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UMTS Terrestrial Radio Access Network (UTRAN); UTRA Handover (UMTS XX.15 version 1.0.0)

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Universal Mobile Telecommunications System

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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Special Mobile Group (SMG).

The present document provides a description of the handover preparation and handover execution as seen essentially from the layer 1 perspective. There might be some overlap with documentation produced by the layer 2-3 group, which requires co-ordination and checking for possible inconsistency.

The contents of the present document are subject to continuing work within TC-SMG and may change following formal TC-SMG approval.

1 Scope

This Technical Report provides a description of the handover from UTRA to UTRA and GSM, as seen from the layer 1.

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, subsequent revisions do apply.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] UTRA FDD XX.03: "Transport and physical channels description".

[2] UTRA FDD XX.04: "Multiplexing, channel coding and interleaving description".

[3] UTRA TDD XX.09: "Transport channels and physical channels description".

[4] UTRA TDD XX.10: "Multiplexing, channel coding and interleaving description".

[5] XX.16: "UTRA Interoperability Description".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

Definition 1: to be completed

A dual mode UE (FDD/GSM) (TDD/GSM) refers to a UE being able to receive information in only one mode at a time.

3.2 Symbols

For the purposes of the present document the following symbols apply:

<symbol> <Explanation>

3.3 Abbreviations

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

A1 Abbreviation 1

4 Handover types

4.1 Overview of the handover types

The mobile station will support three types of handover:

- *Soft Handover*: A handover in which the UE communicates with a new cell without interrupting communications with the current serving cell. Soft handover can only be performed with cells having identical frequency assignments.
- *UTRA to UTRA Hard Handover*: A handover in which the UE is transitioned between disjoint sets of cells, either because those cells are operating on a different frequency assignment or in a different mode (UTRA/FDD to UTRA/TDD or UTRA/FDD to UTRA/FDD or UTRA/TDD to UTRA/FDDUTRA/TDD to UTRA/TDD handover) or because cells are operating on the same frequency but soft handover is either not possible or not needed (e.g. for packet services). A hard handover is also used when a UE is moved from one carrier frequency to another one belonging to the same cell.
- *UTRA to GSM Hard Handover:* A handover in which the UE is directed from a UTRA traffic channel to a GSM traffic channel.

4.2 Soft handover and softer handover

4.2.1 Soft handover

4.2.1.1 Softer handover

Softer handover is the special case of a soft handover between cells belonging to the same NODE B site. Conceptually, a softer handover is initiated and executed in the same way as an ordinary soft handover. The main differences are on the implementation level within the UTRAN. For softer handover, it is e.g. more feasible to do uplink maximum-ratio combining instead of selection combining as the combining is done on the NODE B level rather than on the RNC level.

4.3 UTRA to UTRA hard handover

4.3.1 Intra-frequency handover

4.3.2 Inter-frequency handover

UTRA to UTRA inter-frequency hard handover may typically occur in the following situations:

- handover between cells to which different number of carriers have been allocated, e.g. due to different capacity requirements (hot-spot scenarios);
- handover between cells of different overlapping orthogonal cell layers using different carrier frequencies;
- handover between different UTRA operators/systems using different carrier frequency;
- handover between different carrier frequencies belonging to the same cell.

A key requirement for the support of seamless inter-frequency handover is the possibility for the mobile station to carry out cell search on a carrier frequency different from the current one, without affecting the ordinary data flow. UTRA/FDD and UTRA/TDD supports inter-frequency cell search in two different ways, a dual-receiver approach and a slotted-downlink-transmission approach.

4.4 UTRA to GSM handover

5 Handover scenarios

5.1 Introduction

This subclause studies the handover scenarios from the deployment point of view. It should in particular provide the rules for setting the handover monitoring set (see subclause 8.1), in particular the number of GSM, FDD and TDD cells to monitor. Based on deployment scenarios and UE's speed, it should also set the requirement in terms of detection time and reporting time of a strong cell.

As far as the handover between UTRA and GSM, the handover scenario will be based on interoperability aspects described in XX.16, which among other things will indicate when a handover is needed between UTRA and GSM from the service availability point of view.

5.2 UTRA-UTRA handover scenarios

5.2.1 FDD to FDD

5.2.2 TDD to TDD

5.2.3 FDD to TDD

5.2.4 TDD to FDD

5.3 UTRA-GSM handover scenarios

6 Cells sets for handover

6.1 Overview of the different sets

The UE should maintain the following list of cells:

- *Handover Monitoring set*: All cells (UTRA or from other systems like GSM) that the UE has been tasked by the UTRAN to monitor when in active mode.
- *Active Set*: The UTRA cells currently assigning a downlink DPCH to the mobile station, which corresponds to the cell between which the UE in a soft or softer handover with. The active set may only correspond to UTRA cells.
- *Handover candidate Set*: The cells that are not currently in the Active Set but have been received by the UE with sufficient strength to indicate that the associated DPCHs could be successfully demodulated. These correspond to the cells that are effectively reported by the UE to the UTRAN. These cells may be on the same or different frequencies from the current frequency assignment. Cells in the handover candidate set may be UTRA or GSM cells.
- tbc

<Editor's note: the handover monitoring set corresponds to the BA (SACCH) in GSM. The word handover monitoring set has been chosen so that as in GSM we can define another set corresponding to the BA(BCCH) =, hence to cells to monitor for the cell selection. The description given here does not make any assumption on the way the handover monitoring set is indicated to the UE and how it is updated. This is to be further discussed>.

