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Technical Report

**3rd Generation Partnership Project;
Technical Specification Group Radio Access Network;
Improved Network Controlled Mobility between E-UTRAN and 3GPP2/Mobile WiMAX Radio Technologies
(Release 9)**

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Contents

Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

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

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1 Scope

It is expected that IP based 3GPP services will be provided through various access technologies, including existing broadband radio access standards like IEEE 802.16e/ETSI BRAN, and 3GPP2 including HRPD and 1xRTT. In order to achieve this, inter-technology mobility between E-UTRAN and 3GPP2/Mobile WiMAX is considered in the study item "Improved Network Controlled Mobility between E-UTRAN and 3GPP2/Mobile WiMAX Radio Technologies".

The purpose of this TR is to help TSG RAN to capture a stage 2 level solution for each of the studied mobility scenarios, which can be used as a basis to initiate the stage 3 work when moving to the work item phase. This activity involves the Radio Access Network work area of the 3GPP studies for mobility and has impacts on both the Mobile Equipment and Access Network of the 3GPP systems. Architecture impact involving non-RAN nodes is under the responsibility of SA2.

2 References

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

1. References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
2. For a specific reference, subsequent revisions do not apply.
3. 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 TR 25.913: "Requirements for Evolved UTRA (E-UTRA) and Evolved UTRAN (E-UTRAN)".

[3] 3GPP TR 23.401: "3GPP System Architecture Evolution: GPRS Enhancements for E-UTRAN Access".

[4] 3GPP TR 23.402: "3GPP System Architecture Evolution: Architecture Enhancements for non-3GPP accesses".

[5] 3GPP2 C.S0024-A: "cdma2000 High Rate Packet Data Air Interface Specification".

[6] 3GPP2 C.S0024-0: "cdma2000 High Rate Packet Data Air Interface Specification".

[7] 3GPP2 C.S0001-A: "Introduction to cdma2000 Spread Spectrum Systems – Release A".

[8] 3GPP2 C.S0002-A: "Physical Layer Standard for cdma2000 Spread Spectrum Systems – Release A".

[9] 3GPP2 C.S0003-A: "Medium Access Control (MAC) Standard for cdma2000 Spread Spectrum Systems – Release A".

[10] 3GPP2 C.S0004-A: "Signaling Link Access Control (LAC) Standard for cdma2000 Spread Spectrum Systems – Release A".

[11] 3GPP2 C.S0005-A: "Upper Layer (Layer 3) Signaling Standard for cdma2000 Spread Spectrum Systems – Release A".

[12] 3GPP2 C.S0057-B: "Band Class Specification for cdma2000 Spread Spectrum Systems".

[13] WiMAX Forum™ Mobile System Profile Release 1.0 (Revision 1.4.0), May 2, 2007.

[14] WiMAX Forum™ Network Architecture Release 1.0.0, March, 2007.

[15] IEEE Standard 802.16e-2005: "Air Interface for Fixed Broadband Wireless Access Systems- Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands"

[16] 3GPP TS 36.304: "Evolved Universal Terrestrial Radio Access (E-UTRA) User Equipment (UE) procedures in idle mode (Release 8)"

[17] 3GPP TR 23.882: " 3GPP system architecture evolution (SAE): Report on Technical Options and Conclusions (Release 7)" V 1.12.0 (2007-10)

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [2] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [2].

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Carrier frequency: center frequency of the cell.

Frequency layer: set of cells with the same carrier frequency.

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:

aGW	E-UTRAN Access Gateway
ARQ	Automatic Repeat Request
AS	Access Stratum
CP	Control Plane
DL	Downlink
eNB	E-UTRAN NodeB
E-UTRA	Evolved Universal Terrestrial Radio Access
E-UTRAN	Evolved Universal Terrestrial Radio Access Network
HARQ	Hybrid Automatic Repeat Request
HRPD	High Rate Packet Data
HO	Handover
L1	Layer 1 (physical layer)
L2	Layer 2 (data link layer)
L3	Layer 3 (network layer)
MAC	Medium Access Control
NAS	Non-Access Stratum
PDCP	Packet Data Convergence Protocol
PDU	Protocol Data Unit
PS	Physical Slot
PUSC	Partial Usage of Subchannels
RLC	Radio Link Control
RRC	Radio Resource Control
RTG	Receive/transmit Transition Gap
SAE	System Architecture Evolution
SDU	Service Data Unit
TCH	Traffic Channel
TTG	Transmit/receive Transition Gap
UE	User Equipment
UL	Uplink
UP	User Plane
UMTS	Universal Mobile Telecommunications System
UTRA	Universal Terrestrial Radio Access
UTRAN	Universal Terrestrial Radio Access Network
WiMAX	Worldwide Interoperability Microwave Access

Other abbreviations used in the present document are listed in 3GPP TR 21.905 [2].

4 UE Capability Configuration

UE shall be able to communicate with E-UTRAN about its radio access capability, such as the system (including the release and frequency band) it supports and its receive and transmission capabilities (single/dual radio, dual receiver). UE shall transfer its capability about other radio technologies over E-UTRAN using the same procedure used to carry its E-UTRAN radio capability.

The following UE capabilities are transferred to the network.

- Non-3GPP access technology supporting Inter-RAT HO
  - Identifies non-3GPP access (HRPD, 1xRTT, WiMAX) supported by the UE
  - Identifies if inter-RAT HO is supported by the UE for the non-3GPP access
- List of applicable frequencies bands per access technology
  - Identifies the frequency bands per access technology supported by the UE
  - UE transmit configuration (single/dual)
    - Identifies whether the UE supports a single or dual transmitter
  - UE receive configuration (single/dual)
    - Identifies whether the UE supports a single or dual receiver

- Measurement gaps
  - Identifies whether the UE requires UL/DL measurement gaps

Note: Only capabilities directly related to RAN mobility are discussed. Other UE capabilities related to non-3GPP technologies (e.g. 3GPP2 MEID) can also be transferred over E-UTRAN. The details will be investigated during Stage 3 work.

5 General Requirement on E-UTRAN

The E-UTRAN shall have the following capabilities:

1. Support measurements of non 3GPP channels from the E-UTRAN;

2. Support the ability to trigger a handover to the non 3GPP system;

3. Support the ability to tunnel messages between the non 3GPP system and the E-UTRAN system;

4. Enable varying level of interworking in the specification. Depending on interworking level UE may need to use a tunnelling mechanism that minimizes the coupling between the E-UTRAN and the non 3GPP systems (to perform a handover towards a non 3GPP system);

5. The E-UTRA specifications shall allow different terminal design and interworking levels between the non 3GPP system and E-UTRAN.

6 Mobility between E-UTRAN and 3GPP2 Networks

6.1 Tunneling of cdma2000 Messages over E-UTRAN between UE and cdma2000 Access Nodes

In order to efficiently support handover procedures when on E-UTRAN with the target system, cdma2000 messages are sent transparently to the target system over the E-UTRAN, with the eNB and MME acting as relay points.

To support the MME in its selection of the correct target system node to which it should route an Uplink tunneled message and to provide the target system with information that is needed to resolve technology-specific measurement information (RouteUpdate and pilot strength measurements) that are delivered to the cdma2000 system each eNB cell is associated with a cdma2000 HRPD SectorID and/or with a cdma2000 1xRTT SectorID (generically referred to as cdma2000 reference cellid). This cdma2000 reference cellid is provided by the eNB to the MME over the cdma2000 message transfer capability over S1-AP and forwarded to the target system via the S101 interface and corresponding interface to the cdma2000 1xRTT system.

Further optimization to handle overlapping HPRD coverage areas at the same E-UTRAN cell will be investigated during Stage 3 development.

Tunneling is achieved over the E-UTRAN air link by encapsulating a tunneled cdma2000 messages in the UL Information Transfer and DL Information Transfer RRC messages (e.g., similar to UMTS Uplink/Downlink Direct Transfer). This requires the addition of a specific IE in these RRC message to identify the type of information contained in the message (e.g., NAS, TunneledMsg). Additionally if the message is carrying a tunneled message, an additional IE needs to be added that will carry RRC Tunneling Procedure Information.

RRC Tunneling Procedure Information in the UL direction will include:

- RAT type (1xRTT encapsulated, HRPD encapsulated)

- 3GPP2 message type (e.g. pre-registration or handover initiation)

RRC Tunneling Procedure Information in the DL direction will include:

- RAT type (1xRTT encapsulated, HRPD encapsulated)

AS level security will be applied for these UL Information Transfer and DL Information Transfer RRC messages as normal but there is no NAS level security for these tunneled cdma2000 messages.

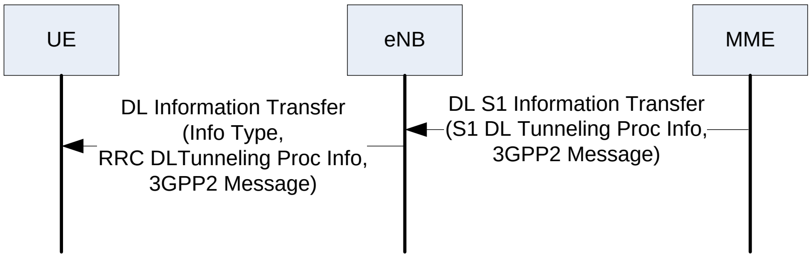

Figure 6.1-1 Downlink Direct Transfer

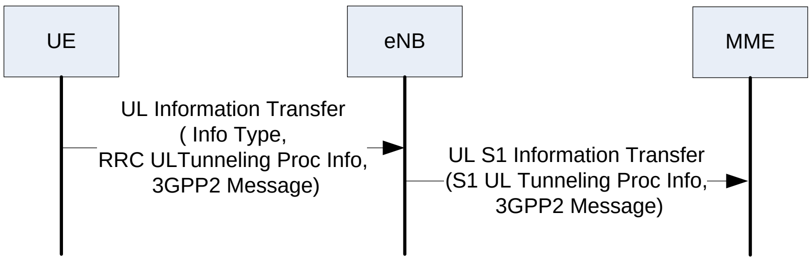

Figure 6.1-2 Uplink Direct Transfer

Tunneling to the MME is achieved over the S1-MME interface by encapsulating the tunneled cdma2000 message in a new S1-MME S1 Information Transfer message. These new S1-MME messages carry S1 Tunneling Procedure Information as well as the tunneled message.

S1 Tunneling Procedure Information in the UL direction will include:

- 3GPP2 Reference Cell Id
- RAT type (1xRTT encapsulated, HRPD encapsulated)
- 3GPP2 message type (e.g. pre-registration or handover initiation)

S1 Tunneling Procedure Information in the DL direction will include:

- RAT type (1xRTT encapsulated, HRPD encapsulated)
- 3GPP2 message type (e.g. pre-registration or handover completion)
- Data forwarding information if required

Further refinement of the Handover messages (e.g. reusing "Information Transfer" or using Handoff specific messages) shall be dealt with during Stage 3 development.

6.2 Mobility between E-UTRAN and HRPD

The system shall support bidirectional seamless service continuity between cdma2000 HRPD (1xEV-DO) Release A [5] and E-UTRAN for best-effort and real-time applications.

The system shall support bidirectional seamless service continuity between cdma2000 HRPD (1xEV-DO) Release 0 [6] and E-UTRAN for best-effort applications.

6.2.1 Supported Frequency Band and System Release

The system shall support mobility between E-UTRAN and cdma2000 HRPD Release A among all cdma2000 band classes [12] and E-UTRAN band classes.

The system shall support mobility between E-UTRAN and cdma2000 HRPD Release 0 among cdma2000 band classes [6] and all E-UTRAN band classes.

6.2.2 Network Architecture and Interfaces

The following architecture, as specified in [4], provides support for interworking and mobility between E-UTRAN and cdma2000 HRPD networks.

