENT message (see 3GPP TS 44.060), T_GSM_delay is increased by 40 ms.		

6.9 Application of new Timing Advance value

When the MS receives a new TA value in response to a handover access burst, the MS shall be ready to transmit using the new TA value within 40 ms of the end of the last timeslot of the message block containing the new TA value.

When the MS receives a new or updated TA value on the downlink PTCCH or downlink PACCH, the MS shall be ready to transmit using the new TA value within 40 ms of the end of the last timeslot of the message block containing the new TA value.

6.10 Definition of "ready to transmit within x ms"

The phrase "ready to transmit within x ms" means that the MS shall transmit no later than the first allowed transmission opportunity that occurs after the x ms, e.g. :

- the first burst of the first TCH or control channel block that occurs after the x ms, in case of an intracell channel change;
- the first burst of the TCH or control channel that occurs after the x ms, in case of a handover;
- the first burst of the PDTCH, EC-PDTCH or control channel that occurs after the x ms;
- the first allowed uplink frame (see 3GPP TS 25.212 and 3GPP TS 25.214 for FDD and 3GPP TS 25.222 for TDD), that occurs after the x ms, in case of an inter-RAT handover to a UTRAN cell.
- the first uplink PRACH frame or (for TDD only) UpPTS field (see 3GPP TS 36.211) that occurs after the x ms, in case of an inter-RAT handover to a E-UTRAN cell.

NOTE: The MS shall keep the timings of the neighbour GSM cells that it is monitoring (according to 3GPP TS 45.008) to an accuracy of ± 1 normal symbol periods.

6.11 Definition of additional reaction times for GPRS mobile stations

6.11.1 Uplink and downlink assignment reaction times

An MS shall be ready to transmit and receive using a new assignment 9 frame periods after the last radio block containing the assignment message. A mobile station that receives an assignment message for a new or ongoing TBF with FANR activated (see 3GPP TS 44.060) shall be ready to transmit and receive using the new assignment in the TDMA frame indicated in Table 6.11.1.1 where N = the last TDMA frame of the downlink block containing the assignment message.

Table 6.11.1.1: Assignment Reaction Time for a TBF with FANR activated

Assignment message block format	Full-rate PDCH uplink block with TDMA frame number
BTTI	(N+5 or N+6) mod 2715648
RTTI	(N+5 or N+6) mod 2715648

If the MS is required to transmit a PACKET CONTROL ACKNOWLEDGEMENT, or, in case of EC operation, the MS is required to transmit an EC PACKET CONTROL ACKNOWLEDGEMENT, subsequent to an assignment message (see 3GPP TS 44.060), the MS shall be ready to transmit and receive, or in case of EC operation transmit or receive, on the new assignment (i.e. after transmitting the PACKET CONTROL ACKNOWLEDGMENT, or, in case of EC operation, the EC PACKET CONTROL ACKNOWLEDGEMENT, using the old assignment) as follows:

- For a TBF operating in BTTI configuration or an EC TBF not using blind physical layer transmissions (CC1), no later than the next occurrence of block B((x+2) mod 12) where block B(x) is the radio block containing the PACKET CONTROL ACKNOWLEDGEMENT or EC PACKET CONTROL ACKNOWLEDGEMENT, respectively.

- For an EC TBF using blind physical layer transmissions the same reaction times as for BTTI configuration apply, where B(x) refers to the last BTTI period used by the blind physical layer transmissions of the EC PACKET CONTROL ACKNOWLEDGEMENT. For example, if the blind physical layer transmissions occur during two BTTI periods, the reaction time is measured from the last BTTI period used by the blind physical layer transmissions.

- For a TBF operating in RTTI configuration, no later than the next occurrence of block $B((x+1) \bmod 12)_b$ where block Bx_a is the radio block containing the PACKET CONTROL ACKNOWLEDGEMENT or no later than the next occurrence of block $B((x+2) \bmod 12)_a$ where block Bx_b is the radio block containing the PACKET CONTROL ACKNOWLEDGEMENT (see 3GPP TS 45.002 [10] for an explanation of RTTI radio block indexing applicable to the RTTI configuration).

- If the assignment message changes the TBF from BTTI to RTTI configuration, no later than the next occurrence of block $B((x+2) \bmod 12)_a$, where block Bx is the radio block containing the PACKET CONTROL ACKNOWLEDGEMENT.

- If the assignment message changes the TBF from RTTI to BTTI configuration, no later than the next occurrence of block B((x+2) mod 12), where block Bx_a or Bx_b is the radio block containing the PACKET CONTROL ACKNOWLEDGEMENT (see NOTE).

NOTE: This is to ensure the reaction time falls on a BTTI radio block boundary.

The reaction time applies also for the reception of the first USF for dynamic uplink assignment and extended dynamic uplink assignment, including when Shifted USF operation is used.