6.2 Content of the sets

This subclause defines the following:

- the content of each cells set, in particular the information related to each cell such frequency, mode;
- the rules associated with each set, such as the maximum number of cells in the set, or the relationship between the number of cells of different types (UTRA FDD, UTRA TDD and GSM).

<Editor's note: the rules characterising the sets are dependent on the scenarios (number of neighbour cells) and the monitoring capability of the UE>.

6.2.1 Handover monitoring set

6.2.1.1 Handover monitoring set in FDD

The handover monitoring set contains the cells to be monitored by the UE in active mode. It may be provided by the UTRAN via the BCCH of the serving cell(s) or via UE specific signalling on the DCH.

The handover monitoring set may contain cells on the same frequency and/or cells on different frequencies. The following subclauses indicate which information are included in the handover monitoring set for cell on the same frequency and cells on different frequencies.

6.2.1.1.1 FDD cells on the same frequency

For each cell to monitor at the same frequency, the handover monitoring list contains at least the following information:

- the cell scrambling code used for downlink scrambling;
- the cell ID number.

It is assumed that the mapping of the cell scrambling codes in relation to the synchronisation channel codes (groups indicated by the secondary synchronisation channel) is known beforehand with the code grouping being determined beforehand.

6.2.1.1.2 FDD cells on different frequencies

6.2.1.1.3 TDD cells

6.2.1.1.4 GSM cells

6.2.1.2 Handover monitoring set in TDD

6.2.1.2.1 TDD cells on different frequencies

6.2.1.2.2 FDD cells

6.2.1.2.3 GSM cells

6.2.2 Active set

6.2.3 Candidate set

6.3 Set Maintenance

This subclause describes the triggering events for moving one cell from one set to another set.

6.3.1 Active set

The UE sends regular (or event driven) measurement reports to the UTRAN.

Based on the measurement reports, the UTRAN decides whether to add or drop some cell(s) to/from the active set and reports the decisions to the UE. There may be a rejection in the new cell to admit a new UE.

7 Handover preparation

7.1 Handover preparation from UTRA to UTRA

7.1.1 Handover preparation from FDD to FDD

The UE operating in UTRA FDD mode monitors other UTRA FDD cells contained in the handover monitoring set.

7.1.1.1 Monitoring of FDD cells on the same frequency

During the measurement process of cells on the same frequencies, the UE shall find the necessary synchronisation to the cells to measure using the primary and secondary synchronisation channels and also the knowledge of the possible scrambling codes in use by the neighbouring cells. As the UE does measurement, at least the following information is obtained:

- Relative signal strength of the measured cell.
- Relative timing between the cells, measured for example from the phase difference between the scrambling code, depending on the timing difference between the cells.

7.1.1.2 Monitoring of FDD cells on different frequencies

7.1.1.3 Measurement reporting

The UE sends regular (or event driven) measurement reports to the UTRAN.

These measurements include (for cells on the same frequency):

- the Cell ID;
- the relative signal strength;
- the relative timing information, accuracy TBD.

7.1.2 Handover preparation from FDD to TDD

7.1.3 Handover preparation from TDD to TDD

7.1.4 Handover preparation from TDD to FDD

7.2 Handover preparation from UTRA to GSM

The handover between UTRA and GSM system offering world-wide coverage already today has been one of the main design criteria taken into account in the UTRA frame timing definition. The GSM compatible multi-frame structure, with the super-frame being multiple of 120 ms, allows similar timing for inter-system measurements as in the GSM system itself. The compatibility in timing is important, that when operating in UTRA mode, a multi-mode UE is able to catch the desired information from the synchronisation bursts in the synchronisation frame on a GSM carrier with the aid of the frequency correction burst. This way the relative timing between a GSM and UTRA carriers is maintained similar to the timing between two asynchronous GSM carriers.

7.2.1 Handover preparation for FDD to GSM

UTRA/FDD-GSM dual mode UES can be implemented without simultaneous use of two receiver chains. Although the frame length is different from GSM frame length, the GSM traffic channel and UTRA FDD channels use similar 120 ms multi-frame structure. Similar timing can be naturally done with UTRA TDD mode as well.

A UE can do the measurementsby using idle periods in the downlink transmission, where such idle periods are created by using the downlink slotted mode [3]. In addition to downlink slotted frames for measurements, the UTRAN will provide uplink slotted frames to allow the UE to GSM cells on frequencies closed to the FDD uplink band. The slotted mode is under the control of the UTRAN, and the UTRAN should communicate to the UE which frame is slotted.

Alternatively independent measurements not relying on the slotted mode, but using a dual receiver approach can be performed, where the GSM receiver branch can operate independently of the UTRA FDD receiver branch.