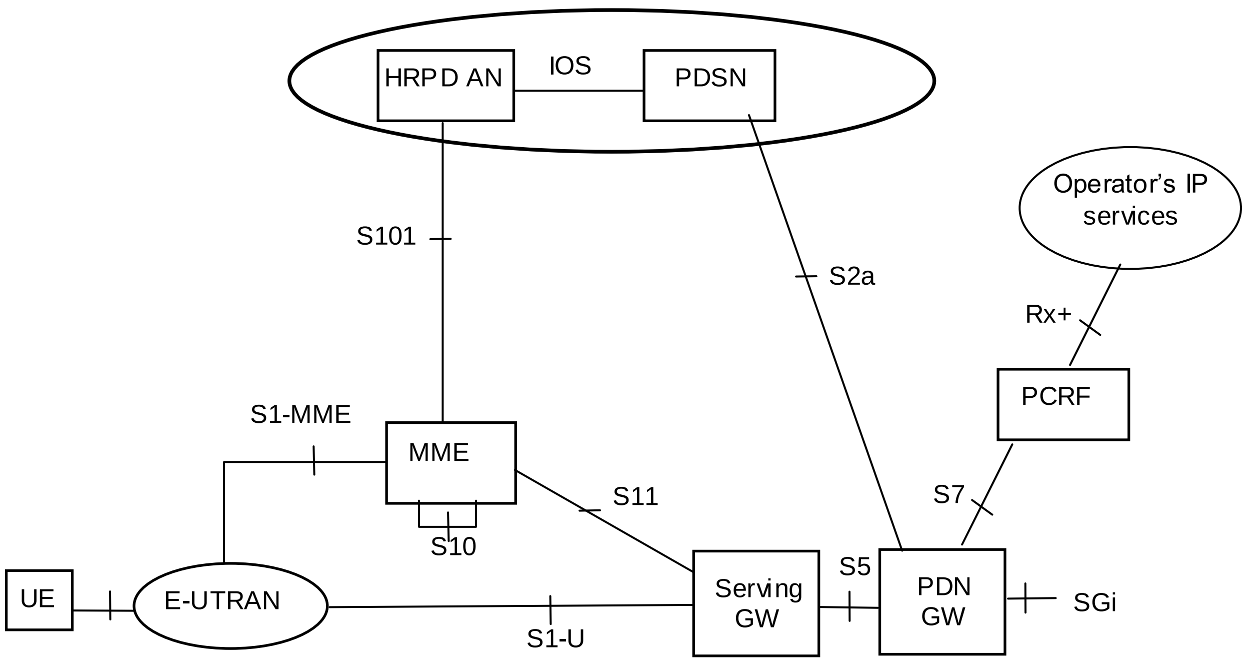

Figure 6.2-1 Architecture for E-UTRAN-HRPD Interworking and Mobility

All of the interfaces and network entities that separate SAE/LTE from HRPD in Figure 6.2-1 are defined in [4].

S101 enables interactions between EPS and HRPD access to allow for pre-registration and handover signalling with the target system

6.2.3 Mobility from E-UTRAN to HRPD

6.2.3.1 HRPD System Information Transmission in E-UTRAN

The HRPD system information block (SIB) shall be included in the Dynamic System Information (SI) of E-UTRAN BCCH for dynamic adjustment of the transmission cycle. The investigation into which SIB(s) the 3GPP2 system information should be has to be in line with RAN2's decision of inter-RAT system information distribution into SIBs and will be dealt with during stage-3 development. The UE shall monitor the E-UTRAN BCCH during the LTE_IDLE and LTE_ACTIVE modes to retrieve the 3GPP2 system information for the preparation of handover from the E-UTRAN to HRPD system. If monitoring the E-UTRAN BCCH during the LTE_ACTIVE mode is not supported, the E-UTRAN shall provide the UE the HRPD system information through dedicated signalling.

The following system information IEs shall be transmitted on E-UTRAN broadcast channel:

- HRPD pre-registration allowed
    a. If the indication is positive, the UE in LTE_IDLE shall perform pre-registration if UE does not have a valid/current HRPD pre-registration; if the indication is negative, the UE in LTE_IDLE shall not perform pre-registration.
- HRPD Pre-registration Zone
    a. Identifies the HRPD AN associated with the E-UTRAN cell (details to be defined in stage 3). When the UE moves from one pre-registration zone to another it will pre-register again if it was already pre-registered.
    b. UE with dual receiver can ignore this item.
- HRPD Neighbor Bandclass
    a. Identifies the frequency band in which the HRPD carriers can be found
    b. Multiple Bandclass IEs can be included
- HRPD Neighbor Frequency
    a. Identifies the carrier frequency within an HRPD band
    b. Multiple carrier frequencies IEs can be included per band
- HRPD Neighbor PN Sequence Offset
    a. Identifies the different HRPD "physical cell identities"
    b. Multiple PN Sequence Offset IEs can be included per carrier
    c. This parameter might not be needed in case all UEs supports dual mode receivers (parallel reception on both accesses)
- HRPD Pilot PN sequence offset index increment
    a. This parameter might not be needed in case all UEs supports dual mode receivers (parallel reception on both accesses)
- HRPD Timing Reference
    a. cdma system time [5] for the starting point of an E-UTRAN subframe;
    b. This parameter might not be needed in case all UEs supports dual mode receivers (parallel reception on both accesses)
    c. If the working assumption is that reading of the BCCH should not be required in LTE_ACTIVE mode, then cdma system time will be provided over dedicated signalling in LTE_ACTIVE mode
- HRPD Searching Window Size
- Number of HRPD Neighbor Bandclass
- Number of HRPD Neighbor Frequency
- Number of HRPD Neighbor PN Sequence Offset
- HRPD Start Measuring E-UTRAN Signal Quality Threshold
- HRPD Start Measuring E-UTRAN Rx Power Strength Threshold

In addition, parameters similar to those used in the intra-3GPP inter-RAT idle mode mobility can also be sent on the E-UTRAN broadcast channel.

6.2.3.2 Measuring HRPD from E-UTRAN

Measurement events and parameters proposed in this TR are assuming Rel-7 inter-RAT measurement framework, alignment with the Rel-8 LTE inter-RAT measurement framework needs to be looked in to when the LTE inter-RAT measurement framework is defined.

6.2.3.2.1 Idle Mode Measurement Control

UE shall be able to make measurements on the HRPD cells in LTE_IDLE mode to perform cell re-selection. UE shall perform HRPD neighbor cell measurements during DRX periods, between paging occasions.

One way to control the idle mode measurements on HRPD is to re-use mechanisms for the intra-3GPP inter-RAT idle mode measurement control. The UE performs measurement on HRPD when the signal quality from E-UTRAN serving cell falls below a given threshold. Additional parameters that control idle mode measurement on HRPD are,

- HRPD Start Measuring LTE Signal Quality Threshold:

  The received signal quality threshold value (relative measurement) is used in the E-UTRAN to determine if HRPD measurements should start;

- HRPD Start Measuring LTE Rx Power Strength Threshold:

  The received power level threshold value (absolute measurement) is used in the E-UTRAN to determine if HRPD measurements should start.

The following rules shall be followed in the idle mode measurement on HRPD system:

If the measured Signal Quality of the serving cell <= HRPD Start Measuring LTE Signal Quality Threshold or the measured Rx Power Strength of the serving cell <= HRPD Start Measuring LTE Rx Power Strength Threshold, the UE shall start making HRPD measurements.

If the measured Signal Quality of the serving cell > HRPD Start Measuring LTE Signal Quality Threshold and the measured Rx Power Strength of the serving cell > HRPD Start Measuring LTE Rx Power Strength Threshold, the UE shall stop making HRPD measurements.

6.2.3.2.2 Active Mode Measurement Control

While the UE is attached in the E-UTRAN network, in LTE_ACTIVE mode, the UE shall perform radio measurements on the HRPD network when directed by the E-UTRAN network. The network provides the required HRPD neighbor cell list information and measurement controls to the UE through dedicated RRC signaling. When needed the eNB is responsible for configuring and activating the HRPD measurements on the UE via the dedicated RRC Connection Reconfiguration signaling message with newly defined IEs.

As for intra-3GPP inter-RAT measurement reporting, periodic and event-triggered measurements are supported. For event-triggered measurements, the events defined for intra-3GPP inter-RAT mobility can be reused, i.e. there is no need to define any HRPD specific events. Based on Rel-7, the following events should be considered:

- Inter-RAT event 1: The estimated quality of the serving LTE cell is below a certain threshold **and** the estimated quality of an HRPD cell is above a certain threshold
- Inter-RAT event 2: The estimated quality of an HRPD cell is above a certain threshold
- Inter-RAT event 3: The estimated quality of HRPD cells is below a certain threshold
- Inter-RAT event 4: Change of best cell in HRPD

For measurement configuration of event-triggered measurements, the following main parameters should be available for each Target RAT:

- Threshold: this is the actual threshold used to trigger the event. The actual threshold definition depends on the event being configured.
- Hysteresis: parameter allowing to control ping-pong between cells
- Time-to-trigger: time during which the triggering condition must be met for a certain cell in order for the measurement report to be triggered

For single-radio terminals, measurement gaps are needed to allow the UE to switch into the HRPD network and do radio measurements. These measurement gaps are network-controlled. The eNB is responsible for configuring the gap pattern and providing it to the UE through RRC dedicated signaling. Terminals with a dual receiver perform measurements on HRPD neighbor cells without tuning away from the E-UTRAN network. No DL gap patterns will be required for UEs which are capable of simultaneous reception on the involved frequency bands. No UL gap patterns will be required for UEs which are capable simultaneous transmission in one access and measuring on another access.

The existing inter-frequency / RAT gap pattern mechanism in E-UTRAN shall be extended to also support gap patterns suitable for HRPD measurements.

In order to assist the eNB, the UE shall inform the network of its gap-related capabilities. This capability shall be transferred along with other UE capabilities. The UE shall at least indicate if it has a dual receiver. In cases that the measurement gaps are not required, the eNB can configure measurements on HRPD cells without the need to configure the measurement gaps.

6.2.3.2.3 Active Mode Measurement

In LTE_ACTIVE mode, the UE shall report the HRPD neighbor cells' Pilot PN Offsets and pilot strengths of the cells identified in the neighbor cell list whose pilot strengths are above the threshold. To do this, the UE shall measure the neighboring HRPD cells' power levels. The UE does not need to decode the synch channel if it has already acquired HRPD synchronization. The UE only needs to decode the PN offset of the HRPD neighbor cells to perform the measurement. The UE shall report the set of Pilot PN Offsets and associated Pilot Strengths in the RRC Measurement Report Message using new IEs for the HRPD specific information.

6.2.3.3 Pre-registration to HRPD Procedure

Pre-registration lets UE pre-register to HRPD system in advance of a cell re-selection or handover. It reduces the time involved in the process of handover or cell re-selection. It also reduces the risk of the UE experiencing a radio link failure while waiting for the "handover command". E-UTRAN network can instruct the UE whether the pre-registration is needed over broadcast channel and possibly the Measurement Configuration message. This makes it possible to avoid pre-registration attempts in areas with no HRPD coverage or no support for HRPD pre-registration.

The need for pre-registration is configured in the network in the following way:

- information provided on the E-UTRAN system information broadcast channel indicates whether pre-registration for UEs in LTE_IDLE is allowed
    - If the indication is positive, the UE shall perform pre-registration if the UE does not have a valid/current HRPD pre-registration; if the indication is negative, the UE shall not perform pre-registration.
    - The information can be provided in conjunction with or by the presence of other CDMA2000 specific IEs (e.g. neighbouring cell information).
    - When the UE performs the pre-registration, it first enters LTE_ACTIVE in E-UTRAN using the NAS Service Request procedure. Upon completion of the pre-registration the UE might be released to LTE_IDLE.
- information sent in dedicated RRC signalling (unless it is determined that the UE will read the E-UTRAN system information broadcast channel in LTE_ACTIVE) indicates whether pre-registration for UEs in LTE_ACTIVE is allowed.
    - If the indication is positive, the UE shall perform pre-registration if the UE does not have a valid/current HRPD pre-registration; if the indication is negative, the UE shall not perform pre-registration.
    - The information can if possible be provided in conjunction with or by the presence of other CDMA2000 specific IEs (e.g. measurement configuration).

E-UTRAN does not need to know whether a specific UE is pre-registered or not.

The pre-condition of the pre-registration is that the UE is already attached to E-UTRAN network and the UE does not have a dormant session in HRPD network yet. The procedure should be transparent to E-UTRAN network. In the pre-registration to HRPD, messages shall be tunnelled inside RRC and S1-AP messages between the UE and MME and in some generic "transfer" messages between source MME and target RNC.

Figure 6.2-2 shows the procedure for pre-registration to HRPD. At the end of the pre-registration the UE has a valid context in the HRPD system. The UE is responsible for maintaining the HRPD context e.g. by performing periodic re-registrations if needed. The UE will use "HRPD Pre-registration Zone" to decide whether a re-registration shall be performed. A dual-receiver UE can ignore the parameter. E-UTRAN will provide the "HRPD Pre-registration Zone" parameter on the E-UTRAN system information broadcast channel or dedicated RRC signalling (unless it is determined that the UE will read the E-UTRAN system information broadcast channel in LTE_ACTIVE). Re-registrations are only allowed in areas where pre-registration is requested.