6.11.2 Change in channel coding scheme commanded by network

Upon receipt of a command from the network to change the channel coding scheme, the MS shall begin to transmit blocks using the new channel coding scheme as follows:

- For a TBF operating in BTTI configuration, or an EC TBF not using blind physical layer transmissions (CC1), no later than the next occurrence of block B((x+3) mod 12) where block B(x) is the radio block containing the command. For an EC TBF using blind physical layer transmissions, B(x) refers to the last BTTI period used by the blind physical layer transmissions of the block containing the command to change the channel coding scheme. For example, if the blind physical layer transmissions occur during two BTTI periods, the reaction time is measured from the last BTTI period used by the blind physical layer transmissions.

- For a TBF operating in RTTI configuration, no later than the next occurrence of block $B((x+2) \bmod 12)_b$ where block Bx_a is the radio block containing the command or no later than the next occurrence of block $B((x+3) \bmod 12)_a$ where block Bx_b is the radio block containing the command (see 3GPP TS 45.002 [10] for an explanation of RTTI radio block indexing applicable to the RTTI configuration).

6.11.3 Contention resolution reaction time

Upon contention resolution during one phase access, the mobile station shall start transmitting RLC data blocks without the TLLI field as follows:

- For a TBF operating in BTTI configuration, or an EC TBF not using blind physical layer transmissions (CC1), no later than the next occurrence of block B((x+3) mod 12) where block B(x) is the radio block containing the contention resolution message (see 3GPP TS 44.060). For an EC TBF using blind physical layer transmissions, B(x) refers to the last BTTI period used by the blind physical layer transmissions of the contention resolution message. For example, if the blind physical layer transmissions occur during two BTTI periods, the reaction time is measured from the last BTTI period used by the blind physical layer transmissions.

- For a TBF operating in RTTI configuration, no later than the next occurrence of block $B((x+2) \bmod 12)_b$ where block Bx_a is the radio block containing the contention resolution message or no later than the next occurrence of block $B((x+3) \bmod 12)_a$ where block Bx_b is the radio block containing the contention resolution message (see 3GPP TS 45.002 [10] for an explanation of RTTI radio block indexing applicable to the RTTI configuration).

6.11.4 Reaction time in response to other commanding messages

Upon a receipt of a commanding message or indication from the network requiring an action by the mobile station, if the reaction time for such action is not specified elsewhere, the mobile station shall begin to perform the required action as follows:

- For a TBF operating in BTTI configuration, or an EC TBF not using blind physical layer transmissions (CC1), no later than the next occurrence of block B((x+6) mod 12), where block B(x) is the radio block containing the commanding message or indication from the network. For an EC TBF using blind physical layer transmissions, B(x) refers to the last BTTI period used by the blind physical layer transmissions of the commanding message. For example, if the blind physical layer transmissions occur during two BTTI periods, the reaction time is measured from the last BTTI period used by the blind physical layer transmissions.

- For a TBF operating in RTTI configuration, no later than the next occurrence of block $B((x+5) \bmod 12)_b$ where block Bx_a is the radio block containing the commanding message/indication from the network or no later than the next occurrence of block $B((x+6) \bmod 12)_a$ where block Bx_b is the radio block containing the commanding message/indication from the network (see 3GPP TS 45.002 [10] for an explanation of RTTI radio block indexing applicable to the RTTI configuration).

6.11.5 PAN related reaction times

A mobile station that receives a PAN corresponding to an uplink TBF with FANR activated (see 3GPP TS 44.060) shall be ready to re-send the first missing uplink RLC data block in the TDMA frame indicated in Table 6.11.5.1 where N = the last TDMA frame of the downlink block containing the PAN.

Table 6.11.5.1: Reaction Time for receiving a downlink PAN

PAN block format	Full-rate PDCH uplink block with TDMA frame number
BTTI	(N+5 or N+6) mod 2715648
RTTI	(N+5 or N+6) mod 2715648

A mobile station that detects a missing/erroneous RLC data block for a downlink TBF with FANR activated (see 3GPP TS 44.060) shall be ready to send an uplink RLC/MAC block for data transfer with a PAN or an EGPRS PACKET DOWNLINK ACK/NACK or EGPRS PACKET DOWNLINK ACK/NACK TYPE 2 message (in the case that there is no uplink RLC data ready for transmission) reflecting the missing/erroneous block in the TDMA frame indicated in Table 6.11.5.2 where N = the last TDMA frame of the downlink block in which the MS detected the problem.

Table 6.11.5.2: Reaction Time for detecting a downlink problem

Downlink TBF block format	Full-rate PDCH uplink block with TDMA frame number
BTTI	(N+5 or N+6) mod 2715648
RTTI	(N+3 or N+4) mod 2715648

6.11.6 DTR related reaction times

A mobile station which is in DTR mode (see 3GPP TS 44.060) and receives a radio block which causes the MS to leave DTR mode shall be ready to receive data on all timeslots, in accordance with its uplink and/or downlink TBF assignment(s) in the TDMA frame indicated in Table 6.11.6.1 or Table 6.11.6.2 where N = the last TDMA frame of the downlink block triggering the leaving of DTR mode.