For smooth inter-operation between the systems, information needs to be exchanged between the systems, in order to allow the UTRAN to notify the terminal of the existing GSM frequencies in the area. Further more integrated operation is needed for the actual handover where the current service is maintained, taking naturally into account the lower data rate capabilities in GSM when compared to UTRA maximum data rates reaching all the way to 2 Mbits/s.

The current subclause addresses in a first part the parametrisation of the slotted mode and in second stage the monitoring process in a more global way and encompasses the setting of monitoring set and reporting. The subclause is organised as follows:

In subclause 7.2.1.1 silence durations definition and parametrisation for SCH or FCCH tracking for one GSM either at initial search or for reconfirmation are defined. Such silence durations SDc correspond to the time required for a UE to listen to c consecutive GSM time-slots and are therefore contained in the idle period generated by the use of slotted frames. There is hence a correspondence between allocation by the UTRAN of slotted frames and silence durations. The subsequent subclauses 7.2.1.1.2, 7.2.1.1.3 and 7.2.1.1.4 then discuss the appropriate Silence duration pattern depending on the availability of timing information between UTRA serving cells and the GSM cell and whether the silence duration is used to initial tracking of a new GSM cell or reconfirmation. Addition silence duration will be required for power measurement of one or multiple GSM cells.

Subclause 7.2.1.2 addresses the parametrisation of the silence durations or equivalently the slotted mode when considering the monitoring of all cells, which requires a combination of power measurements and synchronisation tracking of one cell as a minimum. Different handover scenarios in terms of inter-operability as defined in XX.16 are addressed.

Finally subclause 7.2.1.3 addresses the monitoring in a more general view.

7.2.1.1 Definition and setting of silence duration parameters

7.2.1.1.1 Definition of silence duration parameters

SD_c is defined as the following:

$$SD_c = 2 * t_{synth.} + (c+1) * TS_{GSM}$$

where,

$t_{synth.}$: $t_{synth.}$ is the maximum allowed delay for a UE's synthetizer to switch from one FDD to one GSM frequency. Typically this value could be derived, from the larger frequency difference switch (= 1245 MHz) which is the one from upper FDD downlink frequency (2 170 MHz) to lower GSM downlink frequency (925 MHz). The value of$t_{synth.}$ is set to [500 µs].

c: integer value {0, 1, 2, 3, 4, 5, 6, 7, 8}

$TS_{GSM:}$ GSM timeslot duration. 577 µs

$SD_{c\,:}$ silence duration number c. SD_C is the necessary time for a dual mode UE to switch to one GSM frequency, *decode* c consecutive GSM slots and switch back to the current FDD carrier. In the particular case where the scheduling of silence duration SD_c is synchronized with the scheduling of GSM timeslots, the UE can decode (c+1) consecutive GSM time slots.

SD pattern: a set of consecutive silence durations enabling the capture of at least one timeslot 0 of one GSM BCCH carrier.

T_{SDc}: delay between two consecutive silence durations within a SD pattern when GSM timeslot number i mod(8) is the first timeslot to be captured by the first silence duration and GSM timeslot number (i+c) mod(8) is the first timeslot to be captured by the second silence duration.

$T_{pattern:}$ delay between two consecutive patterns, optionally generalised to $T_{pattern1}$ and $T_{pattern2}$ to be used alternating between consecutive patterns.

$N_{pattern:}$ number of consecutive patterns to be used for scanning a particular GSM frequency before this search attempt is assumed to be unsuccessful.

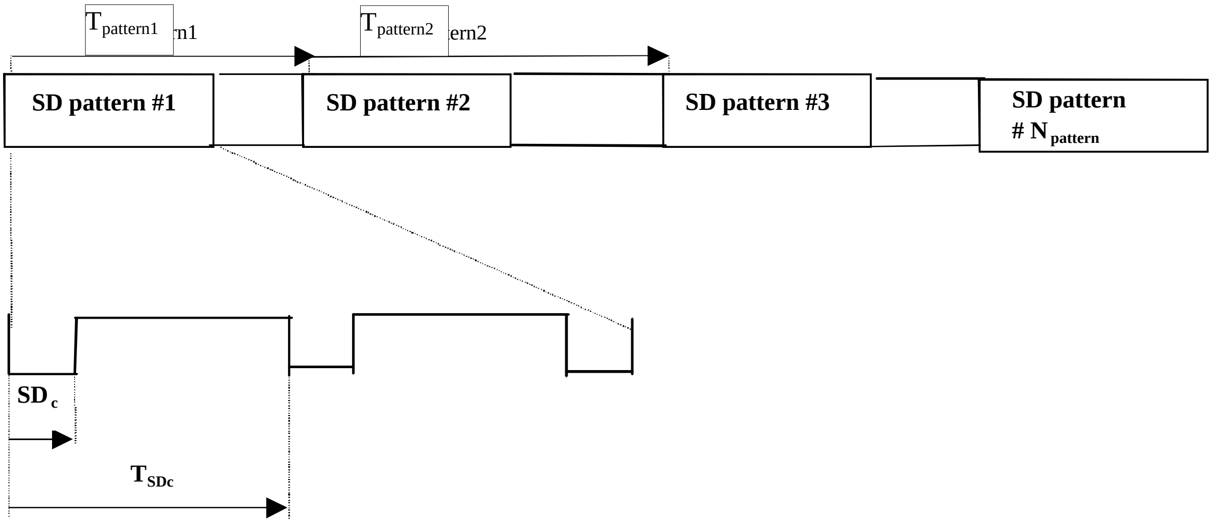

Figure 1: Illustrations of SD patterns, silence duration SD_C,$T_{pattern1}$,$T_{pattern2}$, T_{SDc} and $N_{pattern}$