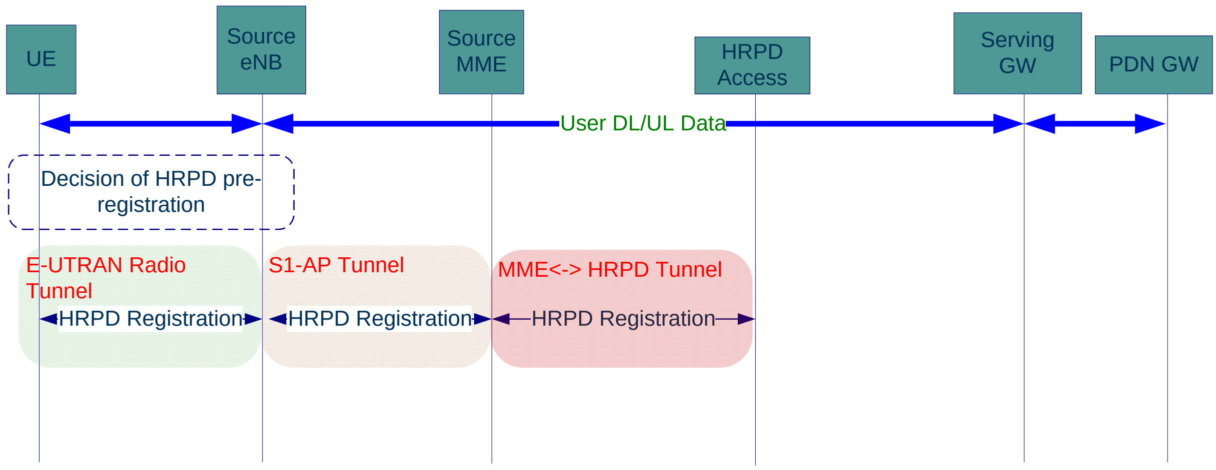

Figure 6.2-2 Pre-registration to HRPD procedure

6.2.3.4 E-UTRAN to HRPD Cell Re-selection

Figure 6.2-3 is the signalling flow for cell re-selection from E-UTRAN to HRPD.

The pre-condition is that the UE is attached in the E-UTRAN network and is in E-UTRAN_IDLE state, and the UE has a dormant HRPD session in the target HRPD network, either through the pre-registration procedure or previous HRPD attachment.

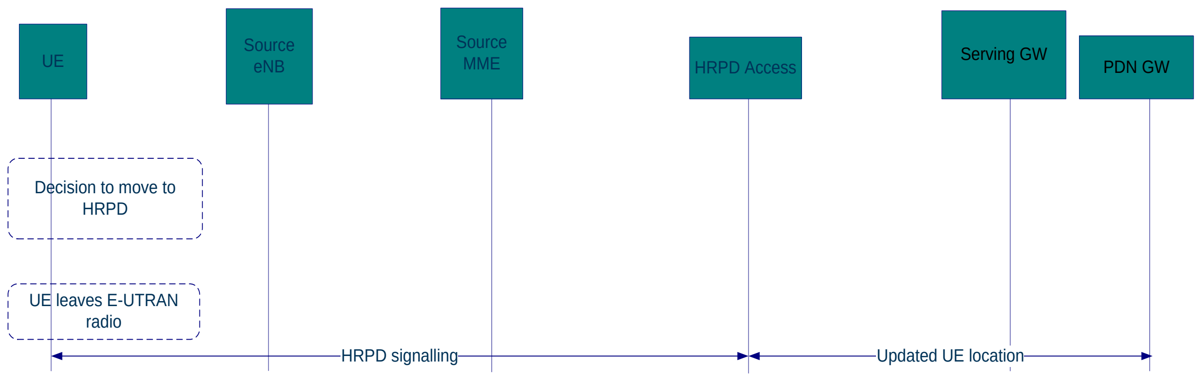

Figure 6.2-3 E-UTRAN to HRPD Cell Re-Selection

Cell reselection from E-UTRAN to HRPD should be aligned with 3GPP inter RAT cell reselection mechanism. The features/parameters designed for 3GPPP inter RAT idle mode mobility should be applied to idle mode mobility between E-UTRAN and HRPD as much as possible. An instance of the set of parameters defined to support these features should be defined for HRPD.

In case only a single value of Treselection is defined for 3GPP inter RAT idle mode mobility, it may be necessary to define specific values of Treselection for HRPD

Schemes on intelligent camping that may be decided in RAN2 (e.g. offset based or priority based) should be applied to HRPD as much as possible.

6.2.3.5 E-UTRAN to HRPD Handover

Figure 6.2-4 shows the handover procedure. The pre-condition for the procedure is that the UE is attached in the E-UTRAN network in E-UTRAN_ACTIVE state and has a dormant HRPD session in the target network (setup during pre-registration). Based on measurement reports received from the UE the eNB initiates a handover by sending a “Handover from E-UTRAN Command” message to the UE to indicate to the UE that it should begin the handover procedure. This message shall include the specified target type and any 3GPP2 specific HRPD parameters needed by the UE to create the appropriate HRPD messages needed to request a connection. These HRPD access parameters are transparent to E-UTRAN. The set of the required HRPD access parameters are to be specified in 3GPP2. The UE can continue to send and receive data on the E-UTRAN radio until it receives the “handover command” ordering it to switch to the target HRPD cell. After the “handover command” is received by the UE, the UE shall leave the E-UTRAN radio and start acquiring the HRPD traffic channel. It will be investigated by 3GPP2 if any additional HRPD parameters is are required for the UE to acquire the HRPD traffic channel. If it is decideddetermined that some additional HRPD parameters are required, the E-UTRAN shall deliver these parameters, which are transparent to E-UTRAN, to the UE before the UE leaves the E-UTRAN radio. The detailed mechanism to deliver these parameters, if required, shall be dealt with during stage-3 development.

The HRPD handover signalling is tunnelled between the UE and HRPD network. It is beneficial if E-UTRAN receives information from the HRPD network about the high level progress of the ongoing HRPD signalling (e.g. Handover Success, Handover Failure). E-UTRAN shall transport the additional HRPD parameters to the UE to assist handover to the HRPD systems. The HRPD parameters are transparent to E-UTRAN. The set of the required HRPD parameters are to be specified in 3GPP2.

When the UE receives the HRPD Traffic Channel Assignment Message (tunnelled over the E-UTRAN), it shall leave the E-UTRAN radio and perform its access over the HRPD radio.

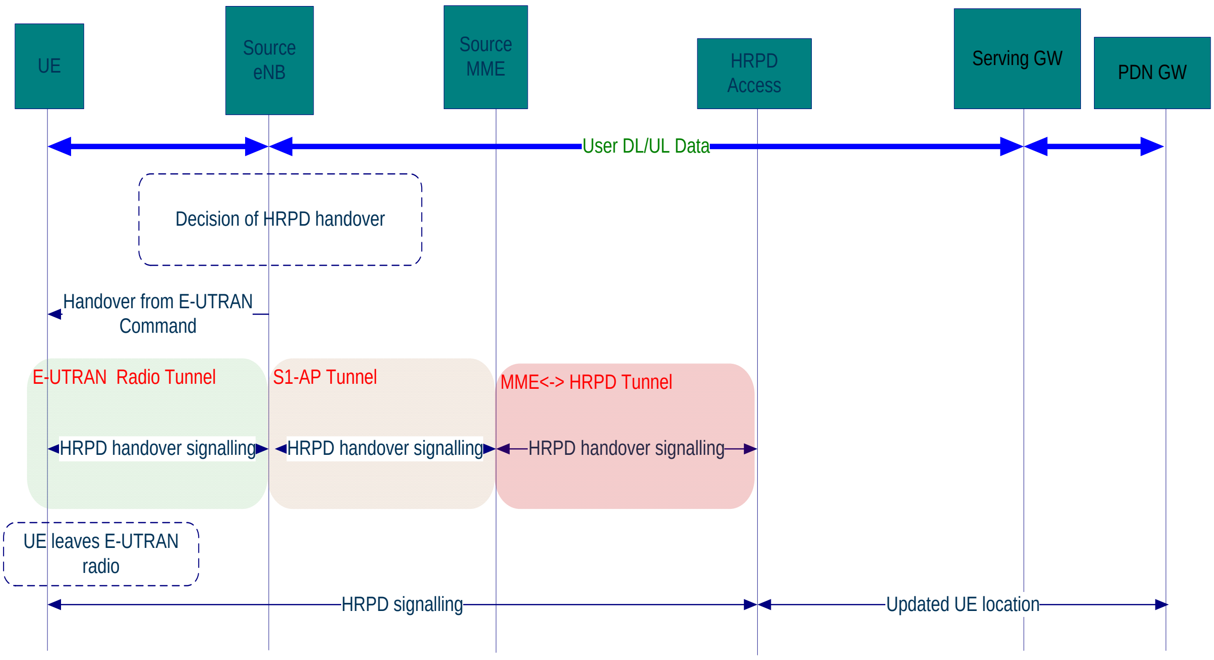

Figure 6.2-4 E-UTRAN to HRPD Handover Procedure

6.2.4 Mobility from HRPD to E-UTRAN

6.2.4.1 HRPD to E-UTRAN Cell Re-selection

It would be possible to reduce the outage time and minimize the risk of lost page messages if the UE performs Attach procedure specified in [3] through the HRPD access prior to leaving HRPD and performing a Tracking Area Update. The Attach procedure should be similar to the normal E-UTRAN Attach procedure with the difference that no S1 context is setup (only transparent signalling over HRPD access is performed).

Upon switching its radio to E-UTRAN, UE performs the normal Tracking Area Procedure used in LTE_Idle mode.

6.2.4.2 HRPD to E-UTRAN Handover

Figure 6.2-5 illustrates the high level procedure.

UE shall perform an Attach procedure and trigger relocation to E-UTRAN while it is still in HRPD. The signalling shall be tunnelled transparently over the HRPD access and the HRPD – MME interface.

E-UTRAN shall be able to send an RRC "Handover to E-UTRAN Command" message containing RRC connection information as well as tunnelled NAS information from MME to UE over HRPD access and the HRPD – MME interface.

UE shall be able to send an RRC "Handover to E-UTRAN Complete" over the E-UTRAN radio.

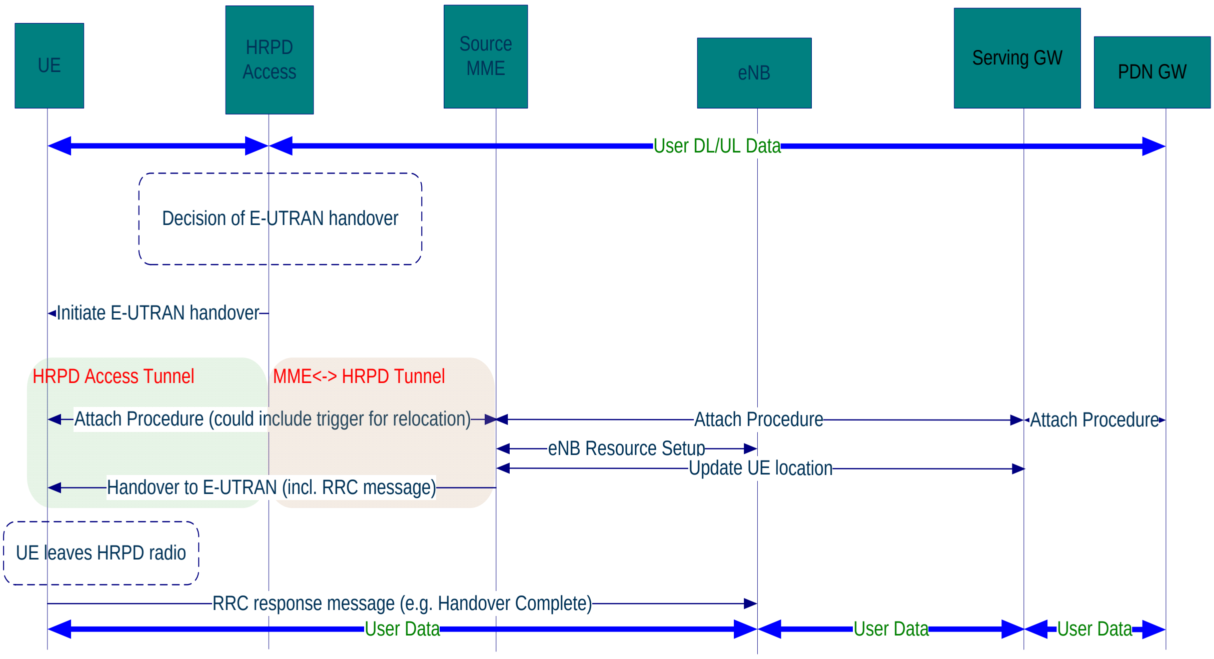

Figure 6.2-5 HRPD to E-UTRAN handover

6.3 Mobility between E-UTRAN and cdma2000 1X

The system shall support seamless voice service continuity from E-UTRAN to cdma2000 1xRTT Release A [7]-[11].