Table 6.11.6.1: Assignment Reaction Time for leaving DTR – MS supports FANR

Radio block format	Full-rate PDCH uplink block with TDMA frame number
BTTI	(N+5 or N+6) mod 2715648
RTTI	(N+5 or N+6) mod 2715648

Table 6.11.6.2: Assignment Reaction Time for leaving DTR – MS does not support FANR

Radio block format	Full-rate PDCH uplink block with TDMA frame number
BTTI	(N+9) mod 2715648

A mobile station shall enter DTR mode within the reaction time as specificied in Table 6.11.6.3 or Table 6.11.6.4 where N = the last TDMA frame of the radio block period in which all conditions for entering DTR were met.

Table 6.11.6.3: Assignment Reaction Time for entering DTR – MS supports FANR

Radio block format	Full-rate PDCH uplink block with TDMA frame number
BTTI	(N+5 or N+6) mod 2715648
RTTI	(N+5 or N+6) mod 2715648

Table 6.11.6.4: Assignment Reaction Time for entering DTR – MS does not support FANR

Radio block format	Full-rate PDCH uplink block with TDMA frame number
BTTI	(N+9) mod 2715648

6.12 Observed Frequency Offset (OFO) reported by the CTS-MS

When required the CTS-MS shall compute the Observed Frequency Offset between the CTS-FP and a specified BTS (see 3GPP TS 45.008). The CTS-FP and BTS received signals frequencies shall be estimated with an accuracy of 0,1 ppm, averaging the signals over sufficient time. The conditions under which this requirements must be met shall be 3 dB below the reference sensitivity level or input level for reference performance, whichever applicable, in 3GPP TS 45.005 and 3 dB less carrier to interference ratio than the reference interference ratios in 3GPP TS 45.005.

6.13 Timing of inter-RAT channel change from GSM to UTRAN

When the MS receives a PS HANDOVER COMMAND for packet-switched handover to UTRAN (see 3GPP TS 44.060) or an INTER SYSTEM TO UTRAN HANDOVER COMMAND (see 3GPP TS 44.018), it shall be ready to transmit on the new channel within Tdelay of the last timeslot of the message block containing the command, unless the access is delayed to an indicated starting time, in which case it shall be ready to transmit on the new channel at the designated starting time, or within Tdelay, whichever is the later. The time between the end of the last complete speech or data frame or message block sent on the old channel and the time the MS is ready to transmit on the new cell shall not exceed Tinterrupt. Tdelay and Tinterrupt are defined in table 6.13.1 for the case of inter-RAT handover to a single UTRAN cell assuming good radio conditions.

Table 6.13.1: Inter-RAT handover delay and interruption times.

Target cell	Tdelay (ms) (Note 1)	Tinterrupt (ms)
Known FDD cell (see 3GPP TS 25.133)	220	120
Not known FDD cell (see 3GPP TS 25.133)	320	220
Known TDD cell (see 3GPP TS 25.123)	190	90
Not known TDD cell (see 3GPP TS 25.123)	350	250
NOTE 1: In case of packet-switched handover, if the MS is required to transmit a PACKET CONTROL ACKNOWLEDGMENT message (see 3GPP TS 44.060), Tdelay is increased by 40 ms.		

6.13a Timing of inter-RAT channel change from GSM to E-UTRAN

When the MS receives a PS HANDOVER COMMAND for packet-switched handover to E-UTRAN (see 3GPP TS 44.060) or an INTER SYSTEM TO E-UTRAN HANDOVER COMMAND (see 3GPP TS 44.018), it shall be ready to transmit on the new channel within Tdelay of the last timeslot of the message block containing the command, unless the access is delayed to an indicated starting time, in which case it shall be ready to transmit on the new channel at the designated starting time, or within Tdelay, whichever is the later. The time between the end of the last complete data frame or message block sent on the old channel and the time the MS is ready to transmit on the new cell shall not exceed Tinterrupt. Tdelay and Tinterrupt are defined in Table 6.13a.1 for the case of inter-RAT handover to a single E-UTRAN cell assuming good radio conditions.

Table 6.13a.1: Inter-RAT handover delay and interruption times.

Target cell	Tdelay (ms) (Note 1)	Tinterrupt (ms)
Known FDD cell (see 3GPP TS 36.133)	150	50
Not known FDD cell (see 3GPP TS 36.133)	250	150
Known TDD cell (see 3GPP TS 36.133)	150	50
Not known TDD cell (see 3GPP TS 36.133)	250	150
NOTE 1: If the MS is required to transmit a PACKET CONTROL ACKNOWLEDGMENT message (see 3GPP TS 44.060), Tdelay is increased by 40 ms.		

6.14 Timing of combined intracell channel change and packet assignment

When the MS receives a combined intracell channel change command and packet assignment in either dedicated mode or dual transfer mode (see 3GPP TS 44.018), the requirements specified in sub-clause 6.8 shall apply to the new dedicated channel.