7.2.1.1.2 Setting of SD parameters for first SCH decoding without any timing knowledge

The setting of the SD patterns is described in this subclause when used for first SCH decoding of one cell when there is no knowledge about the relative timing between the current FDD cells and the neighbouring GSM cell. The UE needs to perform a new SCH search procedure whenever a new neighbour cell is received with a sufficiently high power level (see 7.2.1.1.4).

Silence durations for FDD mode can be used in the downlink in order to enable a one receiver dual mode UE to acquire synchronisation from neighbouring GSM cells. Depending on the UE's capabilities, the search procedure may be sequential (tracking of FCCH burst before decoding of the first SCH) or parallel (parallel tracking of FCCH and SCH bursts). The latter solution achieves SCH decoding faster than the first one thus decreasing the needed number of SD patterns. For example a parallel search with 2 SD patterns every 480 ms using alternatively $T_{pattern1}$ = 216,92 ms (= 47*4,615 ms) and $T_{pattern2}$ = 263,08 ms (= 57*4,615 ms) will be as efficient as a sequential search with 4 SD patterns per 480 ms with $T_{pattern}$ = 120 ms. This has been verified by checking which GSM frame numbers will be observed during 6 successive silence durations for each of the 51 possible frame numbers where the search can happen to be started (note that the GSM FCCH/SCCH schedule has a periodicity of 51 frames).

The parameter $N_{pattern}$ allows to trade in the detection probability on a particular GSM cell against the number of slotted frames i.e. against the impact on the running UTRA connection. By default $N_{pattern}$ should be set to 11 for the serial and 6 for the parallel search procedure. This makes sure a detection is possible even for the worst case relative timing of the GSM cell.

If silence durations are allocated by the UTRAN on a periodic basis in the downlink, then it is up to the UE to trigger the search procedure with the available silence durations. In this case, no specific signalling is needed between the UE and the UTRAN.

If silence durations are not allocated on a periodic basis, the UE then initiates the search procedure by sending a "request new cell search" message to the UTRAN also signalling its capabilities for serial or parallel search as described above. The UTRAN then determines a suitable silence period pattern and signals this to the UE using the normal silence duration indicators. The UTRAN can delay the onset of this pattern depending on the timing priority the Network Operator has set for new BSIC identification. Once the UE has completed the search it signals the UTRAN with the timing of the associated SCH burst or with SCH-not-found (see 7.2.1.1.3) and the UTRAN ceases the silence duration pattern.

Here are some exemples of silence durations and associated SD patterns (at least one GSM timeslot 0 is capture within each SD pattern).

Table 1: Some possible SD_c combinations for SD pattern

Silence Duration	Number of Silence Durations per SD pattern	T_{SDc} between 1st and 2nd SD (in TS_{FDD})	T_{SDc} between 2nd and 3rd SD (in TS_{FDD})	T_{SDc} between 3rd and 4th SD (in TS_{FDD})
SD_2 (= 5 * TS_{FDD})	4	24	24	24
SD_3 (= 6 * TS_{FDD})	3	84	84	N.A.
SD_4 (= 7 * TS_{FDD})	2	48	N.A.	N.A.
SD_3 and SD_5	2	84	N.A.	N.A.
SD_5 and SD_5	2	108	N.A.	N.A.
SD_6 (=9 * TS_{FDD}) and SD_2	2	72	N.A.	N.A.
SD_8 (=10 * TS_{FDD})	1	N.A.	N.A.	N.A.

7.2.1.1.3 Setting of SD parameters for first SCH decoding with timing knowledge

The setting of the SD pattern is described in this subclause for the case where some knowledge on the relative timing between the UTRA FDD cells in the active set and the neighbouring GSM cells is available at the UE, either because delivered by the UTRAN or due to prior knowledge consecutive to previous FCCH detection by the UE.

For GSM cells when the timing is known, the slotted frames (silence durations) can be allocated for a specific frame intended to capture a specific SCH (or FCCH if needed) from the GSM cell with known frame timing with relative to UTRA FDD cells in the active set.

The control is implemented over 306 frames, equal to 13 GSM « 51 multi-frame » duration. As the UTRA 720 ms superframe shifts ¼ of superframe during the period, the 4 times 306 period can be used to fully align the timings of a UTRA FDD and a GSM cells.