The system shall support bidirectional data service interworking between E-UTRAN and cdma2000 1xRTT Release A. There are no requirements that this be seamless.

6.3.1 Supported Frequency Band and System Release

The system shall support mobility between E-UTRAN and cdma2000 1xRTT Release A among all cdma2000 band classes [12] and E-UTRAN band classes.

6.3.2 Network Architecture and Interfaces

Identification of the architecture to support mobility between E-UTRAN and cdma2000 1x networks is a work in progress within SA2. SA2 has captured a potential architecture in the latest version of TR 23.882 [17].

6.3.3 Mobility from E-UTRAN to cdma2000 1X

6.3.3.1 cdma2000 1X System Information Transmission in E-UTRAN

The cdma2000 1X system information block (SIB) shall be included in the Dynamic System Information (SI) of E-UTRAN BCCH for dynamic adjustment of the transmission cycle. The UE shall monitor the E-UTRAN BCCH during the LTE_IDLE and LTE_ACTIVE modes to retrieve the 3GPP2 system information for the preparation of handover from the E-UTRAN to cdma 2000 1X system. If monitoring the E-UTRAN BCCH during the LTE_ACTIVE mode is not supported, the E-UTRAN shall provide the UE the cdma2000 1X system information through dedicated signalling.

The following system information IEs shall be transmitted on E-UTRAN broadcast channel:

- cdma2000 1X Neighbor Bandclass
    a. Identifies the frequency band in which the cdma2000 1X carriers can be found
    b. Multiple Bandclass IEs can be included
- cdma2000 1X Neighbor Frequency
    a. Identifies the carrier frequency within an cdma2000 1X band
    b. Multiple carrier frequencies IEs can be included per band
- cdma2000 1X Neighbor PN Sequence Offset
    a. Identifies the different 1xRTT “physical cell identities”
    b. Multiple PN Sequence Offset IEs can be included per carrier
    c. This parameter might not be needed in case all UEs supports dual mode receivers (parallel reception on both accesses)
- cdma2000 1X Pilot PN sequence offset index increment
    a. This parameter might not be needed in case all UEs supports dual mode receivers (parallel reception on both accesses)
- cdma2000 1X Timing Reference
    a. cdma system time [7] for the starting point of an E-UTRAN subframe
    b. This parameter might not be needed in case all UEs supports dual mode receivers (parallel reception on both accesses)
    c. If the working assumption is that reading of the BCCH should not be required in LTE_ACTIVE mode, then cdma system time will be provided over dedicated signalling in LTE_ACTIVE mode
- cdma2000 1x Searching Window Size
- Number of cdma2000 1X Neighbor Bandclass
- Number of cdma2000 1X Neighbor Frequency
- Number of cdma2000 1X Neighbor PN Sequence Offset
- cdma2000 1X Start Measuring E-UTRAN Signal Quality Threshold
- cdma2000 1X Start Measuring E-UTRAN Rx Power Strength Threshold

In addition, parameters similar to those used in the intra-3GPP inter-RAT idle mode mobility can also be sent on the E-UTRAN broadcast channel.

6.3.3.2 Measuring cdma2000 1X from E-UTRAN

Measurement events and parameters proposed in this TR are assuming Rel-7 inter-RAT measurement framework, alignment with the Rel-8 LTE inter-RAT measurement framework needs to be looked in to when the LTE inter-RAT measurement framework is defined.

6.3.3.2.1 Idle Mode Measurement Control

UE shall be able to make measurements on the 1xRTT system cells in LTE_IDLE mode to perform cell re-selection. UE shall perform cdma2000 1X neighbor cell measurements during DRX periods, between paging occasions.

One way to control the idle mode measurements on cdma2000 1X is to re-use mechanisms for the intra-3GPP inter-RAT idle mode measurement control. The UE performs measurement on cdma2000 1X when the signal quality from E-UTRAN serving cell falls below a given threshold. Additional parameters that control idle mode measurement on cdma2000 1X are,

- cdma2000 1X Start Measuring LTE Signal Quality Threshold:

  The received signal quality threshold value (relative measurement) is used in the E-UTRAN to determine if cdma2000 1X measurements should start;

- cdma2000 1X Start Measuring LTE Rx Power Strength Threshold:

  The received power level threshold value (absolute measurement) is used in the E-UTRAN to determine if cdma2000 1X measurements should start.

The following rules shall be followed in the idle mode measurement on cdma2000 1X system:

> If the measured Signal Quality of the serving cell <= cdma2000 1X Start Measuring LTE Signal Quality Threshold or the measured Rx Power Strength of the serving cell <= cdma2000 1X Start Measuring LTE Rx Power Strength Threshold, the UE will start making cdma2000 1X measurements.

> If the measured Signal Quality of the serving cell > 1xRTT Start Measuring LTE Signal Quality Threshold and the measured Rx Power Strength of the serving cell > 1xRTT Start Measuring LTE Rx Power Strength Threshold, the UE will stop making cdma2000 1X measurements.

6.3.3.2.2 Active Mode Measurement Control

While the UE is attached in the E-UTRAN network, in LTE_ACTIVE mode, the UE shall perform radio measurements on the cdma2000 1X network when directed by the E-UTRAN network. The network provides the required cdma2000 1X neighbor cell list information and measurement controls to the UE through dedicated RRC signaling.. When needed the eNB is responsible for configuring and activating the cdma2000 1X measurements on the UE via the dedicated RRC Connection Reconfiguration signaling message with newly defined IEs.

As for intra-3GPP inter-RAT measurement reporting, periodic and event-triggered measurements are supported. For event-triggered measurements, events defined for intra-3GPP inter-RAT mobility can be reused, i.e. there is no need to define any 1xRTT specific events. Based on Rel-7, the following events should be considered:

- Inter-RAT event 1: The estimated quality of the serving LTE cell is below a certain threshold and the estimated quality of a 1xRTT cell is above a certain threshold
- Inter-RAT event 2: The estimated quality of a 1xRTT cell is above a certain threshold
- Inter-RAT event 3: The estimated quality of 1xRTT cells is below a certain threshold
- Inter-RAT event 4: Change of best cell in 1xRTT

For measurement configuration of event-triggered measurements, the following main parameters should be available for each Target RAT:

- Threshold: this is the actual threshold used to trigger the event. The actual threshold definition depends on the event being configured.
- Hysteresis: parameter allowing to control ping-pong between cells

Time-to-trigger: time during which the triggering condition must be met for a certain cell in order for the measurement report to be triggered

For single-radio terminals, measurement gaps are needed to allow the UE to switch into the 3GPP2 1xRTT network and do radio measurements. These Measurement gaps are network-controlled. The eNB is responsible for configuring the gap pattern and providing it to the UE through RRC dedicated signaling. Terminals with a dual receiver perform measurements on cdma2000 1X neighbor cells without tuning away from the E-UTRAN network. No DL gap patterns will be required for UEs which are capable of simultaneous reception on the involved frequency bands. No UL gap patterns will be required for UEs which are capable simultaneous transmission in one access and measuring on another access.

The existing inter-frequency / RAT gap pattern mechanism in E-UTRAN shall be extended to also support gap patterns suitable for 1xRTT measurements.

In order to assist the eNB, the UE shall inform the network of its gap-related capabilities. This capability shall be transferred along with other UE capabilities. The UE shall at least indicate if it has a dual receiver. In cases that the measurement gaps are not required, the eNB can configure measurements on cdma2000 1X cells without the need to configure the measurement gaps.

6.3.3.2.3 Active Mode Measurement

In LTE_ACTIVE mode, the UE shall report the 1xRTT neighbor cells' Pilot PN Offsets and pilot strengths of the cells identified in the neighbor list whose pilot strengths are above the threshold. To do this, the UE shall measure the neighboring cdma2000 1X cells' power levels. The UE does not need to decode the synch channel if it has already acquired 3GPP2 1xRTT synchronization. The UE only needs to decode the PN offset of the cdma2000 1X neighbor cells to perform the measurement. The UE shall report the set of Pilot PN Offsets and associated Pilot Strengths in the RRC Measurement Report Message using new IEs for the cdma2000 1X specific information.

6.3.3.3 E-UTRAN to cdma2000 1X Cell Re-selection

Normal Attach / Detach procedures to support mobility between E-UTRAN and 1xRTT.

Cell reselection from E-UTRAN to 1xRTT should be aligned with 3GPP inter RAT cell reselection mechanism. Most features/parameters designed for 3GPP inter RAT idle mode mobility should be applied to idle mode mobility between E-UTRAN and 1xRTT. An instance of the set of parameters defined to support these features should be defined for 1xRTT

In case only a single value of Treselection is defined for 3GPP inter RAT idle mode mobility, it may be necessary to define specific values of Treselection for 1xRTT

Schemes on intelligent camping that may be decided in RAN2 (e.g. offset based or priority based) should be applied to 1xRTT as much as possible.

6.3.3.4 E-UTRAN to cdma2000 1X Handover

Figure 6.3-1 shows the high level procedure for handover from E-UTRAN to cdma2000 1X. Registration and handover is performed directly after the handover decision has been made. Based on measurement reports received from the UE the eNB initiates a handover by sending a 3GPP "Handover from E-UTRAN Command" message to the UE to indicate to the UE that it should begin the handover procedure. This message shall include the specified target type and any 3GPP2 specific 1xRTT access parameters needed by the UE to create the appropriate 1X Origination Request message. (e.g. 3GPP2 1x Parameter used in HRPD to 1xRTT mobility). The 1xRTT access parameters are transparent to E-UTRAN. The set of the required 1xRTT access parameters are to be specified in 3GPP2.

E-UTRAN shall transport the additional 1xRTT parameters to the UE to assist handover to the 1xRTT systems. The 1xRTT parameters are transparent to E-UTRAN. The set of the required 1xRTT parameters are to be specified in 3GPP2

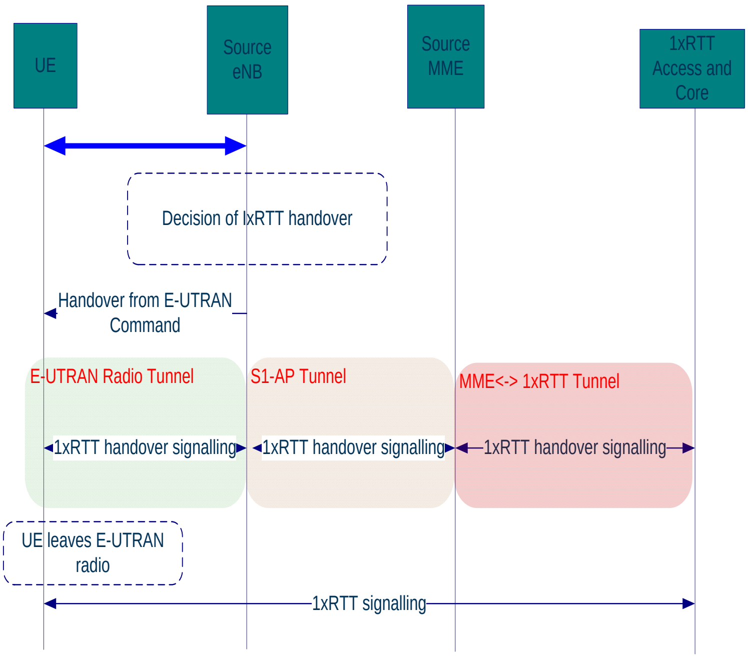

Figure 6.3-1 E-UTRAN to 1xRTT handover

6.3.4 Mobility from cdma2000 1X to E-UTRAN

Mobility from cdma2000 1xRTT to E-UTRAN is supported through idle mode mobility.

No seamless mobility in active mode is specified.

7 Mobility between E-UTRAN and WiMAX Networks

7.1 Introduction

The following high level requirements will be supported:

- It shall be possible for the operator to provide the UE with access network information pertaining to supported WiMAX access technologies. The access network information may also include operator preferences based on available WiMAX access technologies. The information may be restricted to the access technologies, based on the UE's current location and preferences
- The evolved 3GPP system shall support bidirectional service continuity between WiMAX and E-UTRAN.
- The evolved 3GPP system shall support seamless voice service continuity between E-UTRAN and WiMAX in both directions.
- The evolved 3GPP system shall support the above mentioned mobility scenarios for UEs with single radio and dual radio solutions.
- The solution should have minimum impact on deployed WiMAX systems.