In addition, the MS shall be ready to transmit and receive using the packet assignment within T_GSM_delay of the last timeslot of the message block containing the command, unless the access is delayed to an indicated starting time, in which case it shall be ready to transmit on the new channel at the designated starting time, or within T_GSM_Delay, whichever is the later. This applies also for the reception of the first USF for dynamic uplink assignment.

The requirements for using the packet assignment apply also when the MS receives a stand-alone packet assignment (on the main DCCH), causing the transition from dedicated mode into dual transfer mode (see 3GPP TS 44.018).

T_GSM_delay is defined in sub-clause 6.8, table 6.8.1.

7 CTS-FP Requirements for Synchronization

7.1 Frequency source default requirements

The CTS-FP shall use a single frequency source of absolute accuracy better than 5 ppm for both RF frequency generation and clocking the timebase. The same source shall be used for all carriers of the CTS-FP.

7.2 Frequency source for a CTS-FP assisted by a CTS-MS

When the CTS-FP is informed of its Observed Frequency Offset with a BTS, the CTS-FP carrier frequency shall be accurate for one hour to within 2 ppm, or accurate for one hour to within 2 ppm according to the received Observed Frequency Offset.

However, if the Observed Frequency Offset is greater than 2 ppm, the CTS-FP frequency source correction shall have a slope of 0,1 ppm for 936 TDMA frames, i.e. 4,320 seconds.

7.3 Internal CTS-FP carrier timing

The channels of different carriers transmitted by a CTS-FP shall be synchronized together, i.e. controlled by the same set of counters. The timing difference between the different carriers shall be less than 2 symbol periods, measured at the CTS-FP antenna.

7.4 Timeslot length

Optionally, the CTS-FP may use a timeslot length of 157 symbol periods on timeslots with TN = 0 and 4, and 156 symbol periods on timeslots with TN = 1, 2, 3, 5, 6, 7, rather than 156,25 symbol periods on all timeslots.

7.5 Assessment of CTS-MS delay

In order to implement the procedure of control of the CTS-FP service range (specified in 3GPP TS 45.008), the CTS-FP shall monitor the delay of the CTS-MS signal relative to the expected signal from a CTS-MS at zero distance under static channel conditions. The delay of the normal bursts sent by from the CTS-MS shall be assessed in such a way that the assessment error (due to noise and interference) is less than ¼ symbol period. The conditions under which this requirement must be met shall be 3 dB below the reference sensitivity level or input level for reference performance, whichever applicable, in 3GPP TS 45.056 and 3 dB less carrier to interference ratio than the reference interference ratios in 3GPP TS 45.056.

Annex A (normative): Additional requirements for pseudo-synchronization, synchronized handovers and pseudo-synchronized handovers

A.1 General descriptions and definitions

A.1.1 Conventions

The following conventions are adopted in this annex:

- the modulating symbol period is denoted T = 48/13 µs;
- all timing values are considered for descriptive purposes as real numbers modulo the largest period defined in the system i.e. 3394560000T. When transmitted over the air interface, such a value shall be rounded to the nearest integer multiple of a ½ symbol period T/2 and that integer shall either be reduced mod some integer multiple of 256 or the full value shall be used as defined in 3GPP TS 44.018;
- the Timing Advance (TA) value, when the distance between the base station and the MS is equal to or less than 35 km, or in the case of GSM 400 is equal to or less than 120 km, represents the estimated two way propagation delay in T units. For the purpose of the calculations in this annex the timing advance values are considered to represent the estimated one way propagation delay in T/2 units which is equivalent to twice the delay in T units.

A.1.2 Definitions

Assuming that some MS has to perform handover from BTS 0 (the "current" or "old" BTS) to BTS 1 (the "new" BTS), the following quantities are defined.

- t_0 (resp. t_1) denotes the one way line of sight propagation delay between the MS and BTS 0 (resp. BTS 1).
- RTD (Real Time Difference) denotes the value of the local system time in BTS 0 minus that of BTS 1.
- OTD (Observed Time Difference) denotes the timing difference between BTS 0 and BTS 1 as measured by the MS with the same sign conventions as for RTD.

All these four values are slowly time-varying due to the MS movement and oscillators drift in the BTS's, but they are defined here just prior handover execution.