The UE needs to perform a new SCH search procedure whenever a new neighbour cell is received with a sufficiently high power level (see 7.2.1.1.4). The UE then initiates the search procedure by sending a "request new cell search" message to the UTRAN. Then the UTRAN sends to the UE specific signalling with the following information:

- the frame number where slotted mode occurs (frame number x+n times 306, where n=0,1,2,3);
- the GSM carrier for which the particular slotted frame is intended (BS ID, carrier no, etc.);
- the type of slotted mode that will occur (end, middle frame, etc.).

The signalling has to be UE specific as:

- all UEs should not make measurements at the time instant;
- all UEs may not be dual mode.

Once the UE has completed the search it signals the UTRAN with the timing of the associated SCH burst or with SCH-not-found (see 7.2.1.1.3) and the UTRAN ceases the silence duration pattern.

7.2.1.1.4 Setting of SD parameters for SCH decoding for BSIC reconfirmation

In this subclause it is assumed that the UE has successfully decoded one SCH burst of a given neighbouring GSM cell during the call.

If silence durations i.e. slotted frames are allocated on a periodic basis in the downlink, then it is up to the UE to trigger and perform the BSIC reconfirmation procedure with the available silence durations. In this case, no specific signalling is needed between the UE and the UTRAN for BSIC reconfirmation procedure.

If silence durations are not allocated on a periodic basis in the downlink, the UE indicates to the UTRAN the schedule of the received neighbour cell SCH bursts and the size of the necessary silence duration in order to capture one SCH burst. The Network Operator decides the target time for BSIC reconfirmation and the UTRAN uses this and the schedule indicated by the UE to determine an appropriate silence duration pattern. This is signalled to the UE using the normal silence duration indicators. Also if the FDD network as a priori timing knowledge of neighbouring GSM cells as in 7.2.1.1.2 then it can schedule silence durations for BSIC reconfirmation. In that case the signalling is similar to the one in subclause 7.2.1.1.2.

7.2.1.1.5 Setting of SD parameters for Power measurements

For power measurements of GSM carriers, additional silence durations will be used for single receiver FDD/GSM UE. Requirements concerning the number of power measurements per slotted frames are for further study.

7.2.1.2 Parametrisation of the silence durations for handover preparation to GSM

Whereas subclause 7.2.1.2 described the silence duration parametrisation for the initial synchronisation tracking or reconfirmation for one cell and the silence duration parameter for power measurement for one of multiple cells, there is a need to define the global silence duration parameters when considering the monitoring of all GSM cells.

7.2.1.2.1 Scenario A (Handover due to lack of UTRA coverage, see [5], subclause 6.1.1)

The number of downlink slotted frames per reporting period (= 480 ms same as GSM) will depend on:

- the type of slotted frame used in the downlink (see also reference [2]);
- each UE’s capabilities in terms of number of BCCH measurements per slotted frame;
- the required number of measurements per reporting period (to be defined).

or alternatively:

- the type of slotted frame used in the downlink (see also reference [2]);
- for the latter case, this number will be set so that any UE compliant with the specification will make at least the required minimal number of measurements per reporting period;
- the required number of measurements per reporting period (to be defined).

7.2.1.2.2 Scenario B (Handover due to bearer services, see [5], subclause 6.1.2)

Call set-up involves DCH allocation.

In that case, the downlink slotted mode is needed to handle GSM handover preparation (except maybe for handover between co-located FDD-GSM cells). The downlink slotted mode should start as soon as the network knows the proposed bearer service i.e. initial bearer service either sent from the UE for an outgoing call or from the network for an incoming call.

The number of slotted frames per reporting period is for further study. The measurement time will be done over several reporting periods.

Call set-up does not involve any DCH allocation.

In that case, there will be no need of downlink slotted frames since the UE cannot listen to GSM frequencies as a downlink message sent by the FDD cell could happen at anytime.

A particular case nevertheless expected to happen quite often is when FDD and GSM cells are co-located.

In that case, the UE could be allowed not to prepare handover to GSM (no measurements neither neighbouring GSM SCH decoding). See also handover execution subclause.

7.2.1.3 Monitoring of GSM cells and reporting scheme

7.2.1.3.1 Scenario A (Handover due to lack of UTRA coverage, see [5], subclause 6.1.1)

Two alternatives may be considered:

1) The UE may not systematically make and report neighbouring GSM cells measurements. In that case the UTRAN will decide whether or not activate this procedure as a background job.

2) The UE can systematically make and report neighbouring GSM cells measurements when having service from FDD cells located at the border of FDD network. The definition of " border of FDD network " is for further study.

3) Start.

For the first case, the UTRAN decides if and when the UE within the FDD coverage starts measuring and reporting back neighbouring GSM cells. The decision will be based on the uplink received signal and/or the downlink received signal measured by the UE and reported to the network. In the second case, the decision will be based on same information from the network indicating that one FDD cell is at the border of the network.

The handover preparation procedure will stop when one of the following events occur:

- the UE is ordered to execute handover to a GSM cell;
- the UTRAN decides to include a new cell in the active set (start of soft handoff);
- execution of inter-frequency handover within the FDD mode.

7.2.1.3.2 Handover preparation for scenario B (Handover due to bearer services, see [5], subclause 6.1.2)

Handover preparation will depend whether or not Dedicated channel allocation is needed during call set-up.