7.2 Supported Frequency Band and System Release

The system shall support mobility between E-UTRAN and WiMAX specification of TWG Release 1 [13] and NWG Release 1.0.0.

The system shall support the above mentioned mobility scenarios among all WiMAX frequency bands [13] and E-UTRAN frequency bands.

7.3 Network Architecture and Interfaces

Figure 7.3-1 shows the reference architecture for optimized handovers between mobile WiMAX and 3GPP access. This architecture uses the EPC network elements and reference points which are already specified and does not require any changes on these network elements and reference points. It introduces a new logical function (FAF) and a new reference point (X200) in the EPC architecture, which are used only for supporting optimized handovers between mobile WiMAX and 3GPP accesses. The S301 reference point has the same functionality as the S1-MME and terminates to the MME inside the 3GPP Access.

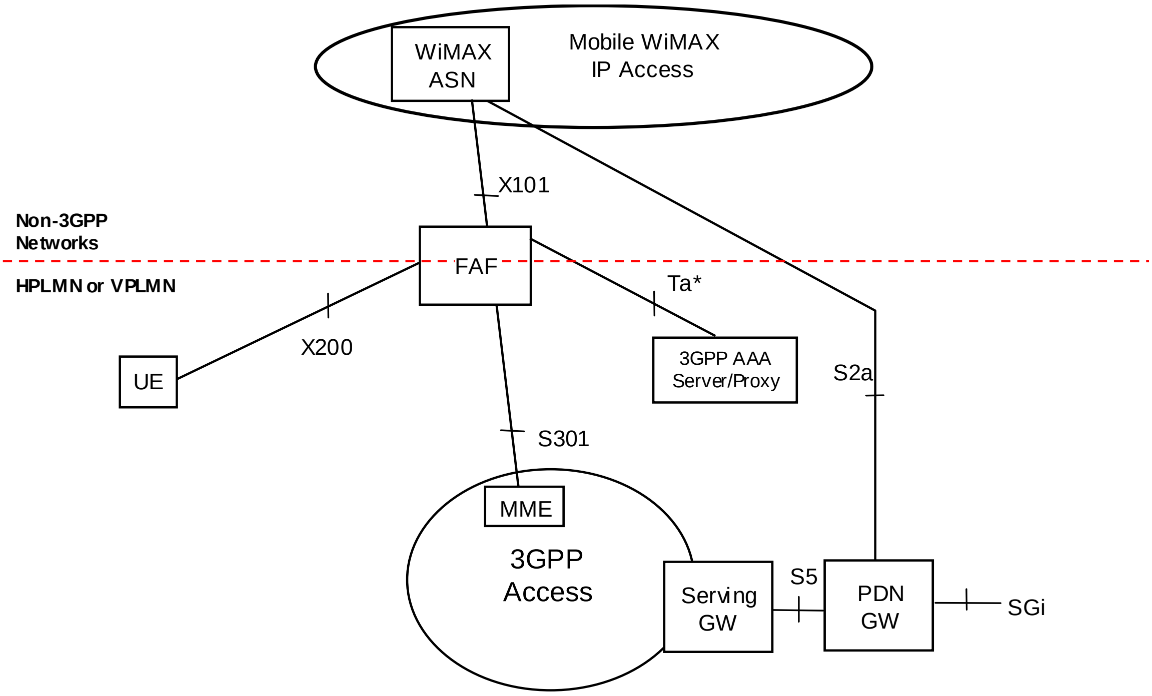

Figure 7.3-1 Architecture for optimized handover between mobile WiMAX and 3GPP access

The reference points illustrated in Figure 7.3-1 are discussed below.

FAF (Forward Attachment Function): The logical function which has interface with target system node using existing protocol. The UE communicates with the FAF over a generic IP access network. The UE may communicate with the FAF through mobile WiMAX IP access in order to prepare handover to a 3GPP access. Similarly, the UE may communicate with the FAF through a 3GPP access in order to prepare handover to mobile WiMAX access.

X200: This reference point supports secure communication between the UE and the FAF through a generic IP access network, e.g. the mobile WiMAX IP access or EPS. It is used for pre-registration and for requesting resource preparation in the target access network.

S301: This reference point has the same functionality as the S1-MME (described in TS 23.401) and terminates to the MME inside the 3GPP Access.

X101: This reference point is outside the scope of 3GPP and can be based on an existing or evolved WiMAX reference point (e.g. R4/R6). It is used for handover from 3GPP access to mobile WiMAX in order to reserve the appropriate resources in the target WiMAX ASN.

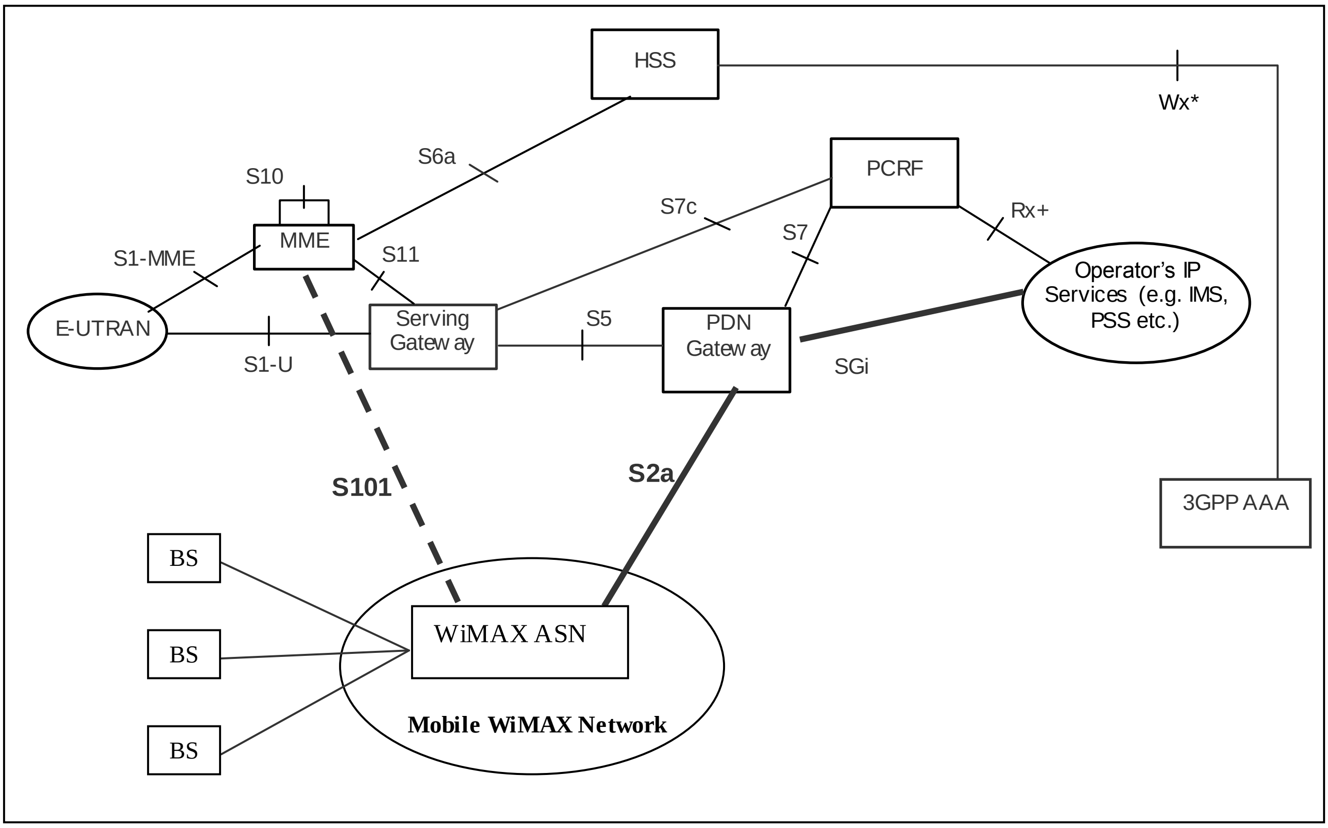

Figure 7.3-2 Architecture for optimized handover between mobile WiMAX and 3GPP using L2 Tunneling

Figure 7.3-2 shows the reference architecture for optimized handovers between mobile WiMAX and 3GPP access using L2 tunneling between MME and WiMAX ASN. This architecture uses the EPC network elements and reference points which are already specified and does not require any changes on these network elements and reference points. All the interfaces and network entities that separate SAE/LTE from WiMAX ASN are defined in [4]. Interface S101 enables interaction between EPS and WiMAX ASN access to allow for handover signalling.

Note: Confirmation of network architecture and interfaces is up to SA2 decision.

7.4 Mobility from E-UTRAN to WiMAX

7.4.1 WiMAX System Information Transmission in E-UTRAN

The following are some of the key information elements that shall be transmitted in E-UTRAN system for WiMAX neighbour cells:

- DL center carrier frequency:
  a. Identifies the DL center carrier frequency of WiMAX neighboring cells.
  b. DL center carrier frequency shall be a multiple of 250 kHz.

- Cell bandwidth:
  a. Identifies the size of cell bandwidth.

- Preamble index:
  a. Identifies the PHY-specific preamble for the WiMAX neighboring BS.

- BS ID:

a. BS (Base Station) ID is a global unique identifier for a WiMAX base station, as defined in the IEEE Std 802.16-2004 and IEEE Std 802.16e-2005 standard. The BS id represents a logical instance of a PHY and MAC function providing 802.16 radio connectivity services to an SS/MS (equivalent to a single frequency sector of a physical base station)

- NAP ID
  a. NAP (Network Access Provider) is a business entity that provides WiMAX radio access infrastructure to one or more WiMAX Network Service Providers (NSPs). A NAP implements this infrastructure using one or more ASNs.
  b. NAP ID is contained in the upper 24 bits of BS ID
- NSP ID
  a. NSP (Network Service Provider) is a business entity that provides IP connectivity and WiMAX services to WiMAX subscribers compliant with the Service Level Agreement it establishes with WiMAX subscribers.
  b. To provide these services, an NSP establishes contractual agreements with one or more NAPs. Additionally, an NSP may also establish roaming agreements with other NSPs and contractual agreements with third-party application providers (e.g. ASP or ISPs) for providing WiMAX services to subscribers.
- MAC Version
  a This information element specifies the MAC version of IEEE 802.16 that is supported by BS.
- System Version:
  a This indicates the Mobile WiMAX release as specified by the WiMAX Forum Mobile Air Interface System Profile.
- Available DL Radio Resources:
  a This indicates the average ratio of non-assigned DL radio resources to the total usable DL radio resources. The average ratio shall be calculated over a time interval defined by the DL_radio_resources_window_size parameter. The reported average ratio will serve as a relative load indicator.
- Available UL Radio Resources:
  a This indicates the average ratio of non-assigned UL radio resources to the total usable UL radio resources. The average ratio shall be calculated over a time interval defined by the UL_radio_resources_window_size parameter. The reported average ratio will serve as a relative load indicator.
- Cell Type
  a This specifies the cell size for hierarchical cell architecture. A lower value of "Cell Type" can represent a smaller value for cell size and a higher value of "Cell Type" can represent larger cell size. Based on the frequency of handovers, decision can be made to move to a larger cell (in case of high handover frequency) or to a smaller cell (in case of low handover frequency).

In addition, other parameter similar to those used in intra-3GPP inter-RAT idle mode mobility can also be sent on the E-UTRAN broadcast channel.

7.4.2 Measuring WiMAX from E-UTRAN

In order to support network controlled mobility, the E-UTRAN system shall support the following WiMAX measurement quantities:

- CINR (Carrier to Interference Noise Ratio)
- RSSI (Receive Signal Strength Indicator)

7.4.2.1 Idle Mode Measurement Control

UE shall be able to make measurements on the WiMAX cells in LTE_IDLE mode to perform cell re-selection. UE shall perform WiMAX neighbor cell measurements during DRX periods, between paging occasions.

To control the idle mode measurements on WiMAX, we can re-use mechanisms for the intra-3GPP inter-RAT idle mode measurement control. The UE performs measurement on WiMAX when the signal quality from E-UTRAN serving cell falls below a given threshold. Additional parameters that control idle mode measurement on WiMAX are,

- LTE-WiMAX signal quality threshold (to start WiMAX measurements):
  The received signal quality threshold value (relative measurement) is used in the E-UTRAN to determine if WiMAX measurements should start.

- LTE-WiMAX Rx power strength threshold (to start WIMAX measurements):
  The received power strength threshold value (absolute measurement) is used in the E-UTRAN to determine if WiMAX measurements should start.

There is no need of different handling of threshold on single RX or dual RX.