A.1.3 Details of operations

The following relation holds:

$$OTD = RTD + t_1 - t_0$$

Synchronized and pseudo synchronized handovers work as follows:

- for the pseudo synchronized circuit-switched handover, it is assumed that RTD is known to BTS 0 and MS supports the scheme, BTS 0 may order pseudo-synchronized handover to BTS 1, including RTD in the "HANDOVER COMMAND" message;
- for the synchronized circuit-switched or packet-switched handovers, BTS 0 may order synchronized handover to BTS 1, and the MS sets RTD as defined in subclause A.3.3;

- under normal operating conditions, t_0 should be closely related to the latest received Timing Advance sent by BTS 0 to the MS; since the MS must have got synch to BTS 1 before performing handover, OTD, RTD and t_0 are available to the MS, hence the value of t_1 that can be used to set the new Timing Advance parameter without receiving it from BTS 1;
- after successful circuit-switched handover, either synchronized, non-synchronized or pseudo-synchronized, the MS shall provide to BTS 1 the value of OTD + t_0 in the "HANDOVER COMPLETE" message, allowing BTS 1 to obtain a non biased estimate of RTD given the transmitted OTD + t_0 and it is estimated value to t_1. In practice, additional processing will be required to mitigate the effects of estimation errors and quantization effects; this matter is left unspecified.

A.2 BTS requirements

A.2.1 The pseudo-synchronization scheme

If the pseudo-synchronization scheme for circuit-switched handovers is supported, the BTS shall comply with the following requirements, in addition to those of the main part of the recommendations.

A.2.1.1 BTS a time difference estimate

The BTS shall maintain for each of a set of neighbouring BTS a time difference estimate encoded as in A 1.1. These time differences can be updated when a MS supporting the pseudo-synchronization scheme enters the cell via a handover: the MS provides the observed time difference corrected for the propagation time with the previous BTS but not corrected for the propagation to the current BTS. When the adaptive frame alignment process in the new BTS has assessed the propagation time, it is used to correct the observed time difference given by the MS and the result is used (possibly after some unspecified processing) to update the value of the time difference with the previous BTS. Other means for maintaining the time difference estimates may be used.

A.2.1.2 The reception epoch criterion

The reception epoch criterion used for evaluating the MS time shift (see subclause 5.6) shall be as close as possible to line of sight path reception epoch, so that with MS supporting the pseudo-synchronization scheme the timing advance for stationary MS is as close as possible to the double propagation delay.

A.2.1.3 Pseudo-synchronized handover

When a handover is requested, if the MS supports pseudo-synchronization, it may be chosen to order a pseudo-synchronized handover. In that case, the time difference between the two BTS, memorized as specified in A.2.1 and encoded as specified in subclause A.1.1 must be sent to the MS.

A.2.2 The synchronization scheme

If the synchronization scheme is supported, the BTS shall comply with the following requirements, in addition to those of the main part of the specifications.

The BTS shall maintain synchronization with a set of neighbouring BTS. In this context, synchronization means that the timing of the TDMA frame at the BTSs is the same, i.e. the timeslot zeros from the BTS transmitted are synchronous with the timeslot zeros of the carriers on the set of neighbouring BTSs. However, the frame numbers need not be the same. All timings are to be referenced at the BTS.

A.3 MS requirements

The MS shall comply to the following requirements.

A.3.1 Provision of time difference information

The reception epoch criterion used for clocking the timebase shall be as close as possible to line of sight path reception epoch so that the timing advance when the MS is stationary is as close as possible to the double propagation delay. However the quantization mentioned in subclause A.1.1 does not impose any additional requirement on the resolution of the measurement.

A.3.2 After each successful circuit-switched handover

After each successful circuit-switched handover the MS shall give to the new BTS the sum of the observed time difference and the last timing advance value received from the old BTS, if required by the BTS encoded as subclause A 1.1.

A.3.3 Synchronized or a pseudo synchronized handover

When a synchronized circuit-switched or packet-switched handover, or a pseudo synchronized circuit-switched handover occurs, the MS shall synchronize to the new BTS and shall use as initial timing advance value the value calculated modulo 256 from the observed time difference between the two BTS, the real time difference and the last timing advance value received from the previous BTS, according to subclause A.1.3. Calculated values between 230 and 255 shall be regarded as negative timing advance. The Real Time Difference (RTD) is in the case of pseudo synchronized handover given with the handover command and in the case of synchronized handover set to 2500*INT(OTD/2500+0,5) by the MS. If the initial timing advance value calculated is outside the range 0 to TA_{max} the MS shall do as follows:

- if the initial timing advance value calculated is greater than TA_{max}, the cell shall be considered as out of range. The MS shall, if it attempts to transmit on the new cell, use a timing advance value of TA_{max} as the initial timing advance value. Whether the MS transmits on the new cell or not depends on the NCI bit as specified in 3GPP TS 44.018;

- if the initial timing advance value calculated is less than 0, the MS shall use a timing advance value of 0 as the initial timing advance value.

Annex B (informative): CTSBCH timeslot shifting properties for CTS-MS synchronization

The determination of TN for CTS-MS synchronization is eased by specific properties of the CTSBCH timeslot shifting procedure. Three successive CTSBCH detection and decoding are always sufficient to set TN.

The CTSBCH shifting procedure may be either active or not. This is signalled by a flag in the CTSBCH-SB (see 3GPP TS 45.002).

B.1 Determination of TN by the CTS-MS when CTSBCH shifting is not active

When the CTSBCH shifting is not active, the CTSBCH TN is equal to the TNC found in the CTSBCH-SB.