Call set-up involves DCH allocation.

See subclause 7.2.1.2.2.

Call set-up does not involve any DCH allocation.

No measurement is needed (see subclause 7.2.1.2.1)

7.2.2 Handover preparation for TDD to GSM

UTRA/TDD-GSM dual mode terminals can be implemented without simultaneous use of two receiver chains. Although the frame length is different from GSM frame length, the GSM traffic channel and UTRA TDD channels rely on similar 120 ms multiframe structure.

An UTRA terminal can do the measurements either by efficiently using idle slots or by requesting free continuous periods in the downlink part obtained by reducing the spreading factor and compressing in time TS occupation in a form similar to the FDD slotted mode. The low-cost constraint excludes the dual receiver approach.

For smooth inter-operation, inter-system information exchanges are needed in order to allow UTRA base station to notify the terminal of the existing GSM frequencies in the area and vice versa. Further more integrated operation is needed for the actual handover where the current service is maintained, taking naturally into account the lower data rate capabilities in GSM when compared to UMTS maximum data rates reaching all the way to 2 Mbits/s.

Basic requirements to correctly perform a handover in GSM are described in GSM 05.08 "Radio subsystem link control".

7.2.2.1 Low data rate traffic: use of TDD idle slots to monitor GSM

In low data rate traffic case, only a few time slots are busy and idle slots may be used for monitoring purpose.

As an example, a simple speech communication is considered. Only two time slots by frame are used, one for uplink and one for downlink. The mobile station is not in transmit or receive state during 8,75 ms in each frame. According to the TS numbers allocated to the traffic, this period can be split into two continuous intervals A and B as shown in figure 2.

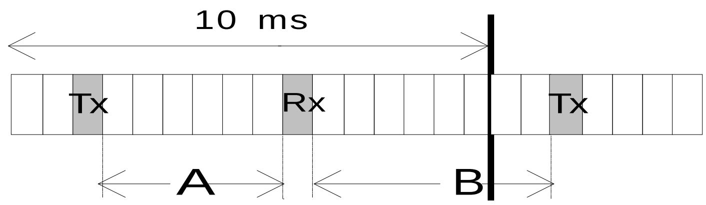

Figure 2: Possible idle periods in a 16 TS frame with two busy TS

A is defined as the number of idle slots between the Tx and Rx slots and B the number of idle slots between the Rx and Tx slots. It is clear that A+B=14 time slots.

In the scope of low cost terminals, a [0,8] ms period is supposed to be required to perform a frequency jump from UMTS to GSM. As detailed in table 1, this will let free periods of A*0,625-1,6 ms and B*0,625-1,6 ms during which the mobile station can monitor GSM. In this table, the UL traffic is assumed to occupy TS0, and the duration of monitoring periods are indicated for each possible location of the DL TS.

Table 1 evaluates the average synchronisation time and maximum synchronisation time, where the announced synchronisation time corresponds to the time needed to find the FCCH. The FCCH is supposed to be perfectly detected meaning that the FCCH is found if it is entirely present in the monitoring window. The FCCH being found the SCH location is unambiguously known from that point.

Table 2: Example-monitoring periods and associated synchronisation time in a 16 TS frame with two busy TS and with 0,8 ms switching time (*)

DL TS n°	Number of free TS in A	Number of free TS in B	Monitoring period within A (ms)	Monitoring period within B (ms)	Synchronisation average time (ms)	Maximum synchronisation time (ms)
1	0	14	Not Used	7,15	43	140
2	1	13	NU	6,525	48	187
3	2	12	NU	5,900	56	188
4	3	11	NU	5,275	63	188
5	4	10	0,9	4,65	68	189
6	5	9	1,525	4,025	75	233
7	6	8	2,15	3,4	74	189
8	7	7	2,775	2,775	48	189
9	8	6	3,4	2,15	73	189
10	9	5	4,025	1,525	73	235
11	10	4	4,65	0.9	66	186
12	11	3	5,275	NU	61	186
13	12	2	5,900	NU	54	186
14	13	1	6,525	NU	47	186
15	14	0	7,15	NU	43	139

(*) All simulations have been performed with a random initial delay between GSM frames and UMTS frames

Each configuration of TS allocation described above allows a monitoring period sufficient to acquire synchronisation.

<Editor's note: the section evaluates the time to acquire the FCCH is all idle slots are devoted to the tracking of a FCCH burst, meaning that no power measurements is done concurrently. The derived figures are better than those for GSM. The section does not derive though any conclusion. A conclusion may be that the use of the idle slots is a valid option. An alternative conclusion may be that this is the only mode to be used, removing hence the use of the slotted frames for low data traffic or the need for a dual receiver, if we were to considering the monitoring of GSM cells only, rather than GSM, TDD and FDD. A more explicit conclusion could be agreed by the SMG2 UMTS-L1 before releasing the present document >.

7.2.2.2 High data rate traffic

7.2.2.2.1 High-end dual synthesisers terminals

In case of high data traffic, a monitoring period of at least two slots is desirable as shown by the simulation results appearing on the table 3 below.