The following rules shall be followed in the idle mode measurement on WiMAX system:

- If the measured Signal Quality of the serving cell <= LTE-WiMAX signal quality threshold or the measured Rx Power Strength of the serving cell <=LTE-WiMAX Rx power strength threshold, the UE shall start making WiMAX measurements.

If the measured Signal Quality of the serving cell > LTE-WiMAX signal quality threshold and the measured Rx Power Strength of the serving cell > LTE-WiMAX Rx power strength threshold, the UE may choose not to perform WiMAX measurements.

7.4.2.2 Active Mode Measurement Control

While the UE is attached in the E-UTRAN network, in LTE_Active mode, the UE shall perform radio measurements on the WiMAX network when directed by the E-UTRAN network. The E-UTRAN network provides the required WiMAX neighbor cell list information and measurement controls to the UE. When needed the eNB is responsible for configuring and activating the WiMAX measurements on the UE via the RRC dedicated signaling message with newly defined IEs.

For single-radio UEs, measurement gaps are needed to allow the UE to switch into the WiMAX network and do radio measurements. These measurement gaps are network-controlled. The eNB is responsible for configuring the gap pattern and providing it to the UE through RRC dedicated signaling. UEs with a dual receiver perform measurements on WiMAX neighbor cells without tuning away from the E-UTRAN network.

In order to assist the eNB, the UE shall inform the network of its gap-related capabilities. This capability shall be transferred along with other UE capabilities. The UE shall at least indicate if it has a dual receiver. In cases that the measurement gaps are not required, the eNB can configure measurements on WiMAX cells without the need to configure the measurement gaps. No DL gap patterns will be required for UEs which are capable of simultaneous reception on the involved frequency bands. No UL gap patterns will be required for UEs which are capable simultaneous transmission in one access and measuring on another access.

7.4.2.3 Active Mode Measurement Control and Reporting

In LTE_ACTIVE mode, the UE measures the RSSI and(or) CINR values of neighboring WiMAX cells. The UE identifies the neighboring WiMAX cells and reports their RSSI and(or) CINR values when they exceed a certain threshold and can be considered as handover candidates. This is done using a RRC Measurement Report Message. Both periodic and event based inter-RAT measurement reporting can be configured. The existing measurement reporting framework should be utilized wherever possible. The following are some of the events that may trigger inter-RAT measurement reports:

- Event 3a: The estimated quality of the serving system is below a certain threshold and the estimated quality of the target system is above a certain threshold

- Event 3b: The estimated quality of target system is below a certain threshold

- Event 3c: The estimated quality of target system is above a certain threshold

- Event 3d: Change of best cell in target system

To limit the amount of event-based measurement reports, a hysteresis parameter and time to trigger parameter may be used with each measurement reporting event.

For configurations for measurement reports, the following main parameters should be available for the WiMAX:
- Threshold: the actual threshold used to trigger the measurement reporting event.
- Period: the period for periodical measurement reports.
- Hysteresis: parameter allowing to control ping-pong between cells
- Time to trigger: time during which the triggering condition must be met for a certain cell in order for the measurement report to be triggered.

For measurement report on WiMAX system, the following information shall be included:
- Preamble index: preamble index for the reported WiMAX BS
- Measured result on preamble index: measured CINR/RSSI
- BS id: a global unique id for the reported WiMAX BS

7.4.3 E-UTRAN to WiMAX Cell Re-selection

Figure 7.4-1 is the signalling flow for cell reselection from E-UTRAN to WiMAX. The UE will initiate WiMAX specific attach procedure after leaving E-UTRAN radio.

Cell reselection mechanism for the intra-3GPP inter-RAT [16] can be used for E-UTRAN to WiMAX cell reselection with the following extensions:
- Criteria X and reselection timer for WiMAX will be defined in stage 3
    - Criteria X: Minimum radio condition for cell reselection to WiMAX to be met to get a reasonable service
    - Reselection timer: Duration that the radio condition to trigger cell reselection to a WiMAX cell should be applicable before performing cell reselection
- CINR/RSSI will be used as cell reselection measurement quantity for WiMAX

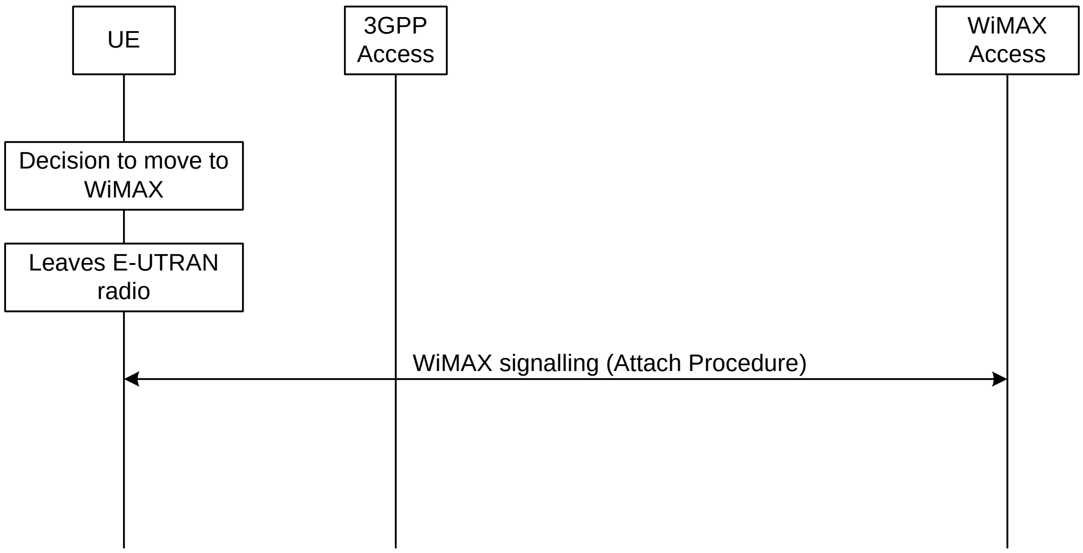

Figure 7.4-1 E-UTRAN to WiMAX cell reselection

7.4.4 E-UTRAN to WiMAX Handover

7.4.4.1 Pre-registration to the WiMAX

Pre-registration lets the UE pre-register/attach to the WiMAX system in advance of a handover. It reduces the time involved in the process of handover. It also reduces the risk of the UE experiencing a radio link failure while waiting a completion of handover preparation in the WiMAX. E-UTRAN network can instruct the UE whether the pre-registration is needed by the dedicated RRC message, e.g. RRC CONNECTION RECONFIGURATION. This makes it possible to avoid pre-registration attempts in areas with no WiMAX coverage or no support for WiMAX pre-registration.

The need for pre-registration is configured in the network in the following way:

- Information sent in the dedicated RRC signalling, e.g. RRC CONNECTION RECONFIGURATION, indicates whether pre-registration for UEs in LTE_ACTIVE is allowed:
  - If the indication is positive, the UE shall perform pre-registration if the UE does not have a valid/current WiMAX pre-registration.
  - If the indication is negative, the UE shall not perform pre-registration.

Figure 7.4-2 shows the pre-registration procedure from the E-UTRAN to the WiMAX. As part of handover preparation the UE registers with the target WiMAX network and passes any essential context to the target network as well. The UE does WiMAX registration and subsequent authentication while attached to the SAE network. The context transfer can include elements such as target WiMAX BS information, UE MAC context and PMIP context. The E-UTRAN network is agnostic to the handover preparation procedure and does not need to know whether a particular UE is pre-registered with WiMAX network or not.

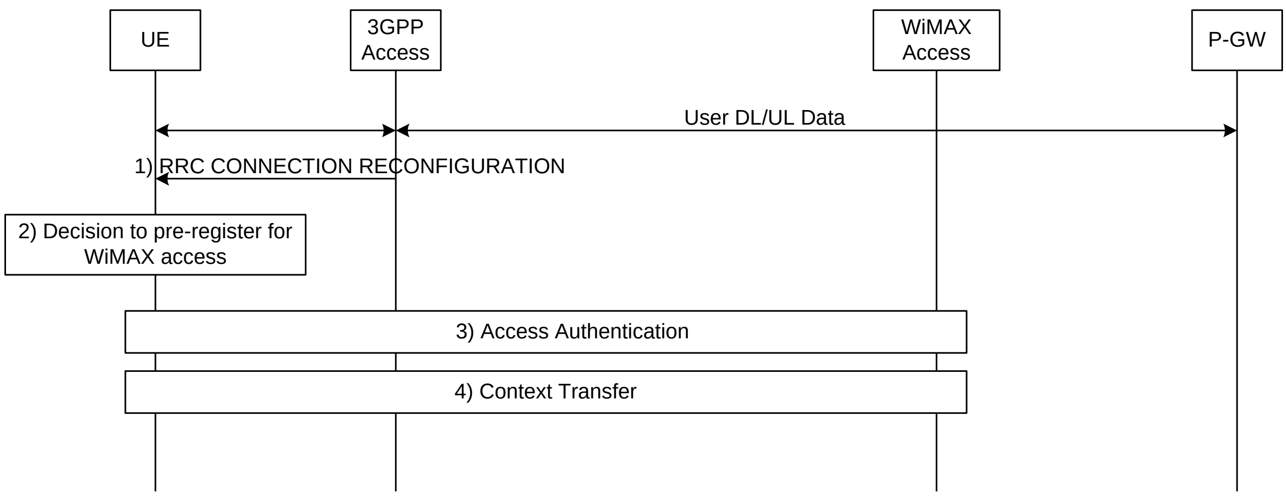

Figure 7.4-2 Pre-registration to the WiMAX

1) The E-UTRAN network instructs the UE to perform pre-registration to the WiMAX access by RRC CONNETION RECONFIGURATION.

2) If the UE does not have a valid/current WiMAX pre-registration, the UE shall initiate pre-registration procedure.

3) The UE performs access authentication and authorization for the WiMAX access by tunneling authentication message (e.g. EAP messages).

Note 1: In the Figure 7.4-2, we will attempt to align messages above as much as possible to the outcome on the intra 3GPP stage-3 details.
Note 2: Pre-registration messages can be sent either using L2 or L3 tunneling. In case of L2 tunneling these messages are sent between UE and source eNB as RRC messages. The source eNB forwards these messages to the MME and the MME sends these messages to the WiMAX ASN-GW as IP payload. Thus a bi-directional L2 tunnel for message

exchange is established between the UE and WiMAX ASN-GW using the SAE network. Detailed transport mechanism from the source system to the target system is upto SA2 decision.

7.4.4.2 E-UTRAN to WiMAX Handover

Figure 7.4-3 shows the optimized handover procedure from the E-UTRAN to the WiMAX. The pre-condition for the procedure is that the UE is attached in the WiMAX through pre-registeration. The UE initiates handover procedure while it is still attached to the E-UTRAN network and after it has done handover preparation in the target WiMAX network by setting up a bi-diectional tunnel with WiMAX ASN and passing any necessary handover context as part of the handover preparation procedure. Thereafter based on the measurement reports and network selection criteria the E-UTRAN network would indicate to the UE to initiate the handover procedure to switch over to the target WiMAX network. This message could include target WiMAX network information and any other specific parameters required by UE to conduct the handover procedure. The UE would then initiate WiMAX specific handover signaling to prepare the target network while continuing to maintain the current connections and send and receive data over the E-UTRAN radio. The WiMAX handover signalling is transparent to E-UTRAN. The E_UTRAN network may receive the status of ongoing handover operation. Once the target preparation is complete the UE would receive the Handover Preparation Complete indication from WiMAX ASN over the tunnel. This would then be an indication to turn off the E-UTRAN radio and switch over to WiMAX radio. Once the initial WiMAX radio entry is completed, the UE would conduct WiMAX specific handover execution and begin receiving data packets over the WiMAX network.