Therefore, the CTS-MS sets TN to TNC when decoding the CTSBCH-SB.

B.2 Determination of TN by the CTS-MS when CTSBCH shifting is active

When the CTSBCH shifting procedure is active, the TN can be derived by the CTS-MS according to following procedure:

1) the CTS-MS detects 3 successive CTSBCH-FB, decodes the three associated CTSBCH-SB and stores the two timeslot shifts values between the three successive CTSBCH-FB;

2) the CTS-MS checks that the three FPBI (see 3GPP TS 45.002) extracted from the three CTSBCH-SB are identical and that the three CTSBCH shifting flags all indicate CTSBCH shifting active;

3) the CTS-MS extracts the TNSCN from the FPBI according to the rule defined in 3GPP TS 45.002;

4) the CTS-MS uses timeslot number series couple ($TNS_{TNSCN,0}$, $TNS_{TNSCN,1}$) (see 3GPP TS 45.002) and the two stored CTSBCH shift values to determine the three timeslot numbers of the three observed CTSBCH. Due to specific properties of the shifting series, only one mapping is possible.

Annex C (informative): BTS frequency source stability and E-OTD LMU reporting periods for LCS

C.1 BTS frequency source stability and E-OTD LMU reporting periods

E-OTD location systems require measurements of OTDs made at both the LMUs and MS. It is by comparing the two sets of OTDs that a location estimate can be determined (see 3GPP TS 43.059 Annex C). In order to reduce signalling requirements each LMU's measurements of OTDs are only reported at intervals by the LMU to the SMLC. (For MS-assisted E-OTD the LMU's OTDs are retained by an SMLC whereas for MS-based E-OTD the OTD's are further reported to the MS periodically (see 3GPP TS 43.059)). The maximum allowable interval between LMU reports depends on both the predictability of the BTS frequency source and the level of accuracy required of the location estimate.

C.2 Frequency source stability

The predictable component of the BTS frequency source behaviour includes any long term difference between the BTS frequency source's actual and nominal frequencies.

C.3 Relationship to E-OTD reporting periods

The relationship between the E-OTD reporting period ΔT, the BTS frequency source's rms time interval error TIE_{rms} (RMS of Time Interval Error, see ITU-T Recommendation G.810), and the maximum admissible range error $r_{\max}$ is given by (see 3GPP TS 45.050, annex V.7):

$$\sqrt{2} \cdot C_{\mathrm{p}} \cdot v \cdot \Delta T \cdot TIE_{\mathrm{rms}} \leq r_{\max}$$

in which v is the speed of the waves (usually taken as c, the speed of light in vacuum) and C_{p} is a constant which sets the percentile $100p$ associated with $r_{\max}$. (When the *TIE* has a Gaussian distribution $C_{67\%} = 1.0$, $C_{95\%} = 2.0$, and $C_{99.7\%} = 3.0$.) In practice, the BTS frequency source stability TIE_{rms} and required E-OTD range accuracy $r_{\max}$ are likely to be given and table C.3.1 allows the corresponding value of the E-OTD reporting period ΔT to be read off.

Table C.3.1: Relationship between frequency source stability, E-OTD reporting period and E-OTD range errors

E-OTD Reporting Period (ΔT)	E-OTD MTIE ± @ 95%	r_{max} ± @ 95%	BTS frequency source stability - Normalised TIE_{rms}
1 second	50ns 100ns 200ns	15 meters 30 meters 60 meters	0.018 µs/sec 0.036 µs/sec 0.072µs/sec
3 seconds	50ns 100ns 200ns	15 meters 30 meters 60 m eters	0.006 µs/sec 0.012µs/sec 0.024 µs/sec
10 seconds	50ns 100ns 200ns	15 meters 30 meters 60 meters	0.0018 µs/sec 0.0036 µs/sec 0.0072 µs/sec
30 seconds	50ns 100ns 200ns	15 meters 30 meters 60 meters	0.0006 µs/sec 0.0012 µs/sec 0.0024 µs/sec
100 seconds	50ns 100ns 200ns	15 meters 30 meters 60 meters	0.00018 µs/sec 0.00036 µs/sec 0.00072 µs/sec
300 seconds	50ns 100ns 200ns	15 meters 30 meters 60 meters	0.00006 µs/sec 0.00012 µs/sec 0.00024µs/sec
1000 seconds	50ns 100ns 200ns	15 meters 30 meters 60 meters	0.000018 µs/sec 0.000036 µs/sec 0.000072 µs/sec

For example given the requirement for r_{max} ± @ 95% shall be better than 60m and an observed frequency stability is 0,00072 µs/sec then the resulting E-OTD Reporting Period (ΔT) from the LMU making the observations will be no greater than 100 seconds.