Table 3: Synchronisation time for a monitoring period of one, two or three consecutive time slot per frame

Number of consecutive TS per frame available for monitoring	Average synchronisation time (s)	Maximum synchronisation time (s)
3	0,23	0,65
2	0,4	1,9
1	7,2	23,2

The number of consecutive Time Slots needed to obtain an effective monitoring period of two Time Slots depends on the synthesiser characteristics that can be better for the high-end high-date rate capable terminal than for the low cost terminal considered in subclause 7.2.2.2. The switching time could for instance be considered as being one or one half of a TS for one-way, resulting in the effective monitoring period indicated in the table 4 below.

For even better performance, a dual synthesiser terminal could be considered: this would allow a negligible switching time between UMTS and GSM frequencies. When the first synthesiser is used, the frequency jump for monitoring is performed by the second synthesiser.

Table 4: Link between the synthesiser performance and the number of free consecutive TSs for a monitoring period of two TSs, needed for GSM monitoring

One-way switching time for the synthesiser	Number of free consecutive TSs needed in the frame for an effective monitoring period of 2 TSs
1 TS (= 625µs)	4
0.5 TS (=312µs)	3
0 (dual synthesiser)	2

7.2.2.2.2 Use of TDD TSs release to accommodate monitoring windows

In high data-rate, when it is not possible to free the number of TS needed for an effective monitoring to prepare a handover from UMTS to GSM, the data rate can be slightly reduced for the duration of the monitoring. This should be acceptable as in any case, the data rate needs to be adapted to the available resource in GSM before the handover can be performed.

7.2.2.3 GSM monitoring enhancement

The timing information of GSM CCH, obtained by a mobile that has acquired pre-synchronisation during GSM monitoring, may be broadcast to others mobiles via the UMTS base station.

An other possibility to fasten GSM monitoring, is to perform monitoring on several GSM frequencies in parallel, all these frequencies being included in a 4 MHz band.

These two possibilities are for further study.

7.2.2.4 Power monitoring of GSM cells

For the power measurements of GSM carriers, corresponding to the measurements normally performed by a GSM terminal during the transmit and receive slots of a frame, two approaches can be considered:

- Devoting some of the frames of the 120 ms multi-frame to that purpose (allocating up to 11 frames every 12 for the power measurement would allow to maintain the monitoring periodicity of the GSM).
- The presented scheme allows a very fast acquisition when all the 12 frames of the multi-frame are dedicated to that purpose. A two step approach could be considered, for which acquisition is performed first, when needed, then followed by an increased number of slots allocated to the power monitoring of carriers on which the synchronisation was acquired.

7.3 Overall handover preparation

This subclause should explain how the inter-frequency handover preparation from UTRA to UTRA and from UTRA to GSM are co-ordinated in terms of measurement and reporting. Whereas subclauses 7.1.1, 7.1.2 and 7.2.1.2 give some principle for the monitoring of a given cell type and requirement in e.g. the dimensioning of the slotted mode, this subclause provides the overall requirement and measurement procedure.

8 Transmission in handover and handover execution procedure

8.1 Soft handover

The serving cell (s) (the cells in the active set) are expected to have knowledge of the service used by the UE. The new cell decided to be added to the active set shall be informed that a new connection is desired, and it needs to have the following minimum information forwarded to it via UTRAN.

- Maximum data rate of the connection and other service parameters, such as coding schemes, number of parallel code channels etc. parameters which form the set of parameters describing the different transport channel configurations in use both uplink and downlink.
- The UE ID and uplink scrambling code.
- The relative timing information of the new cell, in respect to the timing UE is experiencing from the existing connections (as measured by the UE at its location). Based on this the new cellcan determine what should be the timing of the transmission initiated in respect to the timing of the common channels (BCCH) of the new cell.

As a response the UE needs to know via the existing connections:

- From which frame (assuming active set update accepted) does the new cell initiate the transmission to the UE.
- What channelisation code(s) are used for that transmission. The channelisation codes from different cells are not required to be the same as they are under different scrambling code anyway.
- The relative timing information, which needs to be made available at the new cell is indicated in Figure 1 (shows the case where the two involved cells are managed by different Node Bs).