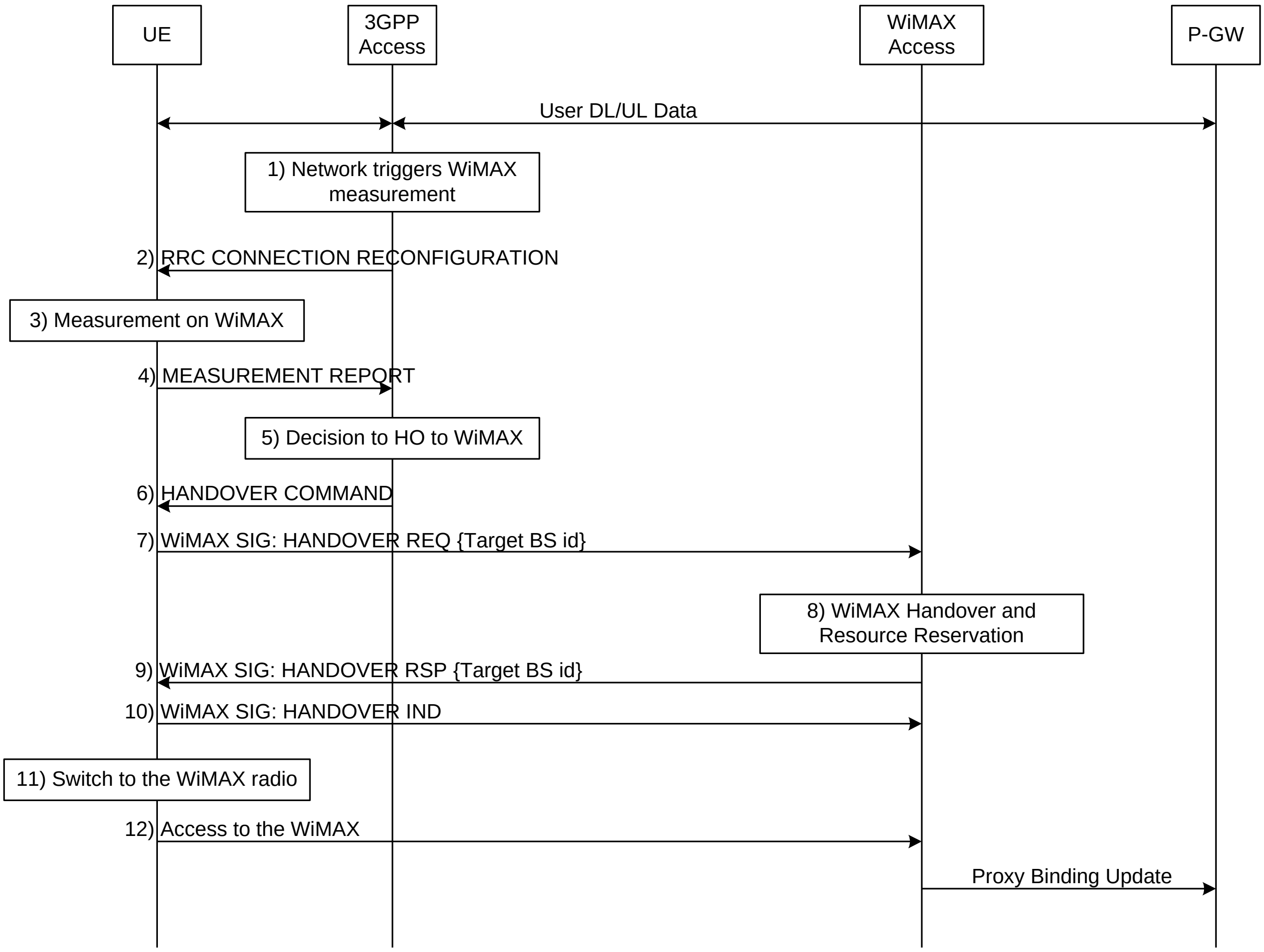

Figure 7.4-3 Optimized E-UTRAN to WiMAX Handover

1) Based on the MEASUREMENT REPORT received from the UE, E-UTRAN may trigger the UE to perform WiMAX measurements. Measurement gap and measurement reporting parameters are configured for the UE. Need of the measurement gap would be dependent on the UE capability. No DL gap pattern will be required for UEs which are capable of simultaneous reception on the involved frequency bands.

2) Configurations for WiMAX measurements and measurement reports are sent by RRC CONNECTION RECONFIGURATION.

3) The UE performs measurement on the WiMAX based on the received WiMAX measurement configuration.

4) The UE sends MEASUREMENT REPORT based on the received WiMAX measurement reporting configuration.

5) Based on the MEASUREMENT REPORT received from the UE, E-UTRAN may decide handover to the WiMAX for the UE. E-UTRAN may also decide handover based on RRM information.

6) E-UTRAN instructs the UE to initiate handover to the WiMAX by HANDOVER COMMAND. E-UTRAN can inform whether optimized handover is supported or not. If optimized handover is supported, 7) – 12) will be followed. If optimized handover is not supported, after the reception of the HANDOVER COMMAND, the UE will leave the 3GPP radio access, switch to the WiMAX radio access, and perform WiMAX specific handover procedure.

7) The UE initiates the handover to the WiMAX by tunnelling a WiMAX HANDOVER REQ message including the target WiMAX BS id.

8) Resources are reserved in the target WiMAX. Also, early path switching can be performed.

9) The WiMAX sends a WiMAX HANDOVER RSP message including the target WiMAX BS id.

10) The UE notifies the WiMAX that it starts handover to the indicated WiMAX BS by tunnelling a WiMAX HANDOVER IND message.

11) The UE leaves the 3GPP radio access and switches to the WiMAX radio access.

12) The UE performs the WiMAX specific access procedure. If early path switching was not used in 8), path switching can be initiated.

Note 1: In the Figure 7.4-3, we will attempt to align messages above as much as possible to the outcome of the intra 3GPP stage-3 details.
Note 2: Handover from 3GPP Radio Access System may be initiated from a non 3GPP Radio access node (e.g. FAF)"
Note 3: Handover preparation and execution messages can be sent either using L2 or L3 tunneling. In case of L2 tunneling these messages are sent between UE and source eNB as RRC messages. The source eNB forwards these messages to the MME and the MME sends these messages to the WiMAX ASN-GW as IP payload. Thus a bi-directional L2 tunnel for message exchange is established between the UE and WiMAX ASN-GW using the SAE network. E-UTRAN network may receive the status of ongoing handover operation. Detailed transport mechanism from the source system to the target system is up to SA2 decision.

7.5 Mobility from WiMAX to E-UTRAN

7.5.1 WiMAX to E-UTRAN Cell Re-selection

Figure 7.5-1 is the signalling flow for cell reselection from WiMAX to E-UTRAN. The UE will initiate attach procedure to E-UTRAN after leaving WiMAX radio.

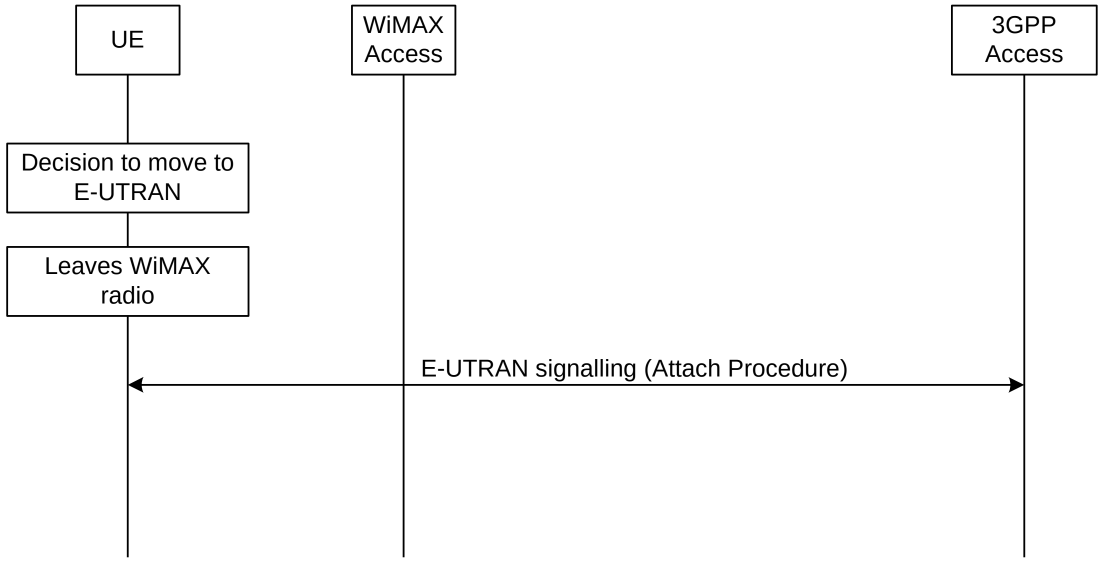

Figure 7.5-1 WiMAX to E-UTRAN cell reselection

7.5.2 WiMAX to E-UTRAN Handover

7.5.2.1 Pre-registration to the E-UTRAN

Pre-registration lets the UE pre-register/attach to the E-UTRAN system in advance of a handover.

Figure 7.5-2 shows the pre-registration procedure from the WiMAX to the E-UTRAN.

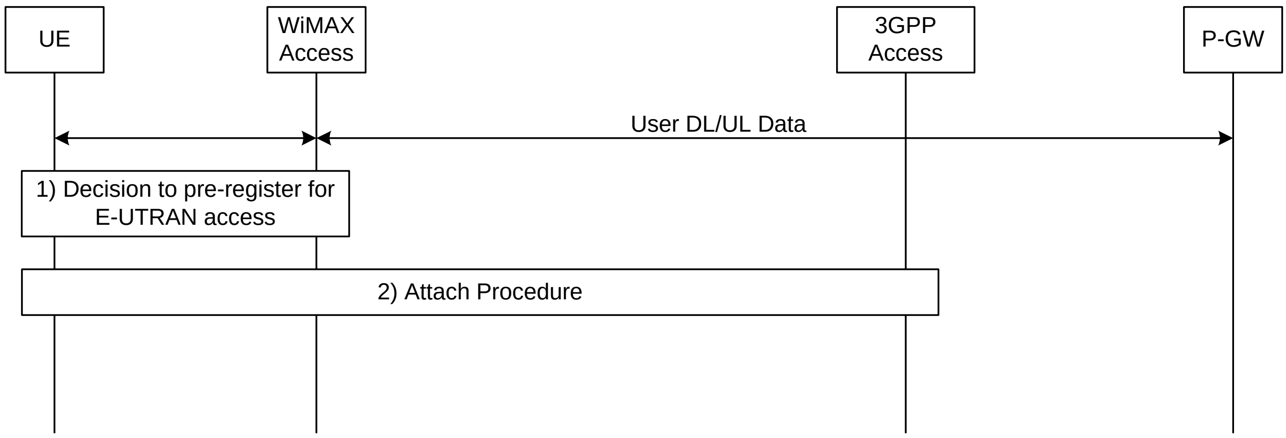

Figure 7.5-2 Pre-registration to the E-UTRAN

1) The UE or the WiMAX decides to initiate pre-registration for the WiMAX access.

2) The UE performs attach procedure for the LTE access by tunnelling ATTACH REQUEST message.

Note1: Figure 7.5-2, we will attempt to align messages above as much as possible to the outcome of the intra-3GPP stage-3 details.
Note2: Detaild transport mechanism from the source system to the target system is up to SA2 decision.

7.5.2.2 WiMAX to E-UTRAN Handover

Figure 7.5-3 shows the optimized handover procedure from WiMAX to the E-UTRAN. The pre-condition for the procedure is that the UE is attached in the E-UTRAN through pre-registeration.

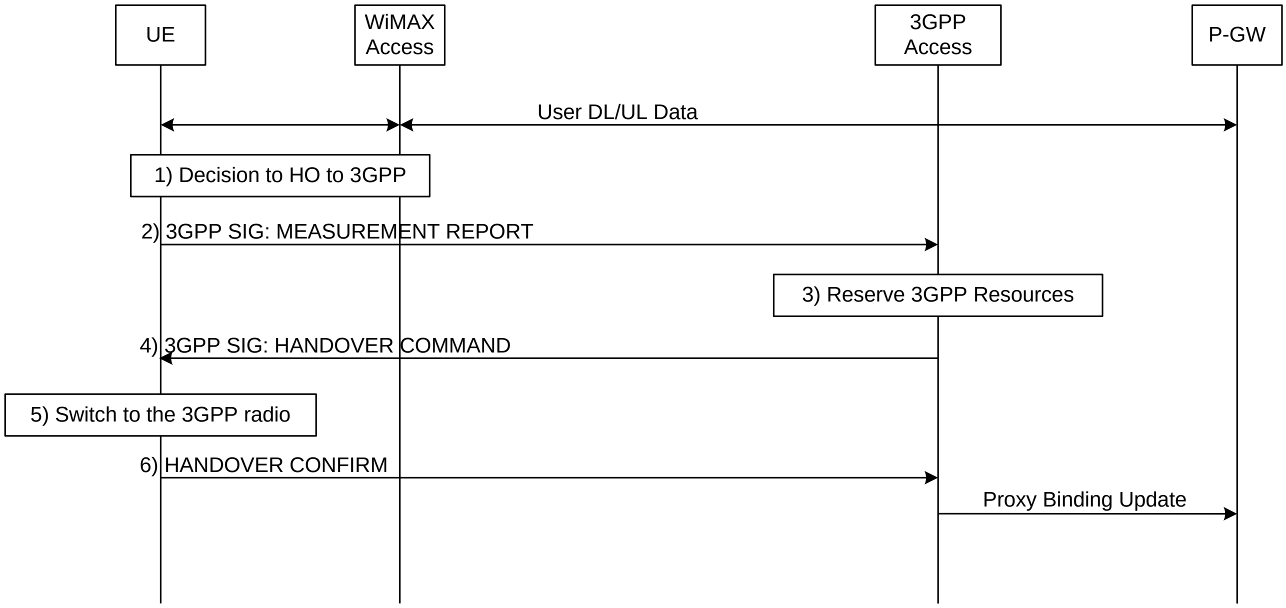

Figure 7.5-3 Optimized WiMAX to E-UTRAN Handover

1) Handover would be decided either by the UE or by the network.