Annex D (informative): Change history

SPEC	SMG# G#	CR	Phase	Version	New_Version	Subject
05.10	s25	A013	R97	6.0.0	6.1.0	Clarification of the use of TAI
05.10	s25	A014	R97	6.0.0	6.1.0	Renaming of GPRS RR states
05.10	s25	A015	R97	6.0.0	6.1.0	GPRS, Missing Timing Advance Updates on PTCCH
05.10	s26	A016	R97	6.1.0	6.2.0	Correction to timing advance for GPRS
05.10	s26	A009	R98	6.2.0	7.0.0	Pico BTS
05.10	s27	A017	R97	6.2.0	6.3.0	Packet polling procedure for calculating new TA
05.10	s28	A020	R97	6.3.0	6.4.0	GPRS MS timing requirements
05.10	s28	A021	R97	6.3.0	6.4.0	Correction of Timing Advance Procedure
05.10	s28	A023	R97	6.3.0	6.4.0	Definition of additional GPRS related reaction times
05.10	s28	A026	R97	6.3.0	6.4.0	Continuous timing advance procedure failure
05.10	s28	A018	R98	6.4.0	7.0.0	Harmonization between GSM and PCS 1900 standard
05.10	s28	A019	R98	6.4.0	7.0.0	Synchronization requirements for CTS
05.10	s28	A025	R98	6.4.0	7.0.0	Synchronization requirements for the control of the CTS service range
05.10	s29	A027	R98	7.0.0	7.1.0	Correction of CTS-FP frequency source correction slope
05.10	s29	A033	R98	7.0.0	7.1.0	Timing advance for access bursts on PTCCH/U
05.10	s29	A036	R98	7.0.0	7.1.0	Reaction time after contention resolution during one phase access
05.10	s30	A038	R99	7.1.0	8.0.0	EDGE Compact logical channels
05.10	s30	A042	R99	7.1.0	8.0.0	Definition of other reaction times
05.10	s30b	A039	R99	8.0.0	8.1.0	Extended range TA information added in 05.10
05.10	s30b	A043	R99	8.0.0	8.1.0	Synchronization of 52-multiframes in EGPRS COMPACT
05.10	s30b	A049	R99	8.0.0	8.1.0	Defining the MS carrier frequency accuracy value for GSM 400 MS
05.10	s31	A050	R99	8.1.0	8.2.0	Modifications for 8-PSK
05.10	s31	A051	R99	8.1.0	8.2.0	Timegroup definition removal from 05.10
05.10	s31b	A054	R99	8.2.0	8.3.0	EGPRS Classic to COMPACT BTS synchronization

05.10	s31b	A056	R99	8.2.0	8.3.0	BTS Synchronization, Location Accuracy and LMU update rates
05.10	s32	A058	R99	8.3.0	8.4.0	Class A Dual Transfer Mode (DTM)
						September 2000 - TSG-GERAN#1
05.10	G01	A059	R99	8.4.0	8.5.0	Correction of assignment reaction time
05.10	G01	A061	R99	8.4.0	8.5.0	Addition of the switching requirement for the GSM to UTRAN
						November 2000 - TSG-GERAN#2
05.10	G02	A065	R99	8.5.0	8.6.0	Corrections to synchronised handover
05.10	G02	A066	R99	8.5.0	8.6.0	Reaction time at packet assignment with polling request
				8.6.0	8.6.1	Front page layout correction
						January 2001 - TSG-GERAN#3
05.10	G03	A067		8.6.1	8.7.0	Delay requirements for blind handover to UTRAN
05.10	G03	A069		8.6.1	8.7.0	Timing requirements for Blind Handover 2G➔2G
						April 2001 - TSG-GERAN#4
05.10	G04	A073	1	8.7.0	8.8.0	Updates to GSM-UTRAN Handover Interruption Times