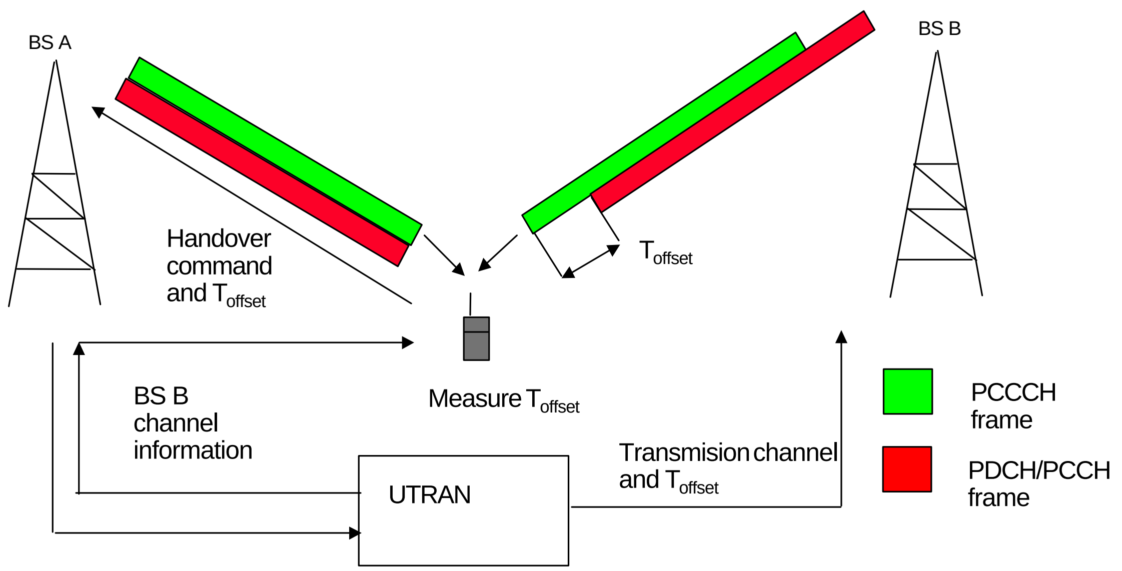

Figure 3: Making transmissions capable to be combined in the Rake receiver from timing point of view

8.2 UTRA to UTRA hard-handover

8.2.1 FDD to FDD

8.2.2 FDD to TDD

8.2.3 TDD to FDD

8.2.4 TDD to TDD

8.3 UTRA to GSM hard-handover

8.3.1 Handover execution for FDD to GSM

8.3.1.1 Handover execution for scenario A

After having received a message requiring handover execution, the UE stops receiving and transmitting on the FDD cell and establishes the main signalling link on the target GSM cell as described in GSM 05.08 and 04.08.

The possibility for the current FDD cell to keep the old channel during a few seconds to allow the UE to come back to this cell after handover failure on the target GSM cell is for further study.

8.3.1.2 Handover execution for scenario B

Call set-up involves DCH allocation.

After having received a message requiring handover execution, the UE stops receiving and transmitting on the FDD cell and establishes the main signalling link on the target GSM cell as described in GSM 05.08 and 04.08.

The possibility for the current FDD cell to keep the old channel during a few seconds to allow the UE to come back to this cell after handover failure on the target GSM cell is for further study.

Call set-up does not involve DCH allocation.

An example of handover between FDD and GSM co-located cells without any preparation could be as following ; after the UE is assigned a frequency belonging to the GSM co-located cell it stops transmitting and receiving on the FDD cell. As it has not any synchronisation knowledge about the GSM cell, the UE then listen to the BCCH frequency to get the slot and frame synchronisation (FCCH and SCH decoding). Finally, the UE establishes the dedicated channel on the required frequency of the target GSM cell.

8.3.2 Handover execution from TDD to GSM

8.3.2.1 Handover execution for scenario A

8.3.2.2 Handover execution for scenario B

8.3.3 Handover failure

The behaviour of the UE after handover failure on the target GSM cell is for further study.

History

Document history		
Date	**Version**	**Comment**
Sept 7th, 1998	0.0.1	First version issues based on FDD description version 4.0.0 and Tdoc SMG2 L1 177/98 agreed during UMTS L1 #5.
Sept 10th, 1998	0.0.2	Second version produced at the UMTS L1 #6 meeting, which aims to avoid overlap between the XX.16 (inter-operability permanent document) and XX.15. The scope of the handover scenarios section in XX.15 was modified in order to cover only the background requirement in terms of monitoring and reporting time, as a function of deployment aspects and inter-operability with GSM as described in XX.16, version 0.0.2 Comments made during the UMTS L1#6 were also taken into account, when they applied to the revised scope of XX.15.
Nov 1st, 1998	0.1.0	Third version produced as the results of the decisions taken at the UMTS L1 #7 meeting. • As agree the text contained in Tdoc UMTS L1 421 was included. However section on monitoring was made to be more general since the text agreed for soft handover applies to monitoring of cells on the same frequency in general not only for soft handover. • As well as some sentences in Tdoc UMTS L1 443 on the handover types (relative to the hard handover between different frequencies on the same cells) where included as agreed at the UMTS L1 #7 meeting. Editor modifications were also performed consisting in changing BTS into cells, mobile stations into UE, BTS site into node B and network into UTRAN.
Jan 14th, 1999	0.2.0	This fourth version is produced as an output of the UMTS L1 #9 meeting. A large part of the text included in Tdoc UMTS L1 451/98, that dealt with handover preparation from TDD to GSM, had been agreed for inclusion and is contained in Tdoc 763/98. Tdoc 763/98 was entirely incorporated in this version, with editorial modification. An editor’s note is added to suggest that is conclusion is taken as far as the low bit rate data services
Jan 19th, 1999	0.3.0	This fifth version is produced as an output of the UMTS L1 #10 meeting, that agreed to include text proposed in UMTS L1 Tdoc 16/99, entitled "a Unified approach for synchronisation issues for Handover preparation from FDD to GSM".
Feb 1st	1.0.0	Version raised after approval from SMG2 #29 plenary

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