2) The UE initiates the handover to the E-UTRAN by tunnelling MEASUREMENT REPORT including measurement results on the E-UTRAN.

3) Resources are reserved in the target E-UTRAN.

4) The E-UTRAN sends HANDOVER COMMAND to the UE.

5) The UE leaves the WiMAX radio access and switches to the E-UTRAN radio access.

6) The UE performs the access procedure and sends HANDOVER CONFIRM.

Note 1: In the Figure 7.5-3, we will attempt to align messages above as much as possible to the outcome of the intra 3GPP stage-3 details.
Note 2: Handover preparation and execution messages can be sent either using L2 or L3 tunnelling. In case of L2 tunneling these messages are sent between WiMAX ASN GW and MME as IP payload. The MME forwards these messages to eNB and then these messages are exchanged between eNB and Ue as RRC messages. Thus a bi-directional L2 tunnel for message exchange is established between the UE and 3GPP access using the WiMAX network. Detailed transport mechanism from the source system to the target system is upto SA2 decision.

8 Conclusions and Recommendations

8.1 Conclusions

During the study it was decided to minimize impacts on the legacy cdma2000 system and to reduce dependencies between the E-UTRA system and the legacy cdma2000 system. It was decided to:

- Re-use the cdma2000 interwork between HRPD and 1XRTT, e.g. supporting S101 [4] interface similar to A21 to exchange messages between E-UTRAN and cdma2000 system
- Use RRC and S1AP tunnelling to transport cdma2000 messages over E-UTRAN
- Use RRC command to trigger UE to initiate handover preparation at target network via tunnelling
- Support network control of mobility
- Support single- and dual-radio UEs, including single-transmitter dual-receiver configuration

The cdma2000 inter-working solution is based on multiple E-UTRA mechanisms, e.g. broadcast, measurement control, cell reselection and UE capability handling. Where these are not decided yet, the study proposes to keep alignment with the final E-UTRA decisions.

It is confirmed that the eight objectives of the Work Item Description and the requirements in section 5 are fulfilled for cdma2000 interworking with E-UTRA.

For mobility between E-UTRAN and WiMAX, studies were made on network architecture and interfaces, WiMAX system information in E-UTRAN, measurement control for RRC_IDLE and RRC_Connected UEs, cell reselection, and handover. Key solutions agreed and captured in this TR comprise:

- TWG release 1 [13] and NWG release 1.0.0 as a target WiMAX release
- Architecture and interfaces with FAF, X200, S301, and X101
- Definition of WiMAX system information
- CINR and RSSI as WiMAX measurement quantities
- Threshold based on LTE_IDLE mode measurement control
- Network controlled measurement gap creation for LTE_ACTIVE UEs
- Use of periodic measurement reports and events-triggered measurement reports to report preamble index, measured result on preamble index and BS id
- Priority based cell reselection to WiMAX
- Handover procedure with pre-registration and handover preparation by UE tunneling of corresponding WiMAX messages to the WiMAX while the UE is in E-UTRAN

Many solutions are derived from the existing intra-3GPP inter-RAT mobility mechanisms and they will be aligned to the outcome of the intra-3GPP stage-3 details as much as possible. Transport mechanism and termination/origination points between E-UTRAN and WiMAX outside of the 3GPP RAN are regarded as a matter for SA2 decision.

In summary, significant progress has been made to resolve issues and to meet the requirements for the mobility between E-UTRAN and mobile WiMAX radio technologies.

1.1 Recommendations

Based on the analysis in this TR., it was found feasible to support CDMA2000 and E-UTRAN interworking and a stage-2 level solution for this interworking has been described. Therefore it is proposed to close the study item on CDMA2000 and E-UTRAN interworking.

Based on the analysis in this TR., it was found feasible to support WiMAX and E-UTRAN interworking and a stage-2 level solution for this interworking has been described. Therefore it is proposed to close the study item on WiMAX and E-UTRAN interworking.

Annex A: Void

Annex B: WiMAX Architecture and Interface (Informative)

The WiMAX Forum (http://www.wimaxforum.org) specifies an end-to-end system architecture, comprising of three major functional aggregations: Mobile Station (MS), Access Service Network (ASN) and Connectivity Service Network (CSN). The figure below depicts the end-to-end Network Reference Model (NRM).

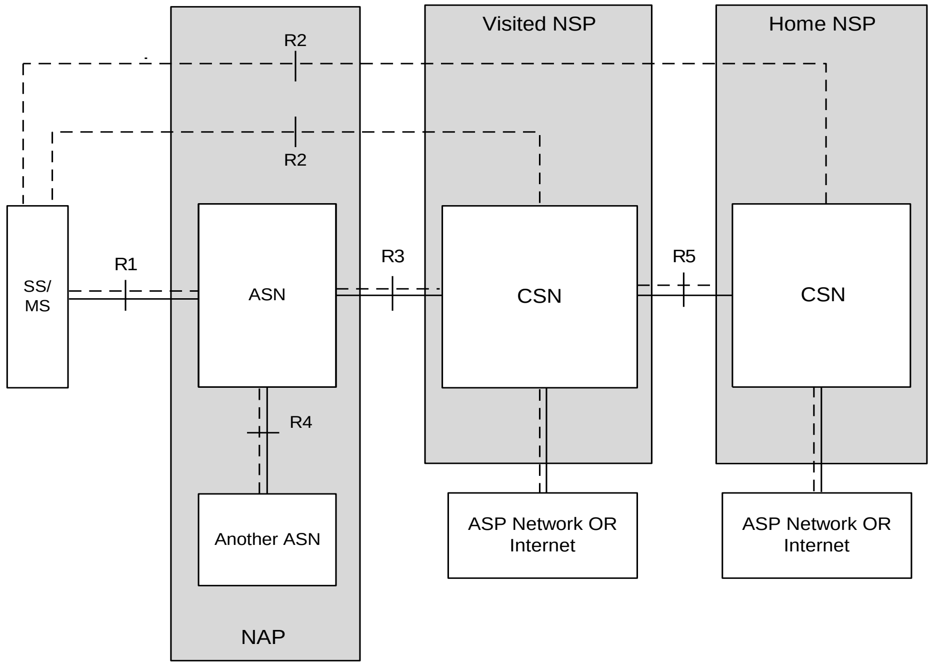

Figure B-1: WiMAX Network Reference Model

The ASN is a collection of functions described as Base Station and ASN Gateway (ASN-GW), which can be rendered in one or more ASN configurations. The CSN comprises network elements such as, user databases, AAA proxy/servers and MIP HA.

Network Access Provider (NAP): NAP is a business entity that provides WIMAX radio access infrastructure to one or more WiMAX Network Service Providers (NSP). A NAP implements this infrastructure using one or more ASNs. A MS detects available NAPs by scanning and decoding DL-MAP (downlink map) of ASN(s) on detected channel. The most significant 24 bits of the "Base Station ID" represent the NAP identifier. NAP discovery is based on procedures defined in IEEE 802.16 specification [15].

Network Service Provider (NSP): NSP is a business entity that provides IP connectivity and WiMAX services to WiMAX subscribers compliant with the service agreements established with WiMAX subscribers. The NSP establishes contractual agreements with one or more NAPs. In addition to NAP ID a list of one or more NSP identifiers is required to completely identify the network and provide adequate information to the UE to make network selection decision.

Reference Point R3: This consists of a set of control plane protocols between the ASN and CSN to support AAA policy enforcement and mobility management capabilities. This also encompasses the bearer plane methods to transfer data between ASN and CSN.

Reference Point R4: Reference Point R4 consists of set of Control and Bearer plane protocols that co-ordinate UE mobility between ASNs. R4 reference point encompasses the following functionality:

- Handover Control and Anchoring: These functions control overall handover decision making and signalling procedures related to handovers.
- Context Transfer: These functions help with the transfer of any state information between network elements.
- Bearer Path setup: These functions manage the data path setup and include procedures for data packet transmission between functional entities.

(Please refer to http://www.wimaxforum.org/technology/documents for the latest specification and definition of these entities in more detail)

The Mobile WiMAX air interface as specified in [13] is based on OFDMA and TDD. For the study of mobility between E-UTRAN and WiMAX networks an exemplary reference Mobile WiMAX system can be considered with the physical layers parameters as specified in table B-1. This reference design does not preclude other physical layer configurations to be considered in the study.

Table B-1: Reference physical layer parameters

Parameter	Value	Description
Duplexing mode	TDD	
Frame length	5ms	
Bandwidth	10 MHz	
FFT length	1024	
Sampling frequency	11.2 MHz	
Subcarrier spacing	10.9375 kHz	Sampling frequency / FFT length
CP length	1/8	
OFDMA symbol duration without CP	91.43 µs	1/Subcarrier spacing
OFDMA symbol duration with CP	102.86 µs	
Number of OFDMA symbols in frame	47	
Number of OFDMA symbols in DL	N=29	-
Number of OFDMA symbols in UL	M=18	
Physical slot (PS)	0.3571 µs	Basic time allocation unit 4/Sampling frequency
TTG	296 PS = 105.7 µs	
RTG	168 PS = 59.99 µs	
DL subcarrier allocation	PUSC	
UL subcarrier allocation	PUSC	

The TDD radio frame structure is illustrated in Figure B-2. Each radio frame is divided into DL and UL subframes separated by Transmit/receive Transition and Receive/transmit Transition Gaps (TTG and RTG resp.) to ensure that the transceiver at the base station has the time to switch between receive and transmit. The DL subframe consists of N OFDMA symbols and the UL subframe consists of M OFDMA symbols with values N, M as specified in table B-1.

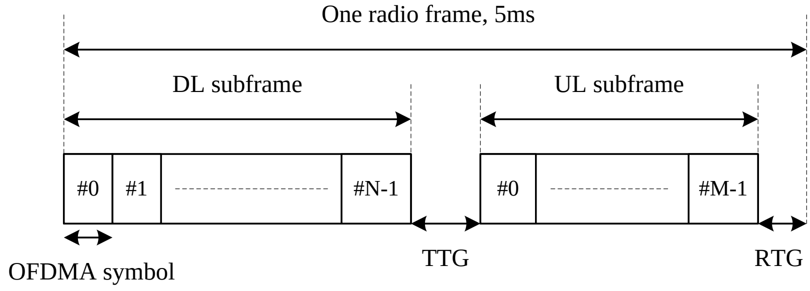

Figure B-2: Frame structure

Annex C: Issues for Further Study

1. Redirection from E-UTRAN to CDMA2000 when UE is in the transition from idle to active mode;

   When RAN2 has defined a scheme for redirection from E-UTRAN to other RATs, it will be evaluated whether such scheme should be applicable to CDMA HRPD as well.

   If RAN2 does not define such a scheme, it will be evaluated whether a scheme allowing redirection to cdma2000 can be designed.

2. Transmission of the address of Forward Attachment Function (FAF) in E-UTRAN for the optimized E-UTRAN – WiMAX handover.

Annex D: Change History

Change history							
Date	**TSG#**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2007-06	RAN2#58-bis	R2-072830			Proposed Skeleton for RAN2#58-bis		0.0.0
2007-08	RAN2#59	R2-073453			With adopted texts of R2-072851 and R2-072928 and changes approved in RAN2#58-bis	0.0.0	0.1.0
2007-8	RAN2#59	R2-073854				0.1.0	0.2.0
2007-8	RAN2#59	R2-073869				0.2.0	0.3.0
2007-10	RAN2#59bis	R2-074656				0.3.0	0.4.0
2007-11	RAN2#60	R2-07xxxx				0.4.0	1.0.0
2007-12	RAN #38	RP-070921			TR 36.938 v1.0.0	1.0.0	8.0.0
2009-12	RP-46	-	-		Upgrade to the Release 9 - no technical change	8.0.0	9.0.0