Change history							
Date	**TSG GERAN#**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2001-04	04				Version for Release 4		4.0.0
2001-04	07	GP-012776	001	1	Correction of references to relevant 3GPP TSs	4.0.0	4.1.0
2002-02	08	GP-020453	002	1	Clarification to Requirements for Synchronization at DTM operation	4.1.0	4.2.0
2002-06	10	GP-021930	005	1	Correction to inter system handover interruption times	4.2.0	4.3.0
2002-06	10				Version for release 5	4.3.0	5.0.0
2002-08	11	GP-022216	007		Editorial clean up of references	5.0.0	5.1.0
2003-02	13	GP-030215	009		Timing of DTM assignment	5.1.0	5.2.0
2003-02	13	GP-030439	011	2	Correction of interruption times for GSM to UTRAN handover	5.1.0	5.2.0
2003-04	14	GP-030884	016		Clarification on continuous TA procedure	5.2.0	6.0.0
2003-06	15	GP-031547	020		Clarification on USF decoding reaction time on reception of a new assignment	6.0.0	6.1.0
2003-08	16	GP-032117	022	1	Clarification of reaction times for Extended Dynamic Allocation and Shifted USF operation	6.1.0	6.2.0
2003-08	16	GP-032284	025	2	Correction of definition of "ready to transmit" for inter-RAT handover	6.1.0	6.2.0
2003-08	16	GP-032186	028	1	MS reaction time upon reception of assignment message on CCCH	6.1.0	6.2.0
2004-11	22	GP-042881	030	1	Timing Advance behaviour for DTM to Packet Transfer mode transition	6.2.0	6.3.0
2005-01	23	GP-050139	031		Timing Advance for multiple TBFs in Packet Transfer mode	6.3.0	6.4.0
2005-01	23	GP-050289	032		Timing advance for MBMS	6.3.0	6.4.0
2005-04	24	GP-050862	033		Clarification of MS requirements for synchronization	6.4.0	6.5.0
2005-11	27	GP-052749	0034	1	Introduction of PS handover	6.5.0	6.6.0
2007-02	33	GP-070200	0035		Clarifications and editorial corrections	6.6.0	7.0.0
2007-05	34	GP-070716	0036		PAN Reaction Times	7.0.0	7.1.0
2007-08	35	GP-071546	0038	2	Introduction of Reduced Symbol Duration	7.1.0	7.2.0
2007-11	36	GP-071967	0039	1	Removal of RL-EGPRS TBF mode	7.2.0	7.3.0
2008-02	37	GP-080370	0042	1	Clarifying Radio Block Specific Reaction Times	7.3.0	7.4.0
2008-05	38	GP-080780	0044	1	Time synchronisation	7.4.0	7.5.0
2008-05	38	GP-080580	0046		Timing requirements for PS Handover to UTRAN	7.4.0	7.5.0
2008-05	38	GP-080663	0049		Reduced Latency terminology alignments	7.4.0	7.5.0
2008-05	38	GP-080919	0050	1	Clarification to the PDAN reaction times when operating in event based FANR	7.4.0	7.5.0
2008-05	38	GP-080582	0048		Editorial corrections	7.5.0	8.0.0
2008-08	39	GP-081141	0047	1	Timing requirements for PS Handover to E-UTRAN	8.0.0	8.1.0
2008-08	39	GP-081344	0052	2	Assignment reaction time when the TTI configuration of a TBF is changed	8.0.0	8.1.0
2008-11	40	GP-081562	0053		Corrections to the timing requirements for PS Handover to E-UTRAN	8.1.0	8.2.0
2009-02	41	GP-090148	0054		Corrections to the timing requirements for PS Handover to E-UTRAN	8.2.0	8.3.0
2009-05	42	GP-090611	0055		Removal of brackets	8.3.0	8.4.0
2009-11	44	GP-092185	0060		Modification of PAN Related Reaction Times	8.4.0	8.5.0
2009-11	44	GP-091962	0056		Introduction of MTD reporting on Hyperframe level	8.5.0	9.0.0
2010-11	48	GP-102064	0061	2	Reaction times for DTR	9.0.0	10.0.0
2011-03	49	GP-110245	0062		DTR Reaction times: removal of square brackets	10.0.0	10.1.0
2012-08	55	GP-120925	0063		Synchronization requirements for Local Area multicarrier BTS	10.1.0	11.0.0
2012-11	56	GP-121260	0064	3	Impact from rSRVCC from GERAN to E-UTRAN	11.0.0	11.1.0
2014-09	63				Version for release 12 (frozen at SP-65)	11.1.0	12.0.0
2015-11	68	GP-151216	0065	5	Introduction of EC-EGPRS	12.0.0	13.0.0
2015-11	68	GP-151218	0066	2	Introduction of Power Efficient Operation	12.0.0	13.0.0
2016-02	69	GP-160182	0067	1	Miscellaneous corrections	13.0.0	13.1.0
2016-02	69	GP-160100	0068		Miscellaneous corrections to eDRX	13.0.0	13.1.0

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2016-05	70	GP-160462	0069	2	F	Clarifications and miscellaneous corrections to EC-GSM-IoT (including name change)	13.2.0
2016-09	73	RP-161392	0070	2	F	Corrections to EC-GSM-IoT	13.3.0
2016-12	74	RP-162070	0072	-	F	Miscellaneous corrections to EC-GSM-IoT	13.4.0
2017-03	75					Version for Release 14 (frozen at TSG-75)	14.0.0
2017-06	76	RP-170923	0071	6	B	Introduction of Multilateration	14.1.0
2017-09	77	RP-171594	0074	3	F	Corrections to BTS Reception Accuracy Capability for Multilateration Positioning	14.2.0
2017-12	78	RP-172188	0075	-	F	Corrections to Timing Advance setting for ESAB, EDAB and Extended AB	14.3.0
2017-12	78	RP-172189	0076	-	F	Correction to BTS Reception Accuracy Capability for Multilateration Positioning	14.3.0
2019-03	83	RP-190061	0078	-	A	Corrections to BTS / MS synchronization and delay assessment error requirements for EC-GSM-IoT	14.4.0
2020-03	87e	RP-200054	0080	-	F	Removal of brackets for Multilateration Timing Advance	14.5.0

History

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